X-6326

MAINTENANCE MANUAL

GM
GENERAL MOTORS CORPORATION
COACHES

COACH MODELS

SDH-SDM
4502, 5302
TDH-TDM
4518, 4519, 5303, 5304

GMC TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
Pontiac, Michigan

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INDEX

INTRODUCTION

This manual contains complete service, maintenance, and repair information on GM Suburban and Transit Coaches. Information in this manual pertains to standard equipment and the most commonly used special equipment.

Operation of the vehicle from the standpoint of the driver is contained in a separate Operating Manual. For information on the Diesel Engine, refer to the current Diesel Engine Maintenance Manual. For information on the Hydraulic Drive Transmission, refer to the current Hydraulic Drive Maintenance Manual.

Every effort has been made to include timely and adequate information on the various units and systems used on these coaches. The maintenance and repair procedures in the various manual sections are the result of extensive service experience. This information should serve not only as a reference for the experienced mechanical force, but also as a comprehensive text for training purposes.

All information contained in this manual is based on the latest product information available at the time of publication approval. GMC Truck and Coach Division reserves the right to make product changes at any time.

GENERAL INFORMATION ABOUT THIS MANUAL

MANUAL ARRANGEMENT

This manual is divided into major sections in the sequence shown on the margin of the title page. A black tab bearing the major section number is placed on the first page of each major section which indexes with the tab on the title page. Many of the major sections are divided into sub-sections, each sub-section containing important and specific information on related units or components. When a major section is divided into sub-sections, a section index appears on the first page of the major section.

PAGE AND ILLUSTRATION NUMBERS

The manual pages are numbered consecutively throughout the manual. Illustrations are numbered consecutively within each section, or within each sub-section when the major section is so divided.

SPECIFICATIONS

Service data, fits, and tolerances are listed at the end of most sections or sub-sections under the heading "Specifications." Manufacturers model or part numbers are used in many instances in the "Specifications" tabulation. These numbers are provided primarily for unit identification and should be referred to when ordering parts. All detail service part numbers must be obtained from the applicable Parts Book.

SPECIAL TOOLS

Special tools and equipment are mentioned, and in many instances illustrated, throughout the text. These tools are specially designed to accomplish certain operations efficiently and readily. Such tools are identified in the text by tool vendor's numbers. These tools are not offered for sale by GMC Truck and Coach Division. Information regarding availability of these tools can be obtained from your GM Coach Service Representative or from the Factory.

SERVICE BULLETINS

Service bulletins are issued, when required, supplementing or in some cases superseding information in this manual. Information in these bulletins should be noted in the text and the bulletin filed for ready reference.

ALPHABETICAL INDEX

Important subjects, with manual page number references, are alphabetically listed at the end of this manual.

GENERAL DATA

The data listed below covers only general information on Coaches covered by this manual. For specific data and specifications on any unit or system, refer to "Specifications" at end of each manual section.

MODEL DATA

	SDH-4502 SDM-4502	TDH-4518 TDM-4518	TDH-4519 TDM-4519	TDH-5303 TDM-5303	SDH-5302 SDM-5302	TDH-5304 TDM-5304
Length (Maximum)	35′	35′	35′	40′	40′	40′
Width (Maximum)	95¾″	101¾″	95¾″	101¾″	95¾″	95¾″
Height (Maximum)	117$\frac{53}{64}$″	118″	118″	118″	118″	118″
Track						
Front	79¼″	85¼″	79¼″	85¼″	79¼″	79¼″
Rear (Center of Dual Tires)	70½″	76½″	70½″	76½″	70½″	70½″
Turning Radius						
Wheel (Right and Left)	31′ 2″	32′ 4″	32′ 2″	37′ 3″	36′ 4″	37′ 1″
Body Corner (Right and Left)	36′ 1″	37′ 3″	37′ 1″	42′ 3″	41′ 4″	42′ 1″
Wheelbase	235″	235″	235″	284¾″	284¾″	284¾″
Tire Size (Single Front-Dual Rear)	11.00/20	11.00/20	11.00/20	11.00/20	11.00/20	11.00/20

SERIAL NUMBER LOCATIONS

Delay and confusion can be avoided when correct serial numbers of vehicle and engine are placed on parts orders and correspondence. Locations of these serial numbers are illustrated below.

PLATE ON DASH COMPARTMENT DOOR

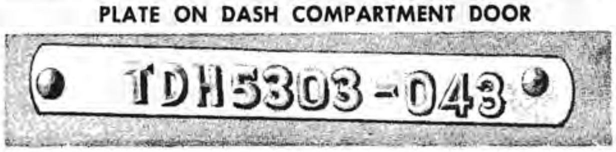
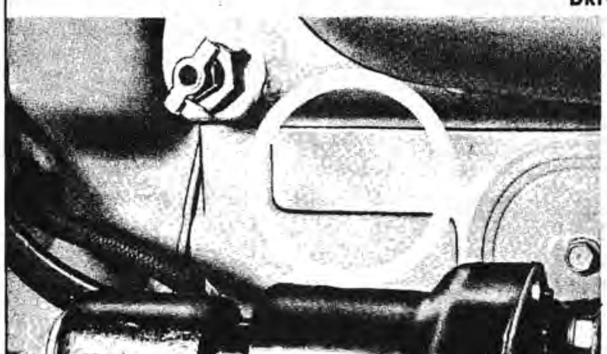


PLATE ON TRIM PANEL BELOW DRIVER'S WINDOW



6-CYLINDER ENGINE—RIGHT SIDE OF CYLINDER BLOCK ABOVE STARTER

8-CYLINDER ENGINE—RIGHT SIDE OF CYLINDER BLOCK AT CENTER

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Front Axle

This group is divided into two sections covering "FRONT END ALIGNMENT" and "FRONT AXLE REPAIR."

1

Front End Alignment

Proper front end alignment must be maintained to insure ease of steering and satisfactory tire life.

Front end alignment inspections generally fall into two groups: (1) regular service inspections performed at periodic intervals, and (2) inspections to determine extent of damage after a collision or severe service.

Regular service inspections are primarily concerned with toe-in, camber, and caster; with proper equipment these specifications are easily checked. Any variation from these specifications will indicate: (1) need for adjustments, or (2) more thorough inspection to determine if any steering or front axle parts are bent and require replacement.

Complete front end alignment data is given under "Specifications" at end of this section.

DEFINITION OF TERMS

WHEEL TOE-IN. Distance front wheels are closer together at front than at rear of axle (see "G" and "H," fig. 1).

WHEEL CAMBER. Amount wheels are inclined from vertical plane (see "C," fig. 1).

FRONT AXLE CASTER. Inclination of king pin from the vertical in the fore and aft direction of the vehicle (see "X," fig. 1).

KING PIN INCLINATION. The slant of the king pin toward the center of the vehicle at the top and outward at the bottom (see "D," fig. 1).

STEERING GEOMETRY. The design of the front end which causes the front wheels to stay in proper relative alignment when the wheels are turned to right or left.

FRONT END INSPECTION

Before checking front end alignment the following front end inspection should always be made:

1. Check tires for proper inflation.
2. Check wheel installation and run-out.
3. Check wheel bearing adjustment.
4. Check tie rod and drag link ends for looseness.
5. Check king pins for looseness.

Front end alignment requires the vehicle to be level while being checked. Full weight must be on wheels with vehicle empty.

ALIGNMENT

FRONT WHEEL TOE-IN

Toe-in may be measured from centers of tire tread or from inside of tires or rims. Measurements at both front and rear of axle (see "H" and "G," fig. 1) must be made at same height from floor.

If measurement is to be made from centers of tire treads, first hoist front of vehicle and spin wheels to obtain a center line on tire treads.

Place wheels in straight-ahead position.

Roll the vehicle straight ahead for several feet to where the inspection is to be made. This will remove any slack caused by looseness in the wheel bearings or steering connections.

Measure at point "H" and "G" (fig. 1). Toe-in is "G" minus "H."

Some toe-in gauges are designed for measuring between the front wheels on the rim or on the tire. If such a gauge is used, measure first at "H." Mark point on tire or rim at which measurement is taken. Roll vehicle forward until mark on tire or rim is at same height at rear as it was at front, then measure "G." Never allow vehicle to roll backwards while checking toe-in.

Incorrect toe-in results in excessive tire wear caused by side slippage. Unstable steering with a tendency to wander may also result.

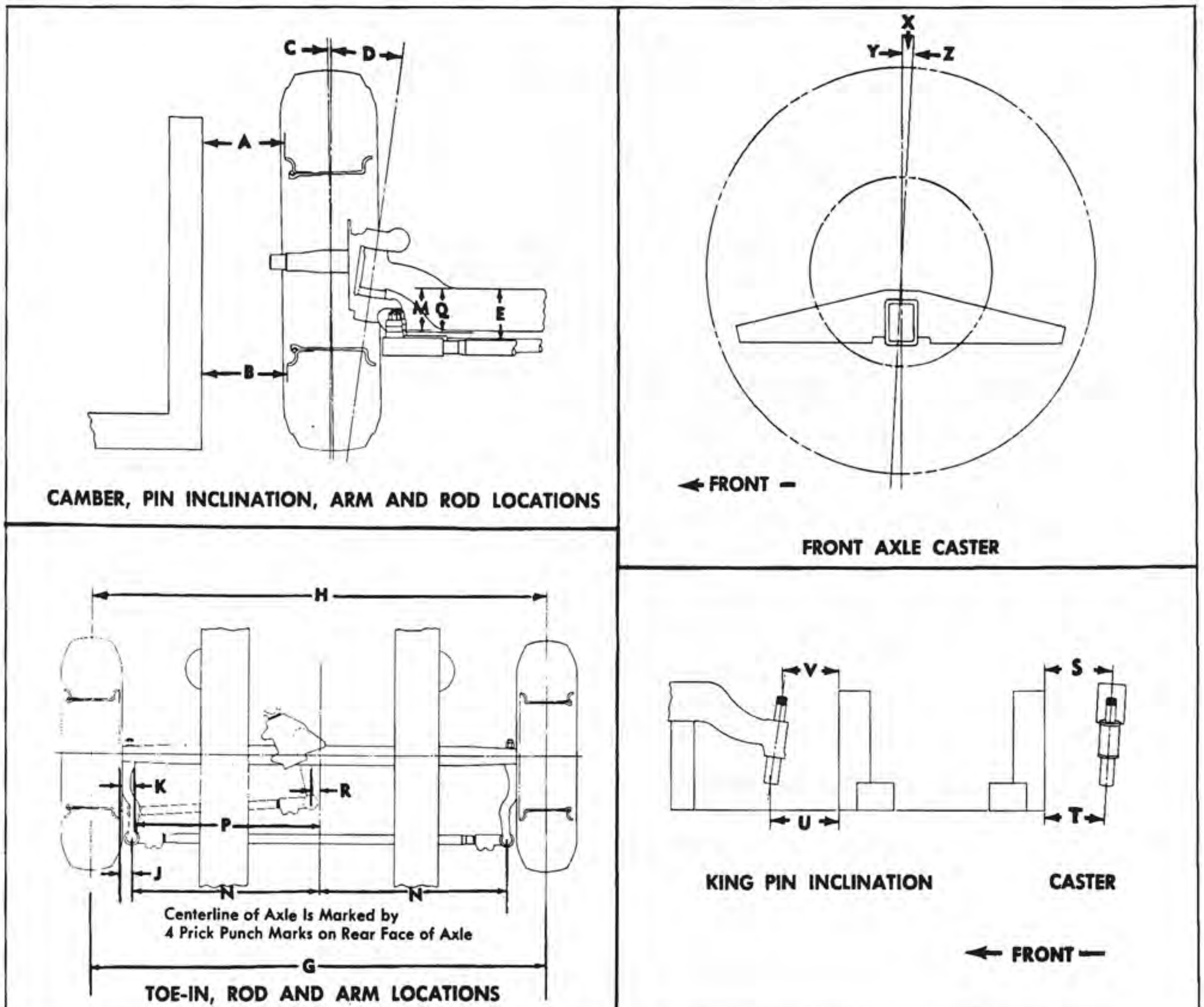
TOE-IN ADJUSTMENT

1. Loosen clamp bolts which retain each tie rod end on tie rod.
2. Using a pipe wrench, turn tie rod tube as required to obtain correct toe-in measurement.
3. After correct adjustment is obtained, make certain that both tie rod ends are in the same plane; then tighten all clamp bolts firmly.
4. Recheck toe-in to make sure adjustment was not changed when clamp bolts were tightened.

FRONT WHEEL CAMBER

Positive Camber is outward inclination of wheels at top. Negative or Reverse Camber is inward inclination of wheels at top. These vehicles are designed with positive camber. Camber variations may be caused by wear at wheel bearings and steeringing knuckle bushings, or by a bent

FRONT END ALIGNMENT



B Minus A . . Camber (Inches)
C . . . . Camber (Degrees)
D . . . . King Pin Inclination (Degrees)
E . . . . Top of Tie Rod Tube Below Top of Axle
G Minus H . . Front Wheel Toe-in (Inches)
J . . . . Centerline of tie Rod End Stud to Wheel Rim
K . . . . Centerline of Drag Link End Stud to Wheel Rim
M . . . . Bottom of Steering Arm Boss to Top of Axle Beam
N . . . . Centerline of Axle to Center of Tie Rod End Studs
P . . . . Centerline of Axle to Center of Steering Arm End (at Drag Link)
Q . . . . Bottom of Tie Rod Arm Boss to Top of Axle Beam
R . . . . Centerline of Axle to Center of Pitman Arm Stud
S Minus T . . Caster (Inches) (Measure at Front of Axle)
U Minus V . . King Pin Inclination (Inches)
X . . . . Caster (Degrees)
Y . . . . Vertical
Z . . . . Centerline of King Pin

Refer to "Wheel Alignment Dimensions" for numerical values. TPM-6916-1

Figure 1—Front End Alignment Chart

steering knuckle or sagging axle center.

In checking camber, it is recommended that an accurate gauge be used. If a camber gauge is not available, readings can be taken as illustrated at "A" and "B" on chart (fig. 1). Place square as shown and measure distance between "A" and rim, and "B" and rim. Lower dimension should exceed upper dimension by amount listed in "Specifications" at end of this section. This dimension on right wheel should not vary over 3/32" from same dimension taken at left wheel.

If final camber reading is incorrect, either steering knuckle or axle center is bent. To determine which part is bent, check king pin inclination ("D," fig. 1). Camber plus king pin inclination is the INCLUDED ANGLE of steering knuckle. If included angle of knuckle varies more than 1/2 degree from value given in "Specifications," knuckle is bent.

Excessive positive camber results in irregular wear of tires at outer shoulders. Negative or reverse camber causes wear at inner shoulders. Ease of steering is affected by any deviation from specified camber.

AXLE CASTER

Positive Caster is the inclination of the king pins toward rear of vehicle. Negative or Reverse Caster is the inclination of king pins toward front of vehicle. These vehicles are designed with positive caster.

Caster variations may be caused by uneven tightening of suspension support studs or bent axle. Precision instruments must be used to check caster angles when axle is installed in vehicle.

Caster can be adjusted on vehicle by loosening clamp bolts in adjusting clamp on upper radius rod as shown in figure 2. By turning clamp, adjust caster to dimension listed in "Front End Alignment Data" at end of this section. Tighten clamp bolts firmly after adjustment.

When axle is removed from vehicle, check can be made on bench as follows:

Place two uniform blocks on level surface, rest suspension support seats on blocks. Using square, measure "S" and "T" at front side of axle (fig. 1); dimensions "S" minus "T" equals caster in inches. If this dimension does not agree with specified value, then axle is twisted.

The purpose of caster is to provide steering stability by keeping the wheels in a straight-ahead-position. Variations from specified caster values will affect steering stability causing wandering, difficulty in pulling out of curves, and a tendency toward wheel shimmy.

KING PIN INCLINATION

Precision instruments must be used to check king pin inclination when axle is installed in vehicle. When axle is removed, check can be made on bench as follows:

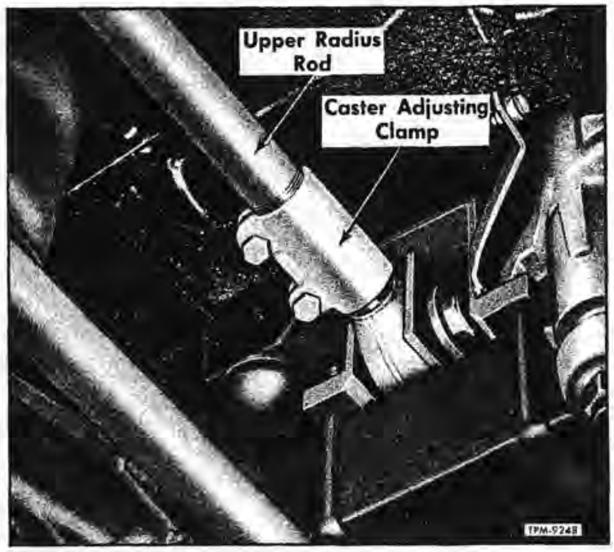


Figure 2—Caster Adjusting Clamp

Place two uniform blocks on level surface, rest suspension support seats on blocks. Using square, measure "U" and "V" dimensions (fig. 1). "U" minus "V" equals king pin inclination in inches.

If axle is bent or twisted, refer to "Straightening Axle Center" later in this section for corrective information.

STEERING GEOMETRY

Since the angularity of the steering arms largely control steering geometry, checking the alignment of the steering arms and linkage is an important alignment factor.

After making all other front end alignment checks, inspect steering arms for proper installation, then measure steering arm angles as follows:

1. Top of tie rod tube below top of axle ("E," fig. 1).
2. Centerline of tie rod end stud to edge of wheel rims ("J," fig. 1).
3. Centerline of drag link end stud to edge of wheel rim ("K," fig. 1).
4. Bottom of steering arm boss to top of axle beam ("M," fig. 1).
5. Centerline of axle to center of tie rod end studs ("N," fig. 1).
6. Centerline of axle to center of steering arm end (at drag link) ("P," fig. 1).
7. Bottom of tie rod arm boss to top of axle beam ("Q," fig. 1).
8. Centerline of axle to center of pitman arm stud ("R," fig. 1).

If these dimensions (see "Specifications") are not within specified values, then the steering arm or steering linkage is bent and should be replaced.

FRONT END ALIGNMENT

ALIGNMENT SPECIFICATIONS

(REFER TO ALIGNMENT CHART, FIGURE 1)

(DIMENSIONS ARE THE SAME FOR ALL MODELS UNLESS OTHERWISE SPECIFIED)

CODE	ITEM	DIMENSION
B-A	Wheel Camber (Inches)	13/32
C	Wheel Camber (Degrees)	1
D	King Pin Inclination (Degrees)	8
E	Top of Tie Rod Tube Below Top of Axle (Inches)	6 Plus or Minus 1/8
G-H	Front Wheel Toe-In (Inches)	1/8 Plus or Minus 1/32
J	Centerline of Tie Rod End Stud to Wheel Rim (Inches)	2 15/32
K	Centerline of Drag Link End Stud to Wheel Rim (Inches)	2 7/8
M	Bottom of Steering Arm Boss to Top of Axle Beam (Inches)	4 3/4
N	Centerline of Axle to Center of Tie Rod End Studs (Inches)	
	SDH & SDM-4502; TDH & TDM-4519; SDH & SDM-5302; TDH & TDM-5304	32 5/32
	TDH & TDM-4518; TDH & TDM-5303	35 5/32
P	Centerline of Axle to Center of Steering Arm End (At Drag Link) (Inches)	
	SDH & SDM-4502; TDH & TDM-4519; SDH & SDM-5302; TDH & TDM-5304	31 23/32
	TDH & TDM-4518; TDH & TDM-5303	34 23/32
Q	Bottom of Tie Rod Arm Boss to Top of Axle Beam (Inches)	5
R	Centerline of Axle to Center of Pitman Arm Stud (Inches)	
	SDH & SDM-4502; TDH & TDM-4519; SDH & SDM-5302; TDH & TDM-5304 (R.H. Side of Axle Centerline)	1 1/4
	TDH & TDM-4518; TDH & TDM-5303 (L.H. Side of Axle Centerline)	1 3/4
S-T	Caster (Inches) (Measured at Front of Axle)	5/16
U-V	King Pin Inclination (Inches)	1 1/2
X	Caster (Degrees) (With Axle Installed)*	1 1/2 to 2
	Front Wheel Track at Ground (Inches)	
	SDH & SDM-4502; TDH & TDM-4519; SDH & SDM-5302; TDH & TDM-5304	79 1/4
	TDH & TDM-4518; TDH & TDM-5303	85 1/4

*Specification for bench inspection is 3 degrees.

Front Axle Repair

Front axle assembly is reverse Elliott type. Axle steering knuckles are constructed as shown in figure 1.

Wheel bearings, air suspension, steering, and brake parts which are mounted on front axle, are described in their respective sections in this manual.

Specifications and pertinent front axle service information are given in "Specifications" at end of this section.

FRONT AXLE CONSTRUCTION

Front axle assembly center section is a hollow rectangular tube in which dowel pins are installed to locate air suspension supports and radius rod brackets. Outer ends of axle center are solid forgings machined to accommodate steering knuckles and king pins. Outer ends are welded to axle center in an offset position to form the built-in caster angle of the axle.

Steering knuckles (fig. 1) are supported on solid king pins which are tapered at center section to fit snugly in tapered holes in axle outer ends. Nut installed at threaded upper end of each king pin draws bushing (3) against spacer (4) and secures king pin in axle. Cotter pins are used to secure king pin nuts.

Load is transmitted from axle center to knuckle through tapered roller thrust bearings (9, fig. 1). Covers and plugs (2 and 7, fig. 1) exclude dust and moisture from knuckle bushings and serve as lubricant seals. Steering knuckle bushings can be replaced.

Left steering tie rod arm has two holes, the rear of which is to accommodate tie rod, and the front to accommodate the drag link. The steering gear assembly is mounted directly on axle center.

Stop screws installed at each end of axle center limit turning angle of front wheels.

FRONT AXLE GENERAL MAINTENANCE

INSPECTION

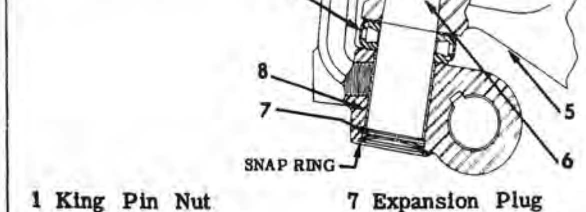
Following inspection operations should be performed at intervals determined by severity of service.

1. Inspect air suspension support stud nuts and U-bolt nuts, and radius rod stud nuts and U-bolt nuts. Tighten as directed in "AIR SUSPENSION" (SEC. 14).
2. Inspect and tighten tie rod and drag link end stud nuts as directed in STEERING (SEC. 16).
3. Inspect tie rod ends for wear. If worn, replace as instructed in STEERING (SEC. 16).
4. Lubricate front axle parts as instructed in LUBRICATION (SEC. 13).
5. When steering difficulty or abnormal tire wear indicate necessity, check front end alignment as previously instructed under "FRONT END ALIGNMENT."
6. Inspect king pin and steering knuckle bushings for wear.
7. Check up and down movement of knuckles on king pins. Excessive movement will pound and damage the thrust bearings. Refer to "Specifications" for minimum axle to knuckle clearance.
8. Check stop screws and adjust when necessary. Stop screw adjustment procedure is described later.

STOP SCREWS

Adjustable stop screws limit front wheel turning angle to right and left. Stop screws must be set to give maximum turning radius to the right and to the left and at the same time prevent interference between front tires and other parts of coach.

Before setting stop screws, refer to STEERING GEAR (SEC. 16) and be sure pitman arm is properly installed on steering gear, and be sure steering gear drag link is properly adjusted for length and not distorted or bent.



1 King Pin Nut	7 Expansion Plug
2 King Pin Cover	8 Steering Knuckle Bushing
3 King Pin Bushing	9 Thrust Bearing Assembly
4 Spacing Washer	10 Steering Knuckle
5 Axle Center End	
6 King Pin	

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Figure 1—Steering Knuckle Assembly

Adjust stop screws as follows:

1. Raise front axle until front wheels are off floor.

2. Turn wheel to extreme left until drag link tube contacts lower radius rod bracket, then turn axle stop screw out to engage knuckle. This should provide 1/2 to 3/4 inch clearance between bellows lower piston and tire. Tighten stop screw lock nut.

3. Turn wheel to extreme right until drag link socket contacts tie rod tube, then turn axle stop screw out to engage knuckle. This should provide 1/2 to 3/4 inch clearance between bellows lower piston and tire. Tighten stop screw lock nut.

4. When adjustment is completed, road test coach and note if any interference takes place between tires and other parts of coach while making sharp turns in either direction.

FRONT AXLE REPLACEMENT

Procedures covering replacement of front axle assembly, including suspension components which are attached to the axle, and replacement of suspension components on axle assembly are covered in AIR SUSPENSION (SEC. 14).

FRONT AXLE OVERHAUL

Steering knuckles, king pins, and bushings can be replaced, and minor axle straightening can be performed without removing front axle assembly from vehicle. However, when front axle assembly requires a complete overhaul, the assembly should be removed.

Certain preliminary inspections can be made, while axle is still mounted on vehicle, which will aid in determining the amount of repair work necessary.

Check front end alignment as directed in "FRONT END ALIGNMENT" previously in this group.

Inability to align front end correctly indicates that axle center or steering knuckle has been distorted, steering arms have been bent, or bushings in steering knuckles are worn beyond limits.

Repair procedures on such items as AIR SUSPENSION, WHEEL BEARINGS, BRAKES, SHOCK ABSORBERS, AND STEERING are covered in their respective sections of this manual.

STEERING KNUCKLE REMOVAL

If desired, steering knuckles may be removed from front axle without removing front axle assembly from the vehicle. To remove steering knuckles from the axle either with or without removing the front axle assembly from vehicle, proceed as follows:

1. Remove tie rod and drag link as directed in STEERING (SEC. 16) of this manual.

2. Remove front wheels, hubs, and bearings. Refer to HUBS, WHEELS, AND TIRES (SEC. 19).

3. Remove air brake mechanism and brake shoes. Detach brake shoe spider from knuckle and remove spider, camshaft, and slack adjuster as an assembly.

4. Remove nuts from steering arms and drive arms out of steering knuckles.

5. Remove cover (2, fig. 1) from top of knuckle to expose king pin nut. Remove lock ring from knuckle lower yoke and remove plug.

6. Remove cotter pin, then remove nut from upper end of king pin. Using suitable brass drift, drive king pin downward out of axle and knuckle. Remove knuckle, thrust bearing, and spacing washer from axle. King pin bushing can be lifted out of knuckle upper yoke.

CLEANING

Wash steering knuckle parts in cleaning solution, being sure to remove all dirt and lubricant. If necessary, soak thrust bearings in cleaner until all old lubricant is dissolved; then slush bearing in cleaning solution until all grit is removed from races.

INSPECTION AND REPAIR

STEERING KNUCKLES

After steering knuckles have been cleaned, thoroughly examine knuckles for distortion, damage, cracks, or fractures. If Magna-Flux inspection equipment is available, use this method to inspect steering knuckles and king pins for minute cracks, checks, or fractures which otherwise would not be visible to the naked eye.

AXLE CENTER

There are two conditions which, if either exists, will necessitate replacement of axle center.

1. If king pin holes in axle center ends are worn to such an extent that a new pin fits loosely, axle center must be replaced.

2. If axle center has been twisted or bent more than 5 degrees from original shape, the center should be replaced. When an extreme bent condition exists, minute invisible fractures may occur and cause failure under ordinary operating conditions.

CHECKING AXLE CENTER

Check axle center for twist with alignment instruments, or on a bench as illustrated in front end alignment chart. If equipment is available, use Magna-Flux method to check axle center for minute fractures.

STRAIGHTENING AXLE CENTER

The straightening of axle forgings must be performed by mechanics who are thoroughly familiar with such operations and use special straightening tools. ALWAYS STRAIGHTEN FORGINGS COLD -- UNDER NO CIRCUMSTANCES SHOULD HEAT BE APPLIED. Application of heat to facilitate straightening weakens the material strength of all forgings.

THRUST BEARING

Examine thrust bearings for excessive wear, pitting, or other damage. If these conditions are evident or if bearing retainers are bent or damaged, bearings should be replaced.

BUSHING REPLACEMENT

Steering knuckle bushings should be replaced if inspection reveals that they are scored, worn, or otherwise damaged.

Removal

1. Clamp steering knuckle securely in vise equipped with soft jaws.
2. Thread tap of suitable size into bushing, if bushing driver is not available.
3. Using soft metal rod, slightly smaller than bushing and long enough to extend at least 1-1/2" through opposite knuckle yoke, drive tap and bushing out of knuckle bore.
4. Repeat process to remove remaining steering knuckle bushing.

Installation

1. Clean the steering knuckle bushing bores, then round off all sharp edges of new bushings slightly.
2. Position bushing so that oil hole in bushing will line up with lubrication fitting hole in steering knuckle yoke, and so that bushing will enter knuckle bore straight when pressed into yoke.
3. Using arbor press and suitable installer, press bushing into knuckle bore until positioned as shown in figure 1. NEVER ATTEMPT TO DRIVE BUSHINGS WITH HAMMER.
4. Ream or hone bushings to diameter given in "Specifications" at end of this section.
5. Clean cuttings out of oil grooves, then round off all sharp edges in grooves.

KING PIN

Check diameter of king pin at upper and lower bearing surfaces against dimensions given in "Specifications" at end of this section. If wear exceeds limits given, replace with new king pin.

King pins should also be inspected for minute cracks or other damage.

STEERING KNUCKLE INSTALLATION

The importance of cleanliness when assembling steering knuckle parts cannot be overstressed. If the king pins and bushings are installed with particles of dirt or metal between bearing surfaces, excessive wear will result necessitating premature replacement of parts.

Install steering knuckles and king pins in the following manner. Key numbers in text refer to figure 1.

1. Position steering knuckle (10) on axle center end (5), then slide thrust bearing assembly (9) into place between lower face of axle center and steering knuckle lower yoke. Make sure retainer is on top of bearing with lip of retainer down. Align king pin holes in steering knuckle yokes with king pin hole in axle center end.
2. With axle center held rigidly, place a jack under knuckle yoke and raise knuckle sufficiently to take up all clearance between lower yoke, thrust bearing, and lower face of axle center end.
3. Check clearance between top face of axle center end and lower face of steering knuckle yoke, then select shim and spacing washer combination which will reduce clearance to limits given in "Specifications" at end of this section. Shim and spacing washer thicknesses available are given in "Specifications" at end of this section.
4. Make certain king pin hole in axle center (5), king pin (6), and nut (1) are carefully cleaned and dry. King pin nut (1) should screw on king pin freely without binding in any manner. These precautions should be taken to assure king pin being securely locked in place when installation is completed.
5. Insert king pin (6) through bottom yoke of steering knuckle (10), then drive king pin into place with lead hammer.
6. Place king pin bushing (3) over threaded end of king pin (6), and into knuckle upper yoke.
7. Make sure threads on king pin nut are clean and dry, then install king pin nut (1). Tighten nut with torque wrench to minimum torque given in "Specifications" at end of this section, then tighten nut until next castellation on nut lines up with cotter pin hole through king pin. Install new cotter pin, full size of cotter pin hole.
8. Position new cover gasket on steering knuckle upper yoke, place dust cap (2) on gasket, then secure cover with attaching screws.
9. Install new plug (7) in lower yoke, then install lock ring to retain plug. Install plug with concave side toward lock ring so edge of plug contacts ring.

FRONT AXLE REPAIR

10. Place keys in keyways in steering arms and drive arms into tapered holes in knuckles. Install nuts on arms and tighten nuts to torque specified in "Specifications" at end of this section. Secure nuts with cotter pins.

11. Install brake spider and camshaft assembly on knuckle, install brake chambers, and connect chamber push rods to slack adjusters. Install brake shoes, hubs and bearings, and brake drums. Refer to HUBS, WHEELS, AND TIRES (SEC. 19) for instructions for adjusting wheel bearings.

12. Install tie rod assembly and connect drag link to steering arm at left steering knuckle as directed in STEERING (SEC. 16) of this manual.

FRONT AXLE SPECIFICATIONS

ITEM	DIMENSION
STEERING KNUCKLE	
Spindle Diameter	
At Outer Wheel Bearing	2.1243"-2.1248"
At Inner Wheel Bearing	2.5613"-2.5623"
Steering Knuckle Bushings	
Inner Diameter	1.7965"-1.7975"
Length	2 3/16"
King Pin Bushing	
Inner Diameter	1.310"-1.311"
Outer Diameter	1.7930"-1.7940"
Length	2 15/32"
KING PIN	
Diameter at Top of Pin	1.3085"-1.3095"
Diameter at Bottom of Pin	1.7930"-1.7940"
Length (Overall)	10 3/4"
FITS AND TOLERANCES	
Clearance Between	
King Pin Bushing and Knuckle Bushing	0.0025"-0.0045"
King Pin and Lower Knuckle Bushing	0.0025"-0.0045"
Axle Center to Steering Knuckle Clearance	0.015" Max.
Means of Adjustment	Shims and Spacing Washers
Shim Thickness	0.015"
Spacing Washer Thicknesses Available	0.093", 0.125", and 0.156"
TORQUE SPECIFICATIONS	
Steering Arm to Knuckle Nut	350-390 Ft.-Lbs.
King Pin Nuts	350-390 Ft.-Lbs.

Rear Axle

Rear axle is full-floating type, using a one-piece axle housing with housing bowl cover welded to housing. Housing bowl is located to the left of axle center line.

As shown in figure 1, drive pinion assembly is mounted at an angle to drive gear, thus increasing the tooth contact area between drive gear and drive pinion gear teeth. Drive is transmitted from transmission angle drive unit through propeller shaft to spiral bevel gears, axle housing, and then to vehicle underframe through upper and lower radius rods.

Differential and drive pinion assemblies are both provided with facilities for adjustment of bearings and gear tooth contact.

DIFFERENTIAL CARRIER

Differential assembly, drive pinion, and pinion cage assembly are mounted in differential carrier. After axle shafts have been removed, and propeller shaft has been disconnected, differential carrier can be removed for inspection and adjustment without removing axle housing from vehicle as directed later in this section.

DIFFERENTIAL ASSEMBLY

Conventional four-pinion type differential is carried in two-piece case mounted on tapered roller bearings. Bevel drive gear is bolted to flanged half of differential case. Drive gear and pinion are furnished in matched, lapped sets, and should always be installed as such to assure satisfactory operation.

Thrust washers are used between differential side gears and case, also between differential pinions and case. Differential case halves are held together with special bolts and slotted nuts, locked in place with lock wire.

DIFFERENTIAL SIDE BEARINGS

Differential is supported in tapered roller bearings which take thrust as well as radial loads. Bearings are mounted in machined supports in differential carrier with thrust loads taken by adjusting rings threaded into carrier supports and bearing caps. Adjusting rings bear against bearing cups and are locked in position by adjusting ring locks bolted to each bearing cap.

2

PINION AND CAGE ASSEMBLY

Bevel drive pinion is installed at an angle in differential carrier. Pinion is straddle mounted in two opposed tapered roller bearings at outer end, and one straight roller bearing at inner end.

Tapered roller bearing cups installed in pinion cage are separated by a machined shoulder in pinion cage.

Pinion bearings are adjusted on shaft by selecting a spacer of correct thickness as described later in this section under "Drive Pinion and Cage Assembly."

Straight roller bearing at inner end of drive pinion is secured in place with a snap ring.

Shims of various thicknesses are used between pinion cage and differential carrier to adjust drive pinion tooth contact and gear backlash.

Pinion shaft and cage assembly cannot be removed from carrier until differential assembly has been removed from carrier.

AXLE SHAFTS AND HOUSING

Axle shafts are full floating type. Drive flange at outer end is attached to hub by studs, nuts, and tapered dowels; inner end of shaft is splined to differential side gear.

Axle housing is one-piece design with differential located off center. Housing is equipped with outer end tubes which are threaded to accommodate wheel bearing adjusting nuts.

MAINTENANCE ON VEHICLE

The following maintenance operations should be accomplished at regular inspection and lubrication intervals.

LUBRICATION

Lubrication checking and draining intervals and filling instructions, also type of lubricant and capacity, are given in LUBRICATION (SEC. 13).

Examine pinion oil seal, axle shaft flange, and carrier to housing gaskets for evidence of lubricant leakage. Tighten bolts or nuts, or replace gaskets and seals to correct leaks.

MOUNTING

Maintenance of the axle mounting on vehicle consists primarily of a regular and systematic

REAR AXLE

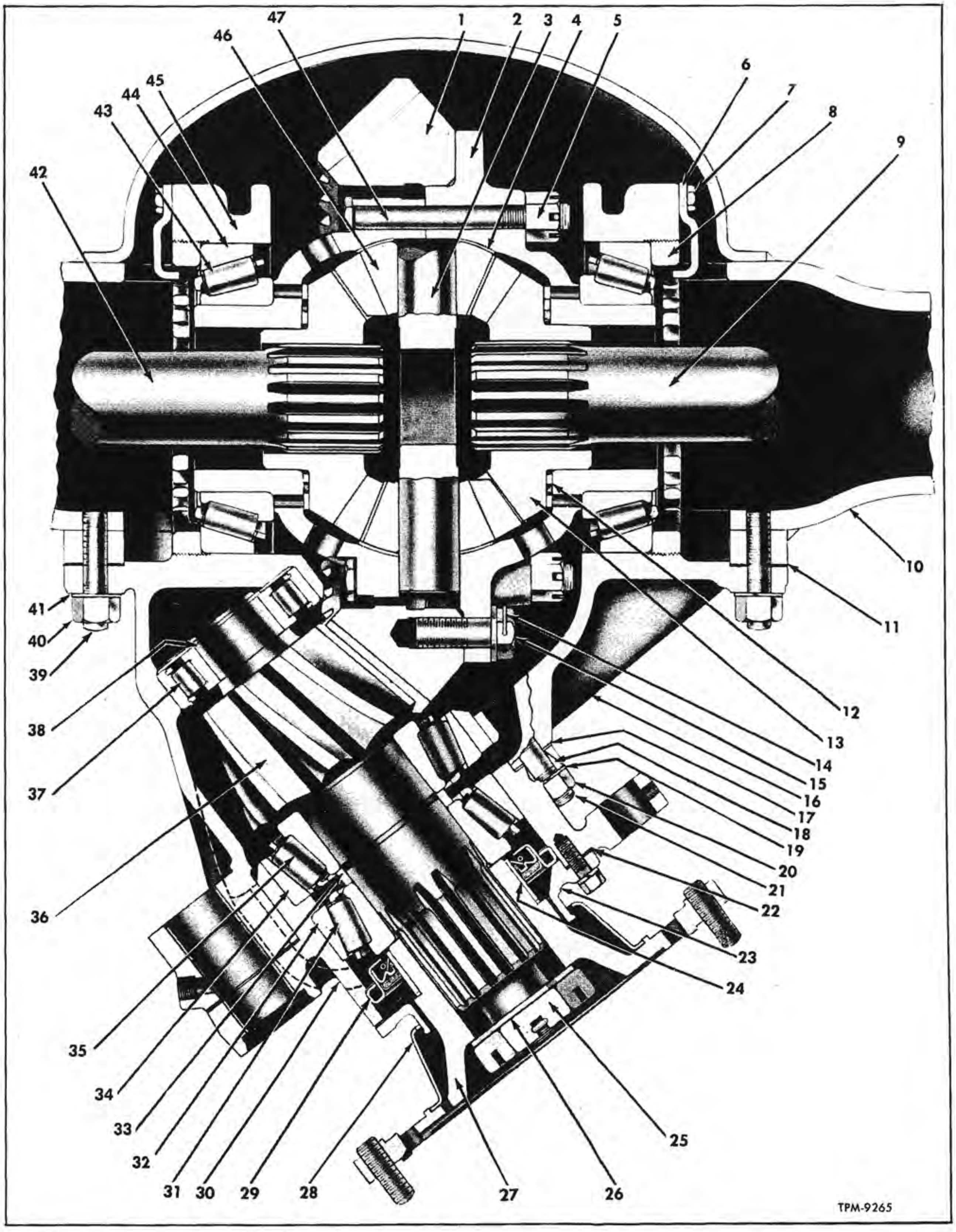


Figure 1—Sectional View Of Rear Axle

1 Drive Gear	17 Pinion Cage Shims	32 Pinion Bearing Cup - Outer
2 Differential Case	18 Pinion Cage Tapered Dowel	33 Pinion Bearing Spacer
3 Differential Spider	19 Lock Washer	34 Pinion Bearing Cup - Inner
4 Pinion Thrust Washer	20 Stud Nut	35 Pinion Bearing Cone - Inner
5 Case Bolt Nut	21 Pinion Cage Stud	36 Drive Pinion
6 Adjusting Ring Lock	22 Pinion Oil Seal Retainer Gasket	37 Pinion Bearing
7 Lock Bolt		38 Bearing Retainer Ring
8 Bearing Adjusting Ring	23 Pinion Oil Seal Retainer	39 Carrier Stud
9 Axle Shaft (Right)	24 Oil Seal Sleeve	40 Stud Nut
10 Axle Housing	25 Pinion Nut	41 Lock Washer
11 Carrier Gasket	26 Pinion Nut Washer	42 Axle Shaft (Left)
12 Side Gear Thrust Washer	27 Propeller Shaft Flange	43 Differential Bearing Cone
13 Differential Side Gear	28 Dust Slinger	44 Differential Bearing Cup
14 Bolt Lock Wire	29 Pinion Oil Seal Assembly	45 Differential Bearing Cap
15 Drive Gear Bolt	30 Pinion Cage	46 Differential Pinion
16 Differential Carrier	31 Pinion Bearing Cone - Outer	47 Differential Case Bolt

Captions For Figure 1—Opposite Page

inspection of air suspension units and radius rods as directed in AIR SUSPENSION (SEC. 14).

AXLE SHAFT AND PINION CAGE MOUNTING

Axle shafts and pinion cage are retained with stud nuts, lock washers, internal-tooth lock washers, and split tapered dowels. The studs must be straight and dowels of correct taper must be used. There should always be a slight clearance between nuts and mounting flange when nuts are tight.

Whenever inspection shows that no clearance exists between nut and flange, this indicates that excessive wear exists at tapered dowels, studs, or tapered holes in drive flange.

If stud nuts are not tightened to recommended torque, play at flange and broken or worn studs will result and damaged parts must be replaced.

AXLE OVERHAUL

Rear axle may be disassembled while the housing remains installed in vehicle if proper equipment is available for handling differential assembly. Information on suspension, propeller shaft, brakes, hubs, bearings, wheels, and tires will be found in respective sections of this manual.

REAR AXLE REPLACEMENT

Complete instructions for removal and installation of rear axle assembly will be found in AIR SUSPENSION (SEC. 14).

AXLE SHAFT REPLACEMENT

The following procedures for removal and installation of axle shafts is applicable regardless whether the axle assembly is removed or installed on the vehicle. Axle shafts are fastened by either seven or ten studs and nuts, dependant upon model.

REMOVAL

1. Remove nuts and washers from hub studs.
2. Strike center of flange with a lead hammer to loosen flange and dowels from studs.
3. If shaft is not loose enough to pull by hand, thread 1/2-13 puller screws in holes provided (either two or three tapped holes).
4. Tighten puller screws evenly and alternately until flange is pulled from hub studs. Withdraw axle shaft from housing, then remove gasket from hub or flange.

INSTALLATION

1. Install and adjust hubs and bearings as directed in WHEELS, HUBS, AND TIRES (SEC. 19).
2. Install new gasket over hub studs.

NOTE: Observe that oil seal assembly and wiper are installed at outer side of hub.

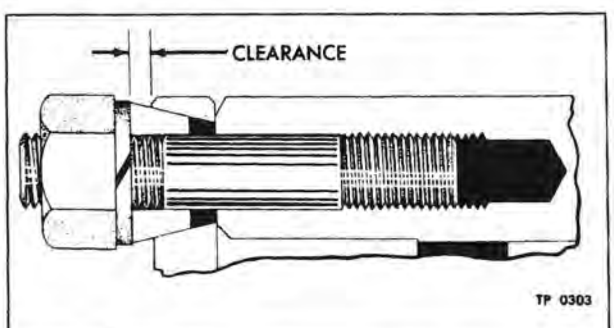
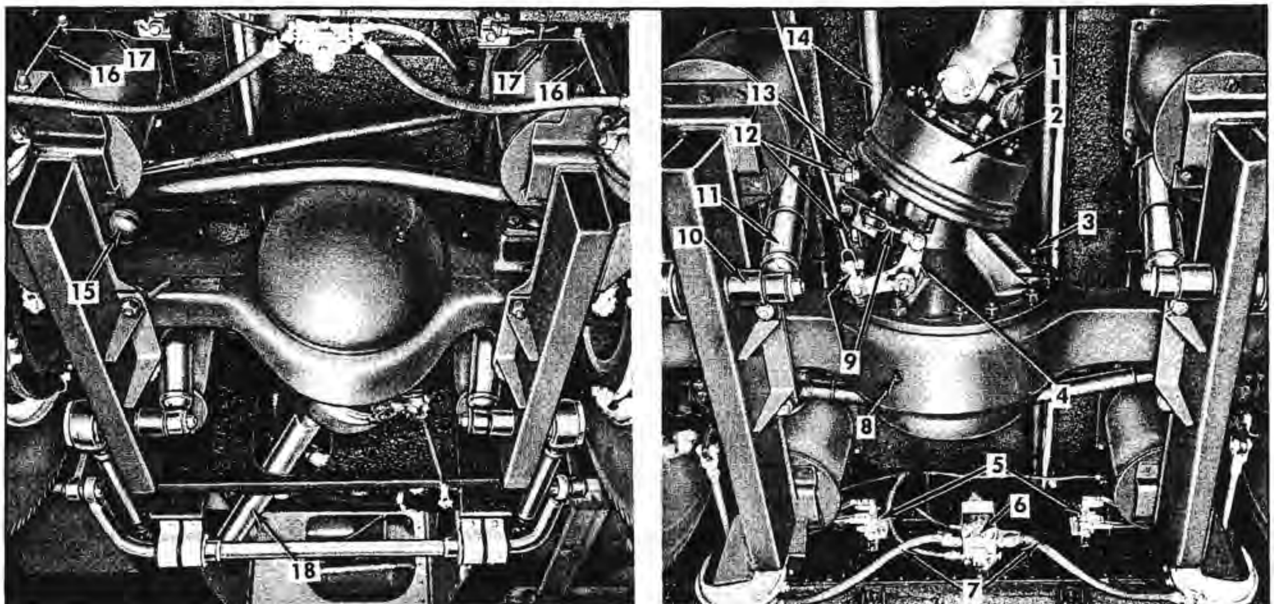


Figure 2—Clearance Between Nut And Flange



FRONT VIEW | REAR VIEW

1 Flange Yoke
2 Hand Brake Drum
3 Puller Screw
4 Bell Crank
5 Height Control Valve
6 Brake Relay Valve
7 Brake Chamber Hose
8 Drain Plug
9 Brake Linkage
10 Mounting Bracket
11 L.H. Shock Absorber
12 Anchor Plate Studs
13 Anchor Plate
14 Upper Radius Rod
15 Axle Bumper
16 Height Control Valve Link
17 Height Control Valve Lever
18 Propeller Shaft

TPM 9266-1

Figure 3—Rear Axle And Air Suspension Installed

3. Dip splined end of axle shaft in rear axle lubricant, then insert shaft into housing, guiding shaft into side gear and at same time align flange holes with hub studs. When studs and flange holes are in alignment, push axle shaft into place.

4. Install split tapered dowels, external toothed lock washers, and nuts on studs at tapered holes in flange (three or four - differs by model); also install lock washers and nuts at remaining four or six studs. Tighten nuts alternately and evenly to 90-113 foot-pounds torque.

5. Observe that clearance exists between nut and flange (fig. 2). If no clearance exists, this indicates excessive wear at studs, dowels, or flange holes. Replace worn parts if necessary.

DIFFERENTIAL CARRIER REPLACEMENT (WITH AXLE IN VEHICLE)

(Key numbers in text refer to figure 3)

REMOVAL

1. Place rear wheels of coach on 10-inch riser blocks, keeping blocks flush with inside of rear wheels. Block front wheels securely, FORE and AFT, to prevent vehicle rolling.

2. Remove both rear axle shafts as instructed under "Axle Shaft Replacement" in this section.

3. Remove drain plug (8) and drain lubricant from the axle housing.

4. Disconnect the propeller shaft (18) at the flange yoke (1), adjacent to the hand brake drum (2), and wire to body understructure to obtain maximum clearance.

5. Place the hand brake lever in released position and disconnect the parking brake control rod linkage (9). Remove bell crank (4) from the differential carrier.

6. On narrow model coaches it will be necessary to remove the left shock absorber (11) from the lower left shock absorber anchor mounting bracket (10). Use a board or wire to hold the shock absorber away from the carrier assembly.

7. Remove the air hoses (7) leading from the rear brake chambers to the brake relay valve (6) to prevent damage to hose when raising body, and disconnect height control valve links (16).

8. Lift up on both height control valve levers (17) to admit air pressure into the rear suspension bellows. Hold levers up until coach body has raised sufficiently to permit installation of safety spacers (approximately 10") between body and axle at each side. The spacers can be made from steel tubing of sufficient diameter to fit over axle bumpers (15).

9. Remove the two anchor plate studs (12) which attach the upper radius rod (14) to the rear

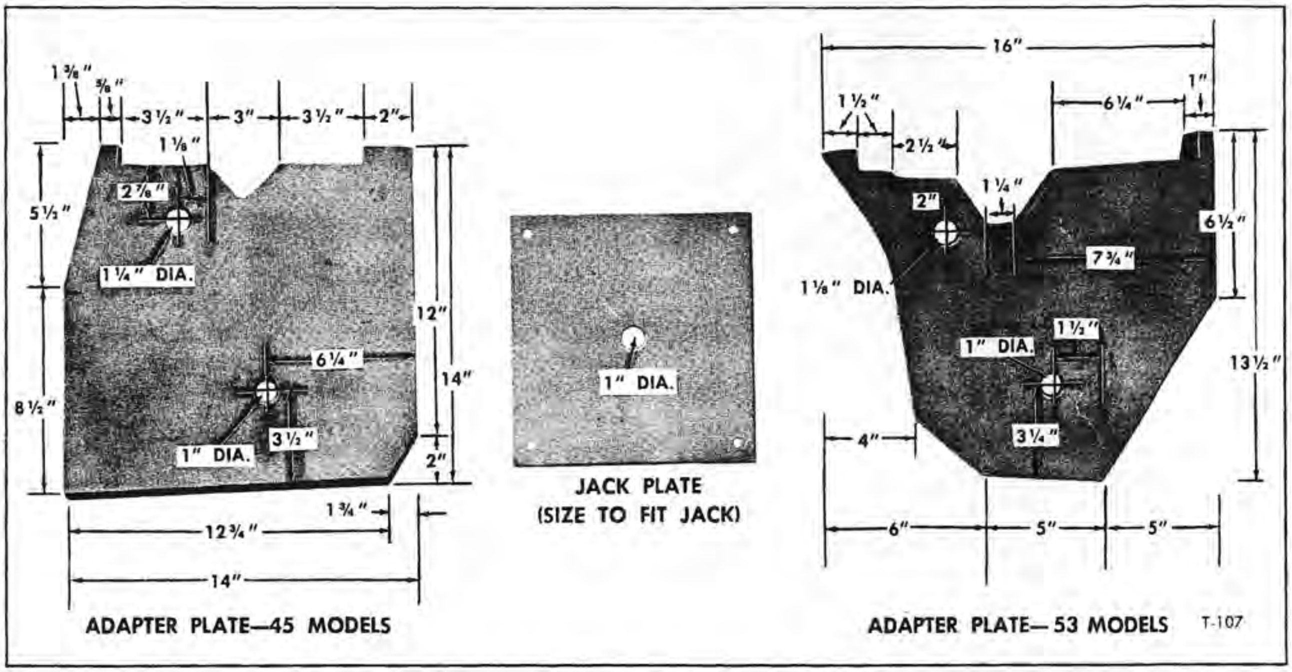


Figure 4—Special Plates For Removing Differential Carrier

axle carrier assembly using a double nut method or a suitable stud puller.

10. Remove the press fit upper radius rod mounting bolt, pry loose, and remove the anchor plate (13).

11. Remove nuts from the differential carrier studs.

12. Remove all studs from the lower half of the axle carrier using a double-nut method or a suitable stud puller.

13. Remove the two puller screws (3) from the carrier assembly and install two 1/2-13 x 3 inch puller screws. Pull carrier assembly to end of studs.

14. A floor model dolly jack, adapted for removing the differential assembly, should be positioned under the coach. An adapter plate should be fabricated locally, using a 3/4-inch flat steel plate and shaped to fit the lower portion of the differential carrier assembly. Two holes must be drilled into this plate. One hole will be used to fasten the slack adjuster bell crank stud to the anchor plate and the second hole will be used to attach the adapter plate to a base plate mounted on the jack.

A second 3/4-inch flat steel plate must be fabricated to fasten to the floor jack and adapter plate to permit rotation of the adapter plate. Refer to figure 4.

15. Pull the carrier assembly back as far as possible. Tilt the gear end of the carrier assembly up until it clears the yoke. As the carrier is moved out of the housing, move it down and to the right to clear all obstructions. (Refer to figure 5, showing carrier removed.)

INSTALLATION

1. Before reinstalling the carrier assembly, clean mating surfaces of carrier flange and axle housing.

2. Back the top stud in axle housing out 1/2-inch to guide the carrier assembly into position.

3. Mount the carrier assembly on the floor jack using the same base plate and adapter plate used to remove the carrier. Use wire or string to secure a new gasket to the carrier flange until the carrier can be positioned in the axle housing.

4. On narrow model coaches it will be necessary to remove the hand brake drum (2) to gain sufficient clearance to reinstall the carrier assembly.

5. With the carrier securely supported on the floor jack, roll under vehicle and maneuver into position at axle housing. Start carrier into housing until studs extend through the carrier flange. Remove wire or string used to attach the gasket to the carrier flange and transfer gasket to the studs of the housing. Use flat washers and nuts on four evenly spaced studs to draw carrier squarely into the housing.

6. Reinstall studs in lower half of the carrier assembly. Seat studs firmly, using a double-nut method or a suitable stud replacer.

7. Remove nuts and flat washers used to draw carrier into position, then install lock washers and nuts on all studs.

8. Remove the two 1/2-13 x 3 inch puller screws used in removing the carrier assembly and install puller screws (3) originally used.

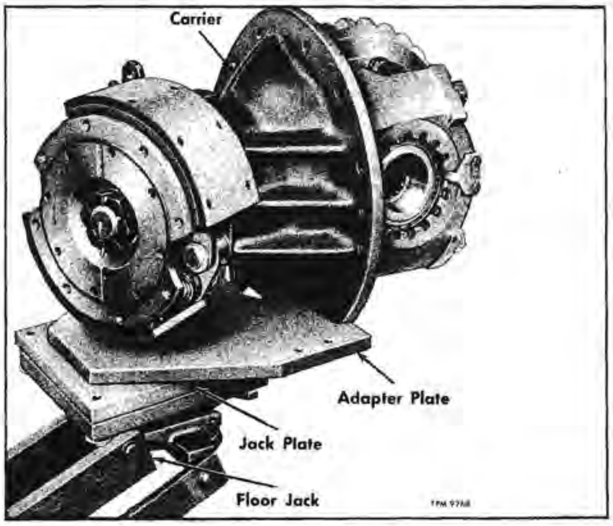


Figure 5—Carrier Assembly Removed

9. Reinstall the hand brake drum (2) if it was previously removed.

10. Reinstall the upper rear radius rod (14) by placing the anchor plate (13) over studs in the carrier. Attach the anchor plate with two anchor plate studs (12) and two anchor plate stud nuts. Position the upper radius rod end and insert the anchor pin and anchor bolt. Install the anchor bolt washer and nut.

11. Remove safety spacers by pushing up on both height control valve levers (17) to admit air pressure into the bellows. When safety spacers have been removed, pull down on both height control valve levers to exhaust air pressure from bellows until normal ride height is achieved. Connect height control valve links (16).

12. Reconnect the air hoses (7) leading from the rear brake chambers to brake relay valve (6).

13. On narrow model coaches it will be necessary to reconnect the left shock absorber (11) to the shock absorber anchor mounting bracket (10).

14. Reinstall the bell crank (4) on the differential carrier and connect the parking brake control rod linkage (9).

15. Reconnect the propeller shaft (18) at the yoke (1), adjacent to the hand brake drum (2).

16. Install drain plug (8) in axle housing and tighten firmly. Fill axle housing with lubricant, and lubricate propeller shaft universal joints and parking brake bell crank (4).

17. Adjust parking brake linkage (9).

18. Install axle shafts.

DISASSEMBLY

The following instructions provide procedures for complete disassembly, cleaning, inspection, repair, and reassembly of rear axle. Axle housing may be checked for bent condition before axle assembly is removed from coach. The following repair procedure is based on the operations necessary when axle is removed from coach.

Before and during disassembly operations, perform following inspections and check all adjustments to determine repairs required.

KEY NUMBERS IN TEXT REFER TO FIGURE 1 UNLESS OTHERWISE INDICATED.

AXLE HOUSING CHECK

At regular inspection intervals, or if conditions indicate that rear axle housing might be bent, housing should be checked, using the following method. This check can be made before or after axle is removed from coach to determine if axle housing is sprung. Conventional camber and toe-in gauges can be used to perform inspection.

1. Support axle in level position using blocks at each support beam; then check rear wheel bearings for proper adjustment as instructed in HUBS, WHEELS, AND TIRES (SEC. 19).

2. Check run-out at each rear wheel and replace wheels having run-out in excess of 3/32".

3. Check for toe-in and camber at rear wheels. Rear wheels should not toe-in or out more than 1/8", and camber should be zero, plus or minus 1/4 degree. If measurements are not within the above dimensions, bent or sprung axle housing is indicated. Make notation of the existing conditions for use when making corrections later.

4. In cases where bent axle housings are indicated, further checks to determine exact location of bend should be made after differential carrier has been removed, then necessary steps taken to correct the condition. Any straightening should be done with axle housing cold; UNDER NO CIRCUMSTANCES SHOULD HEAT BE APPLIED.

DIFFERENTIAL CARRIER REMOVAL

1. Remove axle shafts as previously instructed under "Axle Shaft Replacement" in this section.

2. Remove stud nuts and lock washers attaching parking brake drum to propeller shaft flange, then slide drum rearward over propeller shaft yoke.

3. Remove nuts and bolts attaching propeller shaft yoke to flange, then remove propeller shaft yoke.

4. Remove drain plug and drain lubricant from housing.

5. Remove hand brake control rod from bell crank at differential carrier.

6. Remove stud nuts (40) and lock washers (41) from differential carrier studs (39).

7. Be certain that differential carrier is supported solidly, then proceed to pull complete carrier assembly out of housing. A small pinch bar may be used to keep carrier straight in housing bore while it is being withdrawn, provided end of bar is rounded to prevent damage to carrier flange.

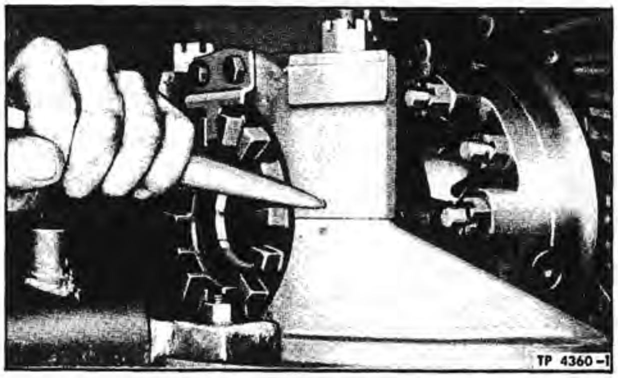


Figure 6—Bearing Cap Alignment Marks

DIFFERENTIAL REMOVAL

1. Remove lock wire from adjusting ring lock retaining bolts (7), then remove locks (6).

2. Remove lock wire from differential side bearing cap bolts. Remove bolts and washers. Make certain that bearing caps (45) and carrier are marked (fig. 6) before removal; then remove side bearing caps (45). Remove side bearing adjusting rings (8). Lift differential assembly with cups (44) from carrier.

DIFFERENTIAL DISASSEMBLY

1. Mark both halves of differential case (2) so halves may be reassembled in original positions (fig. 7).

2. Remove side bearings (43) from each half of case, using suitable bearing puller in manner illustrated in figure 8, or drive out as shown in

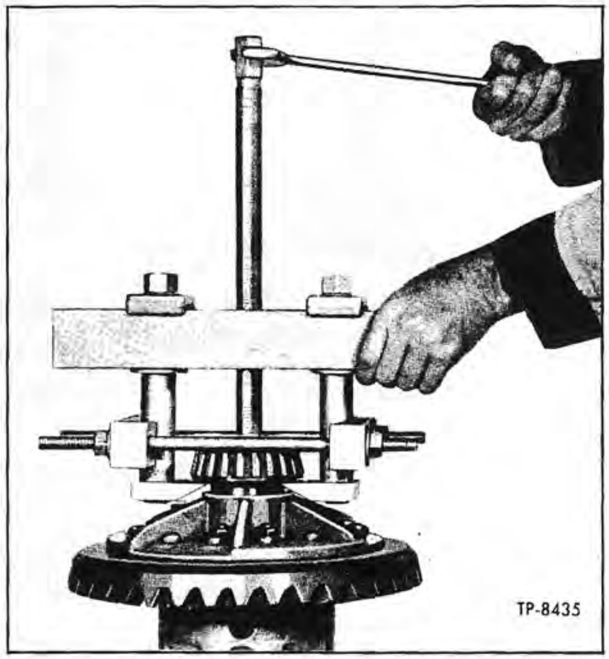


Figure 8—Differential Bearing Removal Using Puller

figure 9, using bearing remover plug (J-4856).

3. Remove lock wire and nuts (5) from bolts (47) which hold the two halves of differential case (2) together; then separate halves of case.

4. Remove side gears (13), thrust washers (12), spider (3), pinions (46), and thrust washers (4) from differential case.

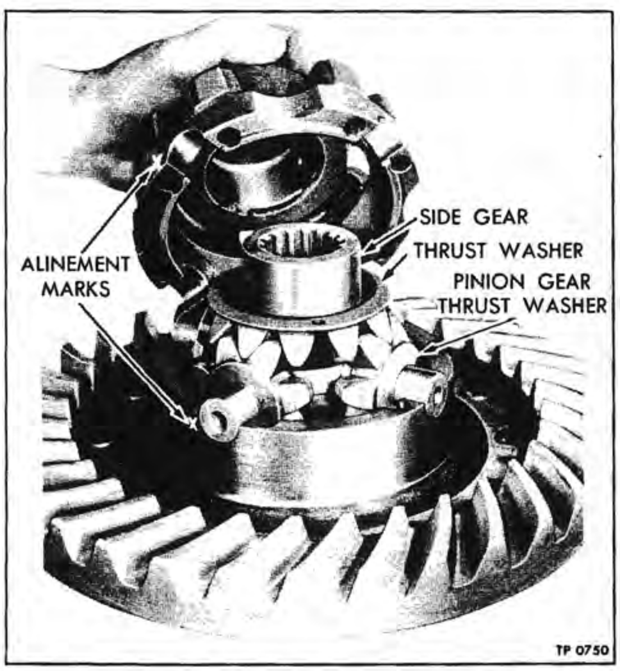


Figure 7—Differential Case Alignment Marks

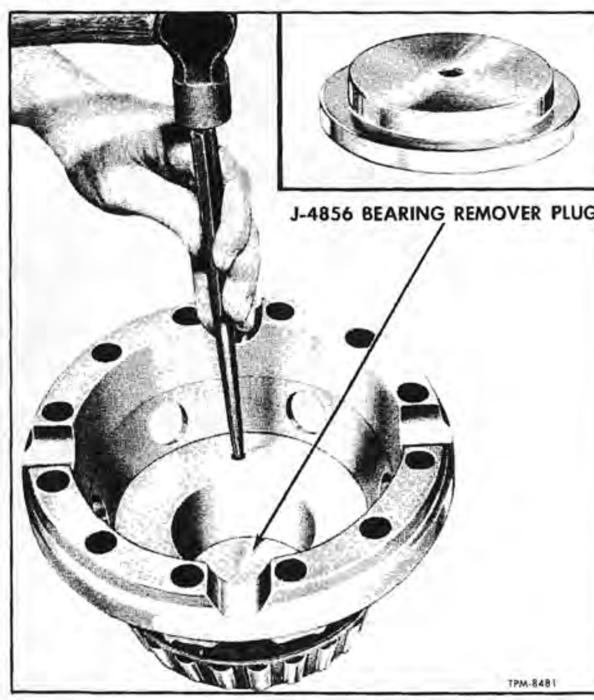


Figure 9—Differential Bearing Removal Using Remover Plug

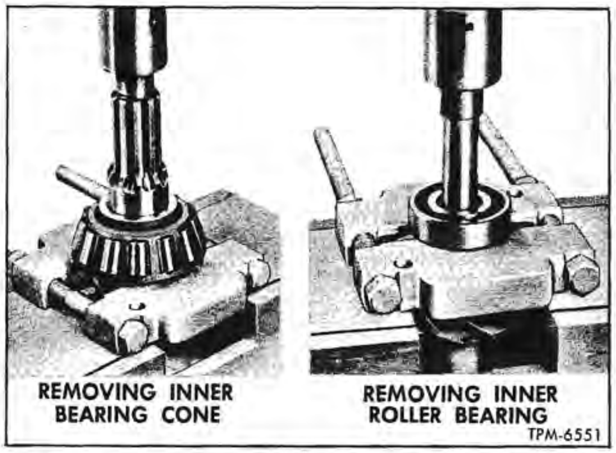


Figure 10—Pinion Bearing Removal

5. If either drive gear (1) or drive pinion (36) are worn or damaged, both must be replaced as a matched set. Never replace drive pinion or drive gear separately.

PINION CAGE REMOVAL AND DISASSEMBLY

1. Remove brake shoe and camshaft as directed in "HAND BRAKE" (SEC. 4).

2. Remove nuts (20) and lock washers (19) which secure pinion cage (30) to differential carrier (16). Tap pinion cage to loosen and remove four tapered dowels (18).

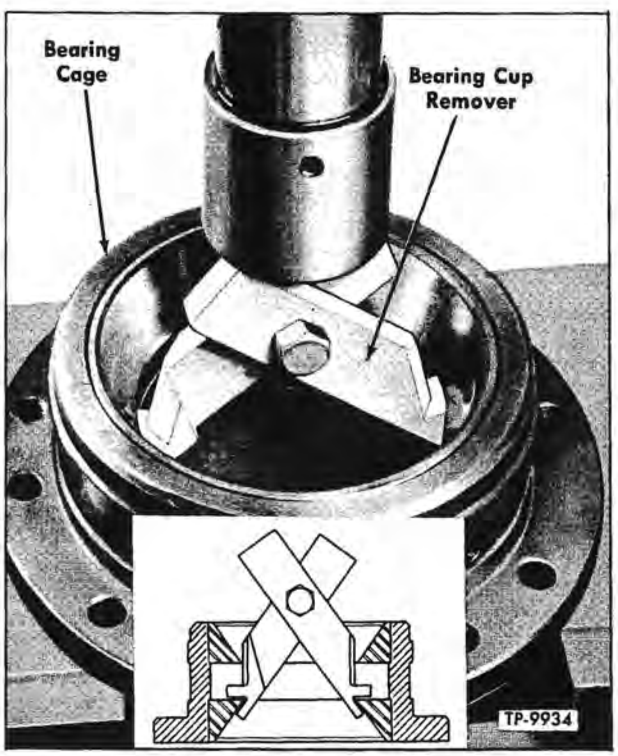


Figure 11—Pinion Cage Bearing Cup Removal

3. Install two puller screws (1/2"-13 x 2-1/2") and tighten alternately and evenly to pull cage (30) out of carrier. Remove shim pack (17) from pinion cage studs (21). Tie shims (17) together so same shim pack may be used at reassembly.

4. Remove retainer ring (38) which secures inner bearing (37) on drive pinion (36); then remove inner bearing from drive pinion using universal puller (J-8176) and arbor press in manner illustrated in figure 10.

5. Clamp pinion in vise equipped with soft jaw plates. Remove cotter pin, nut (25), and washer (26) from drive pinion (36).

6. Place cage and drive pinion assembly in an arbor press and press drive pinion (36) out of flange (27) and pinion cage. Outer bearing (31) will remain in pinion cage (30).

7. Remove cap screws and lock washers attaching oil seal retainer (23) to pinion cage, then remove slinger.

8. Remove bearing adjusting spacer (33) from drive pinion (36) and tag for reassembly reference.

9. If necessary, inner bearing cone (35) can be removed from pinion with universal puller (J-8176) and arbor press as illustrated in figure 10.

10. Remove oil seal (29) assembly from pinion cage.

11. When inspection indicates necessity, cups (32 and 34) can be removed from cage, using remover (J-3940) in manner illustrated in figure 11.

CLEANING, INSPECTION, AND REPAIR

CLEANING BEARINGS

The importance of proper bearing cleaning cannot be over-emphasized. Bearings should always be cleaned separately from other rear axle parts. When cleaning bearings, be sure to perform all of the following steps:

1. Soak differential and drive pinion bearings in clean kerosene, Diesel fuel oil, or other cleaning solvent. Gasoline should not be used as a bearing cleaner. Also, bearings should never be placed in a hot solution tank for cleaning.

2. After old lubricant is loosened, hold bearing races so that bearings cannot rotate, then brush bearings with soft bristled brush until all grit and dirt has been removed.

3. Rinse bearings in clean fluid; then, while holding races, blow dry with compressed air. Be sure air stream is moisture free.

4. Inspect bearings as instructed under "Inspection Operations" later in this section. If bearings pass inspection, dip bearings in differential lubricant recommended in LUBRICATION (SEC. 13); then wrap bearings in clean cloth or paper until ready to reassemble axle.

CLEANING PARTS

Immerse all parts in suitable cleaning fluid and clean parts thoroughly. Use a stiff bristle brush to remove all old lubricant. Remove particles of gaskets which may adhere to mating faces of axle housing, differential carrier, hubs, and axle shaft flanges. Clean out lubricant channels in pinion cage and differential carrier. Clean housing breather. Make certain that interior of axle housing is thoroughly cleaned.

INSPECTION

Whenever available, the Magna Flux method should be used on all steel parts, except ball and roller bearings. This method is especially suited for inspection of ground or highly finished surfaces for wear and cracks which otherwise would not be visible.

INSPECTION OPERATIONS

1. Bearings. Rotate each bearing slowly, and at the same time examine bearing for roughness, damage, defects, or wear. Note condition of bearing cage. Replace bearing if cage is damaged or if any of the conditions previously noted exist.

2. Gears. Examine drive gear, drive pinion, and differential gears for damaged teeth, worn spots in surface hardening, and distortion. Check differential pinions for excessive wear, and fit on spider. Refer to "Specifications" at end of this section for limits. Check radial clearance between differential side gear hubs and differential case.

3. Differential Case. Inspect differential case assembly for cracks, distortion, or damage. If case is in good condition, thoroughly clean case and cover; then assemble case with bolts and mount in lathe centers or "V" block stand. If lathe is not available, install differential side bearings and mount case in differential carrier as directed under "Differential Assembly Installation" later in this section. Install dial indicator and check differential case run-out. Refer to "Specifications" at end of this section, for run-out limits. Whenever run-out exceeds limits, differential case run-out may be corrected as later described under "Repair" in this section.

4. Axle Shafts. Examine splined end of axle shaft for twisted or cracked splines, twisted shaft, or damaged flange. If any of above conditions are evident, install new axle shafts.

5. Axle Shaft and Flange Run-Out. Install axle shaft assembly in lathe centers or "V" blocks. Check shaft run-out with dial indicator; if run-out exceeds limits listed in "Specifications" at end of this section, discard axle shaft. Position dial indicator so that indicator shaft end contacts inner surface of flange near outer edge, then check flange run-out. If run-out exceeds limits listed in "Specifications" at end of this section, discard axle shaft.

AXLE HOUSING INSPECTION

If check made prior to disassembly of axle indicated a bent condition at axle housing, make more complete check of housing on surface plate and after locating point at which housing is bent, the housing may be straightened if equipment is available. Any straightening must be done with axle housing cold, DO NOT APPLY HEAT TO HOUSING.

OIL SEAL INSPECTION

Replacement of oil seal when unit is disassembled is more economical than premature overhaul to replace this part at a future time. Further loss of lubricant through a worn seal may result in failure of other parts, such as gears and bearings.

Handle seal carefully, particularly when being installed. Cutting, scratching, or curling under of lip of seal seriously impairs efficiency of seal. Use of Permatex or equivalent around outer diameter of seal is recommended to insure against leakage at this point.

OIL SEAL SLEEVE

Carefully inspect oil seal sleeve at propeller shaft flange for any pitted, corroded, or worn condition at oil seal contact surface. If such imperfections cannot be cleaned up by polishing, the sleeve must be replaced.

REPAIR

Differential Case. Excessive run-out on differential case may be corrected by machining flange on gear side of case. Remove sufficient metal from flange to correct excessive run-out. Metal must be cut on a true plane, removing just enough metal to bring run-out within limits listed in "Specifications" at end of this section. After differential case has been machined, remove burrs and clean case assembly thoroughly.

Propeller Shaft Flange Sleeve. Whenever inspection indicates that oil seal contact surface of sleeve on propeller shaft flange is corroded or pitted, the condition may be corrected by cleaning and polishing surface with a suitable abrasive cloth. If cleaning and polishing surface of sleeve does not clear up the condition, remove sleeve and install new part.

AXLE ASSEMBLY

After all parts have been thoroughly cleaned, apply a thin coating of differential lubricant, as specified in LUBRICATION (SEC. 13), on all thrust or bearing surfaces. Coating parts will prevent scoring when vehicle is first placed in service.

Use of new lock washers, gaskets, and oil seals is recommended during assembly of axle.

REAR AXLE

All adjustments given in assembly procedures must be made carefully to insure efficient and continuous axle operation.

KEY NUMBERS IN TEXT REFER TO FIGURE 1 UNLESS OTHERWISE INDICATED.

DRIVE PINION AND CAGE ASSEMBLY

1. If pinion bearing cups (32 and 34) were removed during disassembly, press bearing cups firmly against shoulder of pinion bearing cage.
2. Position pinion bearing (35) on drive pinion (36), with widest part of bearing cone toward gear teeth, then press bearing on pinion until bearing cone is seated solidly on drive pinion.
3. Install drive pinion inner bearing (37) on drive pinion (36), using arbor press. Install retainer ring (38) to retain bearing.
4. Lubricate pinion bearing cones and cups with light engine oil. Install original pinion bearing adjusting spacer (33) on drive pinion.
5. Insert drive pinion (36) and bearing assembly into pinion cage (30); then, using an arbor press, press outer pinion bearing (31) firmly against bearing spacer (33). Rotate bearing cage through several complete revolutions to assure normal bearing contact.
6. While assembly is still in press under pressure (14-ton), check drive pinion bearing preload. Wrap soft wire around pinion bearing cage (30) as shown in figure 12. Attach pound scale to wire, then pull on scale, keeping scale in a horizontal plane. Note scale reading when assembly is rotating freely. Reading should be from 5 to 15 inch-pounds. To compute inch-pound value of scale reading, multiply scale reading (pounds) by one-half pinion cage diameter (inches). If reading does not fall between limits given, use thinner spacer (33) to increase or thicker spacer to decrease pinion bearing preload. Spacer thicknesses available are given in "Specifications" at end of this section.

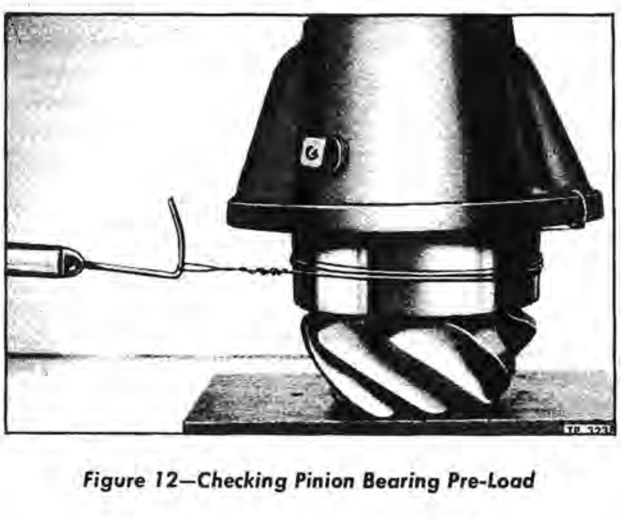


Figure 12—Checking Pinion Bearing Pre-Load

NOTE: If arbor press is not available, temporarily install propeller shaft flange (27), washer (26), and nut (25). Tighten nut to 800-1100 foot-pounds torque, then check pinion bearing preload as directed in preceding paragraph. Remove nut, washer, and flange after adjustment.

7. Lubricate oil seal assembly (29) and cover outer edge of seal body with a non-hardening sealing compound; then install oil seal in cage, being careful that it is straight and is seated against shoulder in cage. Install oil seal sleeve (24).
8. Install oil seal retainer (23) to cage, using new gasket. Install and tighten cap screws to 33-37 foot-pounds torque.
9. Install dust slinger (28) and propeller shaft flange (27).
10. Place washer (26) on drive pinion (36), then install nut (25). Tighten nut to minimum torque of 800 foot-pounds, then tighten nut until next castellation on nut lines up with cotter pin hole in drive pinion and install cotter pin.

DRIVE PINION INSTALLATION

1. Lubricate drive pinion bearings with rear axle lubricant recommended in LUBRICATION (SEC. 13).
2. Place original pinion cage shims (17) over pinion cage studs (21), then position drive pinion and cage assembly on studs (21). IMPORTANT: Oil holes in shims must line up with oil passages in differential carrier and cage when installed, to assure proper lubrication of drive pinion bearings (31 and 35).
3. Install split tapered dowels (18), external toothed lock washers, and nuts at four studs, also lock washer and nut (20) at four remaining studs. Tighten nuts (20) to 80-90 foot-pounds torque.

DIFFERENTIAL ASSEMBLY

After checking differential case run-out as previously described under "Cleaning, Inspection, and Repair" in this section, assemble differential as follows:

1. Lubricate differential case inner walls and all component parts of differential assembly with rear axle lubricant specified in LUBRICATION (SEC. 13).
2. Position side gear thrust washer (12) on hub of side gear (13), then place gear in flanged half of differential case (2).
3. Lay flanged half of case on bench with flange upward, place differential pinions (46) and pinion thrust washers (4) on differential spider (3), place pinion and spider assembly on side gear (13) previously installed, then install remaining side gear (13) and thrust washer (12).
4. Place plain half of differential case on opposite half, with alignment marks positioned as

shown in figure 7. Install case bolts (47) downward through both halves of case.

5. Install nuts (5) on four equally spaced bolts (47), and tighten to torque of 185-205 foot-pounds. Check assembly for free rotation. If rotation is free and smooth, install remaining bolts and nuts and tighten to recommended torque.

6. Position drive gear (1) on flanged half of differential case (2), with alignment marks, stamped on plain case and drive gear, opposite each other. Install and tighten bolts (15) to 290-320 foot-pounds torque. Install lock wire (14) through bolt heads in such a manner that lock wire will become tighter if bolts should become loose.

7. Press differential side bearings (43) on hubs of differential case (2), until bearing cones seat firmly.

DIFFERENTIAL ASSEMBLY INSTALLATION

Proper bearing cup and adjusting ring fit is of utmost importance and should be carefully checked before differential is installed.

1. Temporarily install bearing cup (44), adjuster ring (8), and bearing cap (45), then tighten bolts with washers to 570-630 foot-pounds torque.

2. Bearing cup must be a hand push fit (fig. 13) in bore, otherwise the bore must be reworked with a scraper or emery cloth until proper fit is obtained. Location of high spots in carrier bore can be readily located by applying a light coating of prussian blue to bearing cup.

3. If adjusting ring cannot be turned by hand or with a maximum of 20 foot-pounds torque, this indicates that ring may be oversize and another ring that provides proper fit should be used.

4. Coat differential side bearing cones (43) and cups (44) with rear axle lubricant specified in LUBRICATION (SEC. 13).

5. Place bearing cups (44) over bearing cones (43), then position differential assembly in differential carrier.

6. Insert bearing adjusting rings (8) and turn hand tight against bearing cups (44).

7. Place differential bearing caps (45) in place, with alignment marks in line (fig. 6), then tap lightly into position.

CAUTION: If bearing caps do not seat easily and properly, adjusting rings may be cross-threaded. Remove bearing caps and reposition adjusting rings. Forcing caps into position will result in irreparable damage to differential carrier or to bearing caps.

8. Install bearing cap bolts with hardened washers. Tighten to 570-630 foot-pounds torque.

9. Tighten adjusting rings (8) alternately until tight. Revolve differential assembly after each tightening to assure normal bearing contact and to keep bearing cups straight in bores.

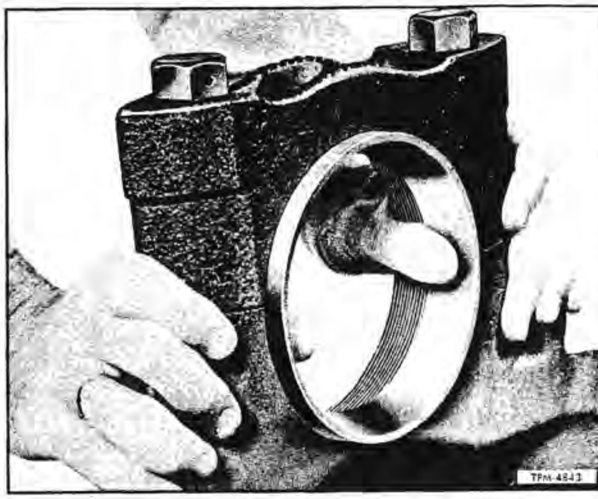


Figure 13—Checking Fit Of Differential Bearing Cup

DIFFERENTIAL BEARING PRELOAD ADJUSTMENT

1. Using dial indicator at back face of drive gear (1) as shown in figure 14, loosen bearing adjusting ring (8), on flanged side, enough to notice end play on dial indicator.

2. Tighten the same adjusting ring until 0.000" end play is obtained.

3. Tighten both adjusting rings (8) one notch each from 0.000" end play position to impose correct preload on differential side bearings.

NOTE: After adjusting bearing preload, proceed with tooth contact and backlash adjustment as directed in following paragraph.

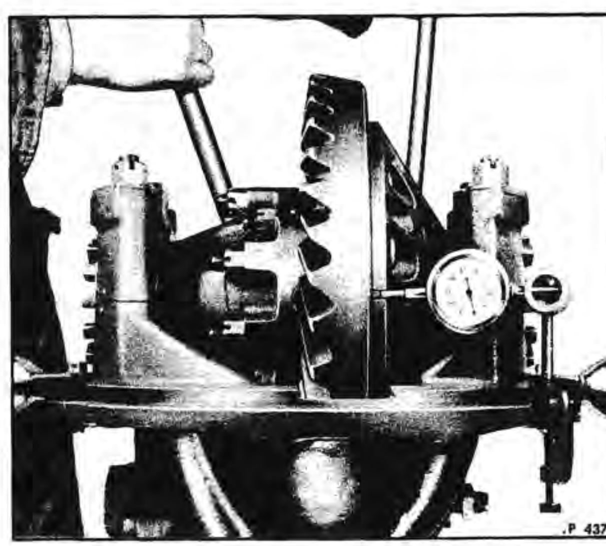


Figure 14—Differential Bearing Pre-Load Check

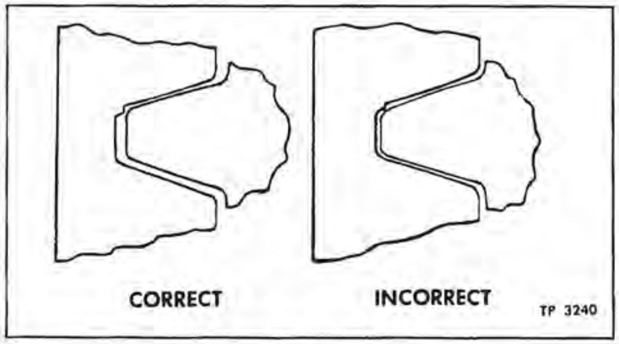


Figure 15—Worn Tooth Cross Section

GEAR TOOTH CONTACT ADJUSTMENT

Drive pinion (36) is adjusted for tooth contact by means of shims (17) between pinion cage (30) and differential carrier (16). Drive gear (1) is adjusted by means of adjusting rings (8).

If original gears are reinstalled in assembly, painting gear teeth will not indicate the same contact as new gears and can be misleading. Gears that have been in service for extensive periods, form running contacts due to wear on teeth. Therefore, the original shim pack (17) plus one 0.005" shim should be maintained to check backlash.

In the event that backlash exceeds maximum tolerances, reduce backlash only in the amount that will avoid overlap of worn teeth (fig. 15).

When new gears are to be installed, differential bearings and drive pinion bearings must be in proper adjustment before any attempt is made to adjust backlash. Check backlash with dial indicator as shown in figure 16, and adjust to obtain 0.006"-0.012" lash. Adjust backlash and tooth contact in the following manner:

1. Paint at least ten teeth of bevel gear with a mixture of red lead or prussian blue and engine oil. Rotate gears through a few revolutions in both directions by hand. Refer to gear tooth contact charts (fig. 17), for directions for making proper adjustments.

2. When satisfactory tooth contact and backlash has been obtained, install adjusting ring locks (6) and secure bolts (7) with lock wire.

DIFFERENTIAL CARRIER INSTALLATION (WITH AXLE OUT OF VEHICLE)

1. Clean flanges of differential carrier (16) and axle housing (10), then position new differential carrier gasket (11) on carrier studs (39).

2. Roll differential carrier assembly into position using roller jack (or comparable type support). Start carrier into housing using four flat washers and nuts (40) equally spaced, then tighten nuts alternately and evenly to draw carrier squarely into housing.

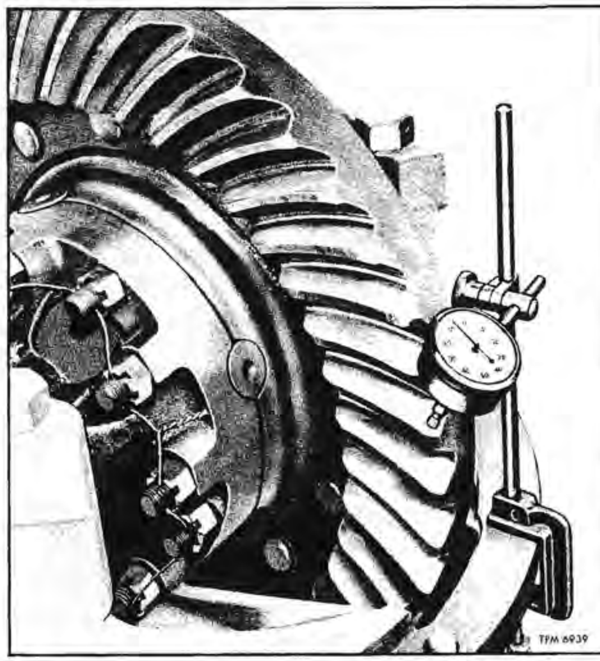


Figure 16—Gear Backlash Check

CAUTION: Driving carrier into axle housing by use of a steel hammer will not only damage carrier stud flange but will also cause oil leaks.

3. Remove nuts and flat washers, then install lock washers (41) and stud nuts (40). Tighten nuts to 290-320 foot-pounds torque.

4. Install brake camshaft and brake shoes as directed in "HAND BRAKES" (SEC. 4).

5. Install brake drum and propeller shaft yoke.

6. Adjust hand brake as instructed in "HAND BRAKES" (SEC. 4).

7. Install drain plug and tighten firmly. Fill axle housing to proper level with lubricant specified in LUBRICATION (SEC. 13). Install and tighten filler plug.

COMPLETING ASSEMBLY

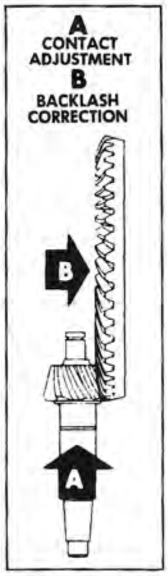
1. Before installing axle shafts, hubs should be removed, and bearings cleaned, inspected, and adjusted as directed in HUBS, WHEELS, AND TIRES (SEC. 19).

2. Install axle shafts as directed previously under "Axle Shaft Replacement" in this section.

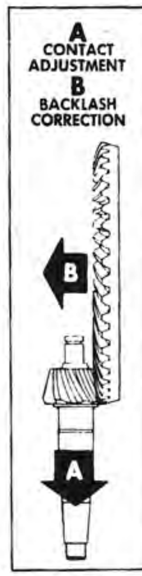
3. Complete instructions for installation of rear axle assembly will be found in AIR SUSPENSION (SEC. 14).

PAINTING GEAR TEETH

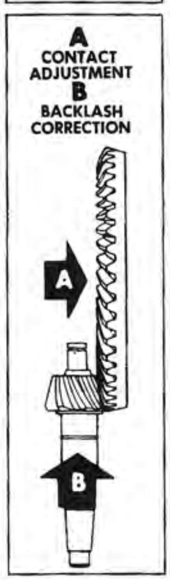
CORRECT TYPE TOOTH CONTACT



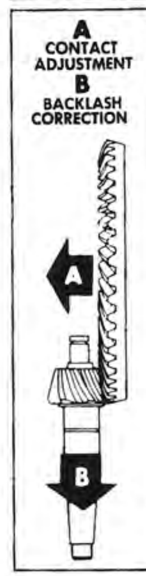
A HIGH NARROW CONTACT is not desirable. If gears are permitted to operate with an adjustment of this kind, noise, galling and rolling over of top edge of teeth will result. To obtain correct contact, move pinion toward bevel gear. This lowers contact area to proper location. This adjustment will decrease the backlash which may be corrected by moving bevel gear away from pinion.



A LOW NARROW CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, galling, noise and grooving of teeth will result. To obtain correct contact, move pinion away from drive gear. This will raise contact area to proper location. A correct backlash is obtained by moving bevel gear toward pinion.



A SHORT TOE CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, chipping at tooth edges and excessive wear due to small contact area will result. To obtain correct contact, move drive gear from pinion. This will increase the lengthwise contact and move contact toward heel of tooth. Correct backlash is obtained by moving pinion toward bevel gear.



A SHORT HEEL CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, chipping, excessive wear and noise will result. To obtain correct contact, move drive gear toward pinion to increase lengthwise contact and move contact toward toe. A correct backlash is obtained by moving pinion away from drive gear.

TP 3239

Figure 17—Tooth Contact Chart

SPECIFICATIONS

TYPE . . . . . Angle Spiral Bevel

DRIVE . . . . . Radius Rods

RATIO

SDH-4502	4-5/7 to 1	SDH-5302	5-1/7 to 1
SDM-4502	4-1/8 to 1	SDM-5302	4-1/9 to 1
TDH-4518	4-5/7 to 1	TDH-5303	5-1/7 to 1
TDM-4518	4-1/8 to 1	TDM-5303	4-1/9 to 1
TDH-4519	4-5/7 to 1	TDH-5304	5-1/7 to 1
TDM-4519	4-1/8 to 1	TDM-5304	4-1/9 to 1

ADJUSTMENTS AND CLEARANCES
Drive Gear and Pinion Backlash . . . . . 0.006"-0.012"
Adjustment Method . . . . . See Text
Shim Thickness (Carrier to Cage) . . . . . 0.003"-0.005"-0.010"-0.020"

Pinion Bearings
Adjustment Method . . . . . Selective Spacers
Spacer Thickness . . . . . 0.187"-0.188"-0.190"-0.192"-0.194"-0.196"-0.198"-0.200"-0.201"-0.215"-0.229"
Rotating Torque (In. Lbs.) 5-15

Differential Bearings
Adjustment Method . . . . . Threaded Adjusting Rings
Bearing Pre-Load . . . . . See Text

DIFFERENTIAL CASE
Run-Out (Max.) . . . . . 0.003"

SPIDER PINION
Bore Diameter (Grind) . . . . . 1.252"-1.254"
Clearance—Pinion to Spider . . . . . 0.004"-0.008"

SPIDER
Diameter of Arms . . . . . 1.246"-1.248"
Arms in Same Plane Within . . . . . 0.0025"

THRUST WASHER THICKNESS
Side Gear . . . . . 0.121"-0.125"
Spider Pinion . . . . . 0.058"-0.062"

AXLE SHAFT
Type . . . . . Full Floating
Drive Flange Run-Out (Max.) . . . . . 0.005"
Shaft Run-Out at Center (Max.) . . . . . 1/16"
Diameter at Splined End . . . . . 2.372"-2.377"

TORQUE SPECIFICATIONS (Ft. Lbs.)
Propeller Shaft Flange Nut 800-1100
Pinion Cage Stud Nuts 80-90
Carrier to Housing Stud Nuts 290-320
Differential Case Bolt Nuts 185-205
Differential Bearing Cap Bolts 570-630
Bevel Gear Cap Screw 290-320
Adjusting Ring Lock Cap Screw 15-20
Axle Shaft Flange Stud Nut 90-113

Body

This group is divided into three sections covering "GENERAL BODY MAINTENANCE," "DOORS AND CONTROLS," and "HEATING AND VENTILATION."

General Body Maintenance

GENERAL MAINTENANCE

Unlike the conventional motor vehicles which have separate frame the coach body comprises the main structure of the vehicle. Body construction is basically aluminum, reinforced with steel components. Chassis units such as the power plant, axles and steering system, etc., are attached directly to the body.

The body framing and outer panels are constructed into a box-type unit which absorbs all the road shock, driving and braking stresses. A small amount of twist occurs in body, as complete rigidity of the structure is not desirable. It is, therefore, important that body be regularly inspected for loose rivets and bolts.

Entire vehicle should be regularly inspected for condition of paint and for corrosion damage, with particular attention given to underside. Inspection should be made more frequently in freezing weather due to the corrosive effect of road deicing materials (salt, calcium chloride, etc.) on metal. If inspection discloses any evidences of corrosion, paint failure, or bare metal, corrective measures as outlined under "Painting" (later in this section) should be immediately employed.

EXTERIOR MAINTENANCE

Body painted surfaces and polished side moldings should be protected by a coating of wax, applied at regular intervals. Periods between applications should be sufficiently short to assure continuous protection of the finish. Any good body wax can be used for both painted and polished surfaces. Wax should be applied immediately after coach has been cleaned.

When necessary to remove previous wax coating, gasoline or similar solvents meeting local fire and health regulations may be employed.

Hard, anodized finish on side moldings is produced by an electrochemical process. Anodic coating is abrasion-resistant and may be cleaned, if necessary, with a mild abrasive cleaner. However, this finish, like other aluminum, is attacked by many acids and most alkalies. Consequently, considerable care should be taken in the selection of chemical cleaners. Do not use an alkaline cleaner.

3

PAINTING

Aluminum corrodes just as iron and steel rusts. Under certain conditions aluminum will corrode more rapidly than steel. Inspect body surfaces regularly for corrosion and paint condition.

REFINISHING ANODIZED ALUMINUM TRIM PANELS

All exterior aluminum trim panels may be refinished with an air-dry refinishing process utilizing an aluminum enamel No. 181-65751.

The recommended procedure for refinishing anodized aluminum trim panels is as follows:

1. Wipe the entire area to be refinished with cloths saturated with DuPont No. T-3812 reducer. While area is still wet, wipe dry.

2. Treat any scratched or abraded areas with DuPont No. VM-5717 metal conditioner reduced one (1) part by volume with four (4) parts of water.

a. Apply the above mixture with a sponge or brush and allow to stand approximately three (3) minutes.

b. Scrub the wet metal with steel wool or a stiff brush to remove dirt and corrosion.

c. Wipe area with a damp cloth, dry thoroughly and refinish.

3. (OPTIONAL) - Apply a thin, semi-transparent coat (0.3-0.5 MIL.) of DuPont No. 63-150 zinc chromate primer, reduced one (1) part with two (2) parts of DuPont No. T-8837 reducer and allow at least thirty (30) minutes to dry.

4. Apply two (2) coats of DuPont "Preparakote" Synthetic Primer Surfacer or DuPont No. 63-Line Non-Sanding Primer reduced in accordance with label directions. Allow "Preparakote" to dry two (2) to three hours before dry sanding or over night before wet sanding. The 63-Line Non-Sanding Primer may be scuff sanded if necessary, after thirty (30) to forty minutes of drying.

5. Apply DuPont No. 181-65751 aluminum enamel top coat for final refinishing process.

The above mentioned materials are readily available through E.I. DuPont de Nemours and Company.

GENERAL BODY MAINTENANCE

REPAINTING NON-ANODIZED ALUMINUM PARTS

1. Thorough cleaning is essential: All corrosion, grease and other foreign matter must be removed. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.

2. Completely remove old paint by use of organic solvents. Do not use alkaline paint remover on aluminum. If old primer is very difficult to remove and there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.

3. Apply a coat of pre-primer (sometimes called wash-primer), preferably by spraying to a uniform and complete coverage coat on all surfaces. This type primer uses a special accelerating agent containing phosphoric acid which produces an excellent bond to metal. AP-10 made by United Chromium, Inc., and XE-5220 made by Bakelite Corporation, or any equivalent material made by a reputable paint manufacturer should be acceptable. These materials must be used within a few hours after addition of accelerator, therefore, directions of manufacturer should be observed carefully. In lieu of a pre-primer, apply warm 5% sodium dichromate or potassium dichromate solution (two ounces dichromate in one quart of water) to cleaned surfaces. Apply by spraying. Allow parts to dry.

4. Use a zinc chromate primer such as DuPont 63-1016 or Arco 214-30089, or any equivalent material made by a reputable manufacturer. Apply primer, preferably by spraying, in a very thin coat. If zinc chromate primer cannot be obtained, use of a red oxide primer is recommended, but only as an emergency measure.

5. Apply finish coats:

a. For understructure and other parts not requiring color, apply two coats of the following, or equivalent; Reduce five parts of DuPont RC-147 clear Dulux with one part Duco #3637 Thinner. To each gallon add two pounds Albron (aluminum) paste, stirring mixture thoroughly.

b. If synthetic aluminum enamel is not available, any synthetic or other enamel, aluminum lacquer, or other lacquer, in that order, may be used; but only materials made by a reputable manufacturer should be employed. Then apply one heavy coat of asphalt-base sheet metal deadener approximately 1/32" thick, special spray equipment, including pressure tank, must be used if deadener is applied by spraying.

c. To exposed body parts, apply air-drying surfacer and color coats in accordance with standard practice.

PAINTING NEW NON-ANODIZED ALUMINUM PARTS

When installing new aluminum parts, or new parts which contact with aluminum parts in assembly, succeeding procedures should be followed:

1. Remove old parts to be replaced.

2. Treat all exposed sides of adjacent parts remaining in body according to previous instructions in steps 1, 2, 3, and 4 under "Repainting Non-Anodized Aluminum Parts," if aluminum; if steel, treat as in steps 1, 2, and 3 under "Repainting Steel Parts" following. Apply finish coat per step 5a under "Repainting Non-Anodized Aluminum Parts" to all surfaces both steel and aluminum.

3. Prime coat all sides of new parts to be installed as outlined in step 4 of "Repainting Non-Anodized Aluminum Parts," and step 3 of "Repainting Steel Parts"; then apply finish coat as in step 5a. under "Repainting Non-Anodized Aluminum Parts" to all surfaces both steel and aluminum.

4. Use only zinc or cadmium coated bolts, washers, and nuts. Dip all bolts, nuts, washers, and rivets in primer and allow to dry.

5. Install new parts, then apply finish coats as outlined in step 5 of "Repainting Non-Anodized Aluminum Parts."

REPAINTING STEEL PARTS

The foregoing procedures may also be applied to steel and iron parts, with following exceptions:

1. Apply a coat of pre-primer (sometimes called wash-primer), preferably by spraying to a uniform and complete coverage coat on all surfaces. This type primer uses a special accelerating agent containing phosphoric acid which produces an excellent bond to metal. AP-10 made by United Chromium, Inc., and XE-5220 made by Bakelite Corporation, or any equivalent material made by a reputable paint manufacturer should be acceptable. These materials must be used within a few hours after addition of accelerator therefore, directions of manufacturer should be observed carefully. Use of phosphoric-base metal conditioner, such as "Metalprep" (Neilson Chemical Co.) or "Deoxidine" (American Chemical Paint Co.) is also recommended in preparing steel for painting. These materials vary in method of application and use, and should be employed only as directed by the manufacturer.

2. Both organic and alkaline paint removers may be used on steel parts. However, if alkaline removers are used, all traces of alkali must be washed off before primer is applied.

3. Oxide-type primer is recommended for use on steel parts, instead of zinc chromate primer.

PAINTING NEW STEEL PARTS

The above procedures may be applied to new steel and iron parts except that oxide base primers are recommended in place of zinc chromate type.

REPAIR AND REPLACEMENT OF STEEL OR ALUMINUM PARTS

GENERAL

Body and underframe can be repaired and replaced by competent craftsmen with proper tools and equipment.

In the event of serious collision damage, the Coach Technical Service Department of GMC Truck and Coach Division will furnish data, sketches, and other information upon request. Reply will be expedited by specific description of damage, and particularly if photographs are furnished.

REPLACING BODY PARTS

Whenever repairing or replacing aluminum parts, carefully follow accepted and recommended practices. The Aluminum Company of America will furnish, upon request, booklets titled "Riveting Alcoa Aluminum" and "Welding and Brazing Alcoa Aluminum." The booklets explain detailed procedures necessary in repair and replacement of aluminum parts.

Proper precautions must be observed, particularly with reference to welding, reinforcing, corrosion prevention, and replacement, as follows:

1. Welding of aluminum structural members, or any aluminum parts subject to strain or compression, is not recommended. To maintain proper body strength, replace damaged posts, and other structural members with new parts obtained from the factory.

2. To prevent galvanic corrosion of aluminum, all surfaces of dissimilar metals in contact with aluminum must be properly coated with paint and or plating. This also applies to attaching parts such as bolts, washers, nuts, and rivets. Refer to "Repainting Non-Anodized Aluminum Parts" and "Painting New Non-Anodized Aluminum Parts," earlier in this section.

CAUTION: Avoid mixing steel and aluminum structures or parts when making repairs. Do not substitute steel for aluminum in coach structure. Steel can be used for support fittings for separate units, such as air tanks, control rods, etc. Greater deflection of aluminum causes steel parts to tend to take entire load when used in combination with aluminum parts.

STRAIGHTENING

Use of heat when straightening structural parts of body is not recommended, since heat affects structural characteristics of certain alloys and especially heat-treated parts. All body structural members should be straightened cold; any part bent or buckled sufficiently to show strains or cracks after straightening should be replaced, or properly reinforced.

CUTTING

When cutting a structural member, cut at an angle of 30 degrees. Thus, actual length of cut is twice width of piece being cut, and stress or load is distributed over a longer joint when welded. Cutting can be done by torch, although use of saw is preferred, since cut is cleaner and less material is removed.

REINFORCING

CAUTION: Before reinforcing any part of vehicle, determine cause of failure. Body and frame are integral; therefore, driving stresses and strains are transmitted throughout body. Reinforcing a point of apparent failure without correcting underlying cause of failure, may transfer stress to other parts not engineered for such stress, with resultant development of new failures. Since body is designed to "weave" a rigid reinforcement in any part of body may nullify the design of entire vehicle.

Reinforcements can be made of flat, angle or channel stock, whichever is most suitable for purpose. Use of angle reinforcements is recommended due to difficulty in fitting channel reinforcements. Reinforcements should be sufficiently long to distribute load evenly over a considerable area and thickness should not exceed that of member being reinforced. Reinforcements should be riveted to broken parts.

RIVETING

Cold aluminum rivets should be used in aluminum parts.

Diameter of rivets should be approximately 100% thickness of plates to be riveted, although rivet diameter is also dependent upon spacing and number used.

Replacement of body parts will necessitate removal of rivets in many cases. Rivets can be removed by first center-punching a hole in absolute center of head, then drilling a hole slightly less in diameter than the rivet shank to the depth of the rivet head. Shear off rivet head with a square-faced blunt chisel using a minimum amount of force; being careful not to deform the surrounding metal, remove the rivet.

WELDING

Refer to Step 1 under "Replacing Body Parts," regarding welding of structural parts.

Inert arc welding is recommended as heat of weld is localized and burning of material minimized with this method. When welding a cut member, fill or weld cut completely. Welding rods should be of substantially same material as parts to be welded.

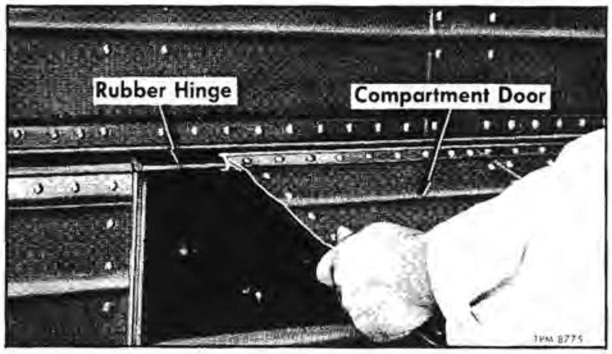


Figure 1—Replacing Rubber—Hinged Compartment Door

SEALING

When replacing front, side, rear panels, and particularly roof panels, special attention should be given to sealing of joints with sealing and caulking compounds.

REPLACEMENT OF RUBBER-HINGED COMPARTMENT DOORS

REMOVAL (Fig. 1)

1. Open door to full open position; then remove screws which secure door hinge channel to hinge.

2. Lower door to a position until door is at an approximate 90 degree angle to side of coach. With the aid of an assistant, slide door from hinge.

INSTALLATION (Fig. 1)

1. Apply glycerin, talcum powder or a soap solution to hinge to facilitate door installation.

IMPORTANT: Do not use oil or grease on rubber hinge as hinge will be damaged.

2. With aid of an assistant at one end of door, align door hinge channel with hinge and slide door onto hinge. Secure door to hinge with screws.

SASH AND GLASS

INSERT-RETAINED GLASS

All window glass except side window sash is retained in body openings by insert-type rubber-like retainer. Retainer seal and seal insert are shown typically in figures 2 and 3.

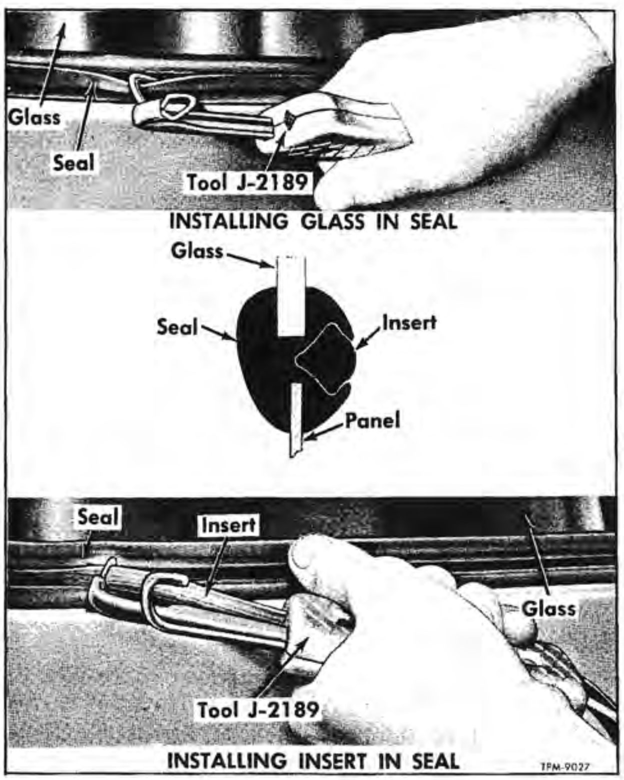


Figure 2—Replacing Insert—Retained Glass

Although possible to install retainer and seal insert without use of special tools, seal and insert installer tool (J-2189) (fig. 2) is recommended to facilitate installation.

GLASS REMOVAL

CAUTION: Wear gloves when handling glass.

NOTE: Before windshield center or lower glass section can be replaced the retention band across front of windshield must be removed. Figure 4 shows location of band and method of removing.

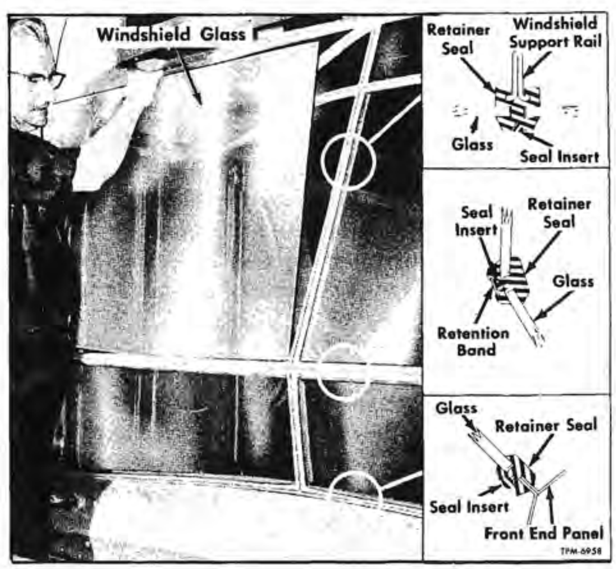


Figure 3—Installing Windshield Glass

1. Raise one end of insert out of groove in retainer seal with pointed tool; then pull insert out by hand.

2. Station an assistant outside of vehicle to prevent glass falling; then push glass outward from opening.

3. Remove retainer seal from glass or body opening.

GLASS INSTALLATION

1. Straighten panel flange around opening to assure a good fit in retainer seal groove.

NOTE: Windshield and rear window retainer seal is of one-piece and does not require cutting.

2. Wax or apply soap solution to grooves of retainer, then position retainer seal into flange around opening, making sure seal is pushed into place in corners. Ends of retainer seal should come together at side of opening near top.

3. Cut off retainer seal ends, allowing sufficient overlap to secure a tight joint, and carefully butt into position.

4. Position new glass into groove of retainer seal. Figure 3 shows a section of windshield glass being installed. Use pin end of installer tool (J-2189) to assist locating glass in seal groove as shown in upper view of figure 2.

5. Thread end of rubber insert through handle and eye of installer tool. Refer to lower view of figure 2. At point opposite joint in retainer seal, push tool eye and end of installer into seal groove.

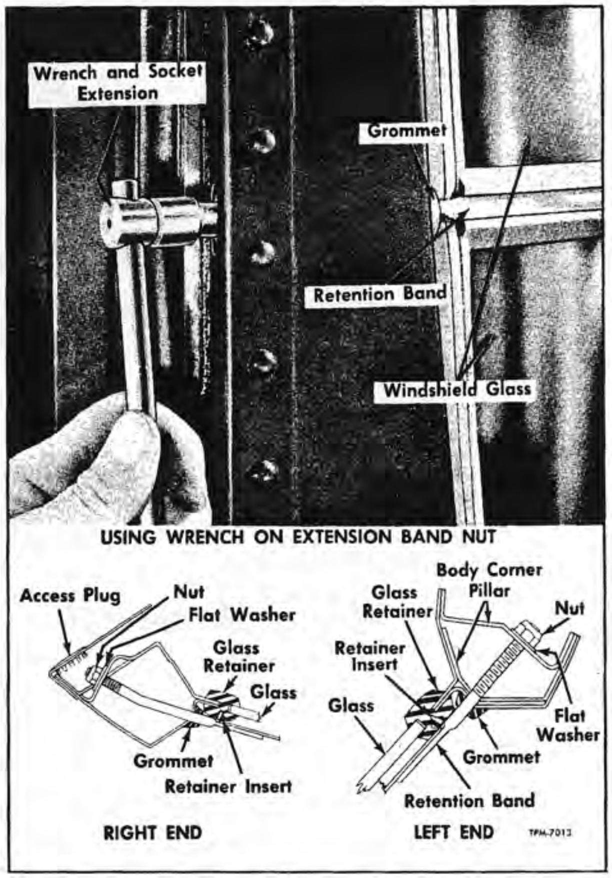


Figure 4—Windshield Retention Band Installation Views

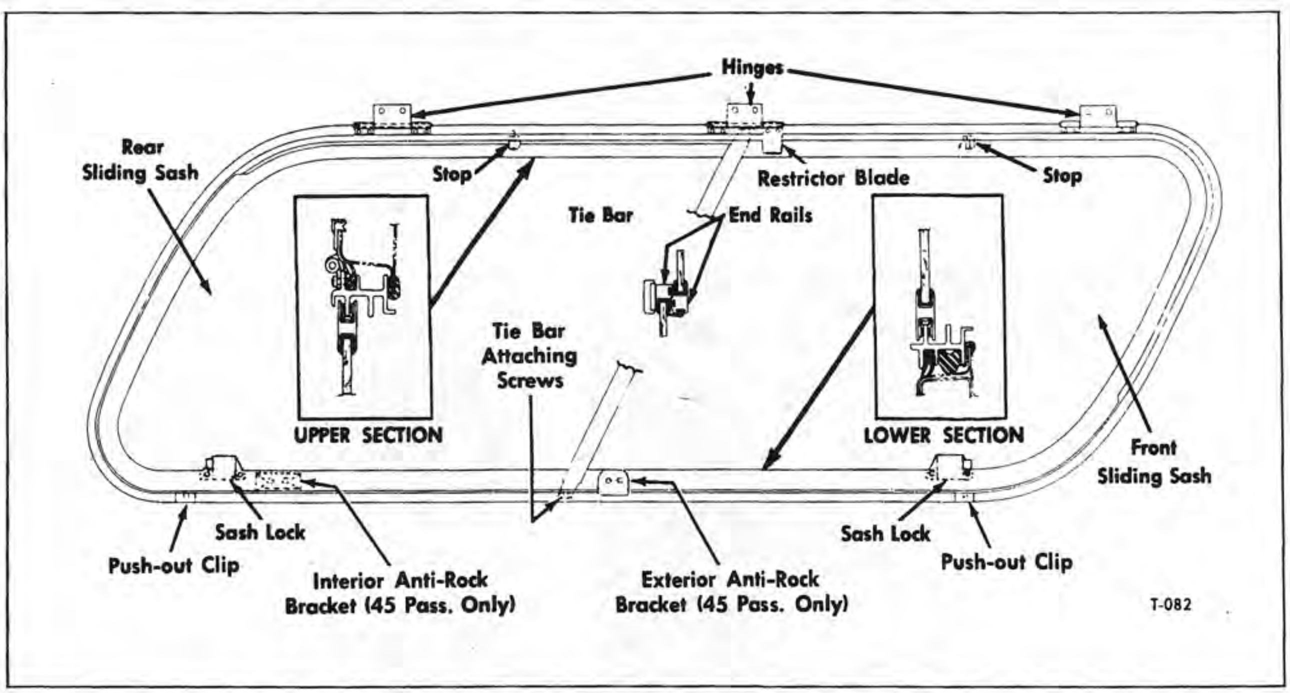


Figure 5—Long Side Window Assembly

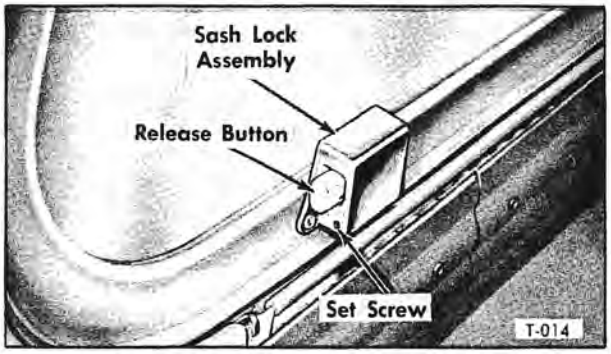


Figure 6—Side Window Sash Lock

Feed into groove in retainer seal. Use a hitching motion to prevent elongation of insert.

6. Cut off insert, allowing overlap, and butt ends tightly into groove.

LONG SIDE WINDOWS

Long side windows consist of two sections of sliding sash and glass enclosed in a one-piece aluminum frame (fig. 5). Window can be opened by sliding front section rearward and rear section forward. Each section is retained in closed position by a latch-type lock. The front section can be located and retained in one of three opening positions by means of notched stopping bar at window base.

The window sections can be locked closed, thus preventing passengers from opening windows and interferring with the heating or air conditioning systems. A small set screw at forward end of lock (fig. 6) can be turned in (clockwise) with release button not held in until screw bottoms against the lock pawl. This will block the travel of the lock plunger thereby preventing the unlatching of lock.

EMERGENCY ESCAPE

Long side windows are hinged at top to provide passenger escape under emergency conditions.

Window is retained in closed position by bent-down tangs of two push-out clips at bottom of windows (fig. 7). Clips of U-shape construction are inserted over channel rail of window and tangs of clips are then bent down over body panel flange when window is held in closed position.

Under emergency conditions, bottoms of windows can be forced outward, causing tangs of clips to straighten out.

SIDE WINDOW REMOVAL (Fig. 5)

Side window is readily removed after first opening window to emergency escape position. With the aid of an assistant to hold window, remove screw from end of each pin, then remove pins from hinges. Push out at top of sash, then lower window assembly from opening.

SIDE WINDOW INSTALLATION (Fig. 5)

1. Before installing window, inspect window outer seal and rubber support blocks. Replace if necessary.

2. With support blocks located at bottom and ends of window frame, position window assembly to opening in coach. Insert hinge pins, then secure each with a screw.

3. Locate new push-out clips to bottom of window frame, then slide front and rear sections to center (fig. 8). Raise bottom of window at point "A," then let weight of window assembly rest on window opening sill (fig. 8). Inside of coach, at points "B," pull window inward evenly to retain window in completely closed position. While holding window in closed position have assistant bend tangs of push-out clips downward as shown in figure 7.

SLIDING SASH AND GLASS REMOVAL

CAUTION: Wear gloves when handling glass.

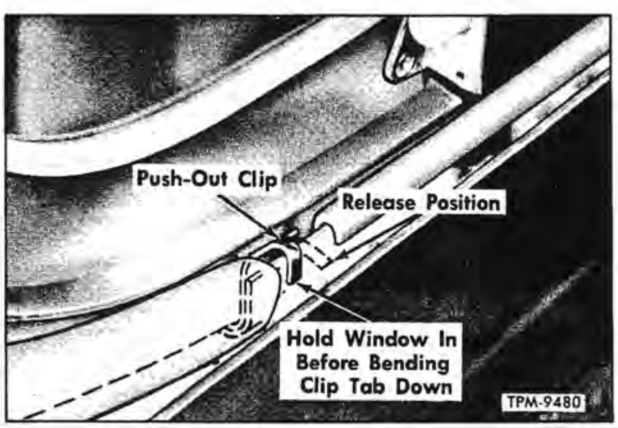


Figure 7—Emergency Escape Push-Out Clip Installed

Figure 8—Installing Long Side Window (Typical)

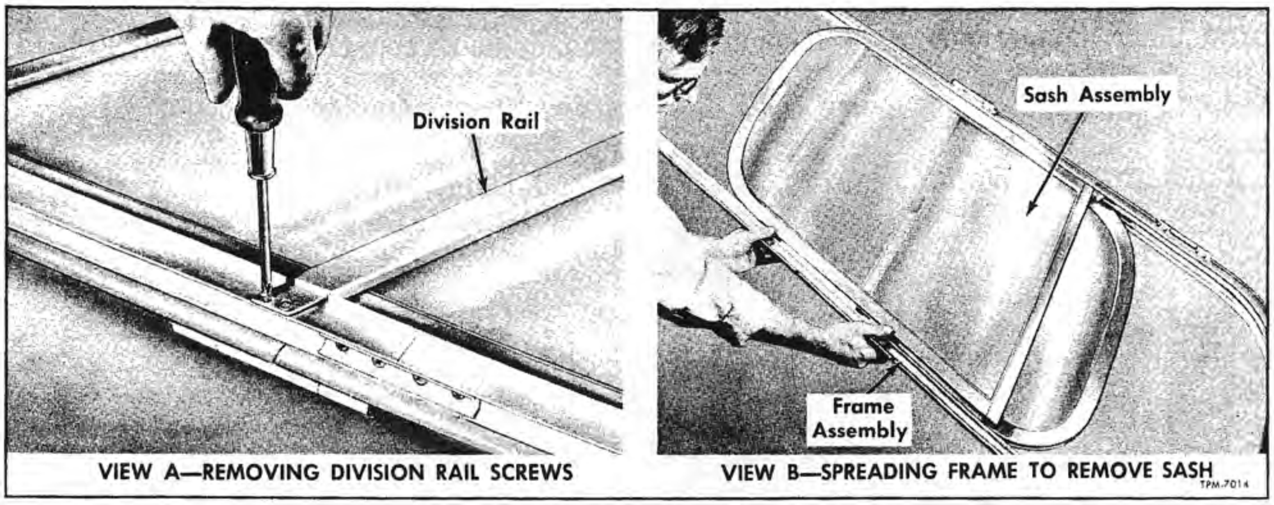


Figure 9—Replacing Side Window Sash Assemblies

1. Remove side window as previously directed under "Side Window Removal."

2. On 45 passenger coaches small anti-rock brackets (one inside of glass and the other outside of glass) must be removed. Brackets are retained with two screws.

3. Remove two screws which attach one end of tie bar to window frame (View "A," fig. 9). Purpose of tie bar is to prevent window frame from spreading in the center when window is being carried or when in emergency escape position.

4. Referring to View B, figure 9, spread window frame in the center only enough to permit removing sash and glass sections from frame channels.

5. To disassemble sash and glass sections remove screw (View A, fig. 10) at upper and lower end of section vertical-slanting end rail. Remove end rail, then carefully remove broken glass and glazing rubber from sash.

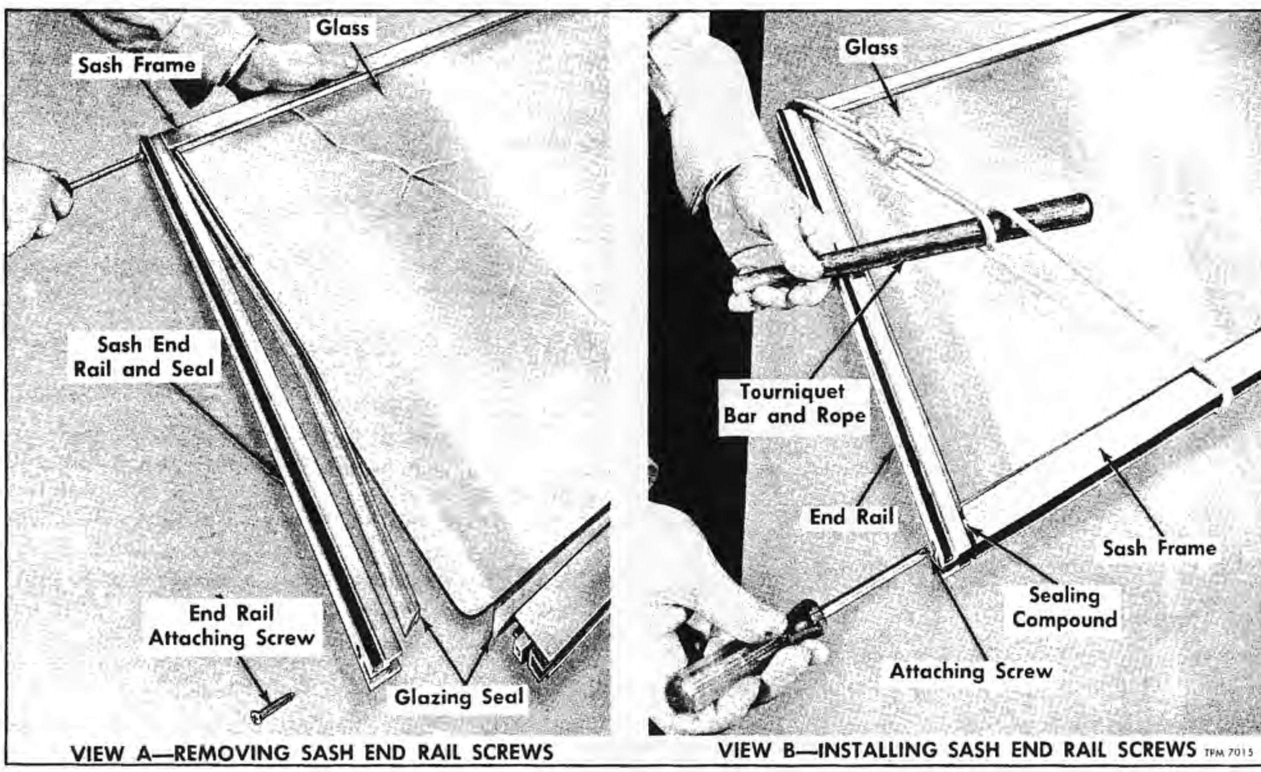


Figure 10—Replacing Sliding Section Glass

GENERAL BODY MAINTENANCE

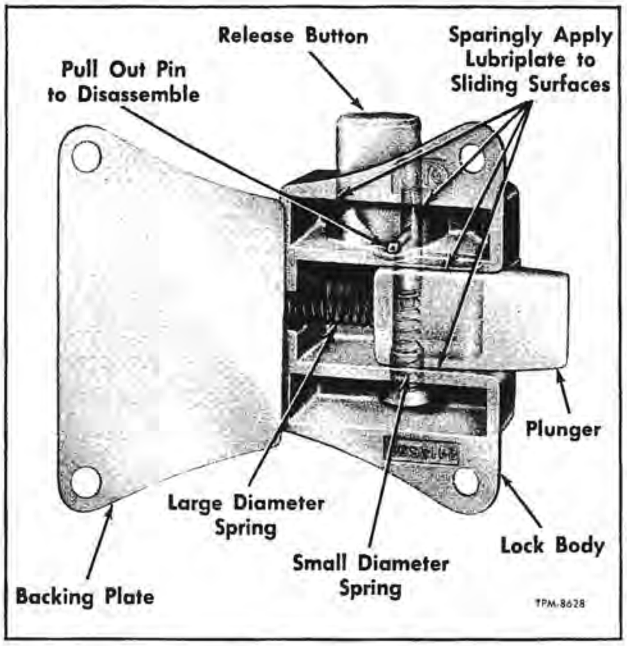


Figure 11—Side Window Lock Mechanism

SLIDING SASH AND GLASS INSTALLATION

1. Clean glass sash channels thoroughly.
2. Position new glazing rubber on glass; then using parafin or glycerin on glazing rubber to facilitate glass installation, install glass with rubber in sash.

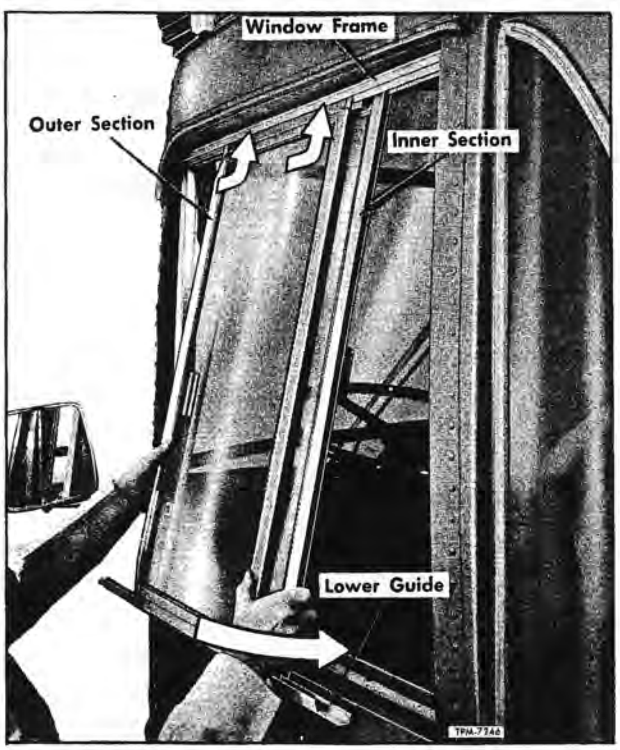


Figure 12—Replacing Driver's Window

3. Using a strong cord as a tourniquet to press sides of frame into position as shown in View B, figure 10, install vertical-slanting end rail to sash with attaching screws.
4. Spread window frame apart at center only sufficiently to allow installing sash in frame channels (View B, fig. 9).
5. Install tie bar to window frame with screws (View A, fig. 9).
6. On 45 passenger coach windows, install anti-rock brackets.

SLIDING SASH POSITION LOCK

Two lock assemblies are located at bottom of window assembly for retaining sliding sections in closed or open positions.

Pushing inward on release button will free lock plunger from notch in sash rail. If release mechanism binds or fails to operate properly, remove lock assembly from sash frame.

Using a pointed or flat bladed tool, pry backing plate from rear side of lock body (fig. 11). If operation of release button does not indicate point of trouble, pull small pin which retains all moving mechanism in position. Remove components from lock body. Check for broken or distorted springs and also for rough spots on all sliding surfaces.

Install components in lock body. Sparingly apply special lubricant (S-17) to all sliding surfaces (fig. 11). Refer to LUBRICATION (SEC. 13) of this manual, for description of special lubricant (S-17). Operate lock mechanism to check action. If operation is satisfactory, reinstall backing plate, then install lock assembly to sash. Tighten lock attaching screws firmly.

NOTE

Check operation of all sash locks at regular periodical inspections. Replace if necessary.

DRIVER'S WINDOW REPLACEMENT

REMOVAL (Refer to Fig. 12)

1. At bottom of window, remove four screws which attach window lower guide to window outer frame ledge.

NOTE: Center or forward sliding section can be moved fore or aft for access to attaching screws.

2. While assistant within coach forces bottom of sash sections outward, grasp window as shown in figure 12 and lower from window opening.

INSTALLATION

1. Slide window sections to center as shown in figure 12, then lift sections to openings and engage section upper channels over mating guide rails of window outer frame in body opening.

2. Swing bottom of sections inward and at same time raise to support bottom guide on window outer frame ledge. Install four screws attaching bottom guide to ledge. Tighten screws firmly.

IMPORTANT

Heads of screws must not contact bottom of sliding sections when being moved fore or aft.

WINDSHIELD WIPERS

Two air-operated windshield wipers are mounted in front panels, below windshield. Air pressure for wiper operation is supplied by auxiliary air system, fed in turn from coach main air system. A pressure regulating valve, interposed in air lines (fig. 13), prevents depletion of main air system when pressure in main air system falls below approximately 65 psi.

Windshield wiper motors are individually controlled by valves, mounted on dash panel at left of steering column. Valves can be partially disassembled for cleaning as explained later.

Refer to BRAKES (SEC. 4) for maintenance and repair information on auxiliary system air pressure regulator valve, air lines, and connections. Figure 13 illustrates typical systematic diagram of windshield wipers and controls.

Operation of wipers can be checked without wetting windshield glass by inserting a small nail into holes at base of each wiper arm after pulling arms forward (fig. 14). This will retain blades from contacting glass.

NOTE: Some coaches are equipped with a special oiler device which is located in the wiper air supply line under dash. Air supply to wiper motors must first pass through oiler where some lubricant is picked up and is then carried into the wiper motors for automatic lubrication of internal parts.

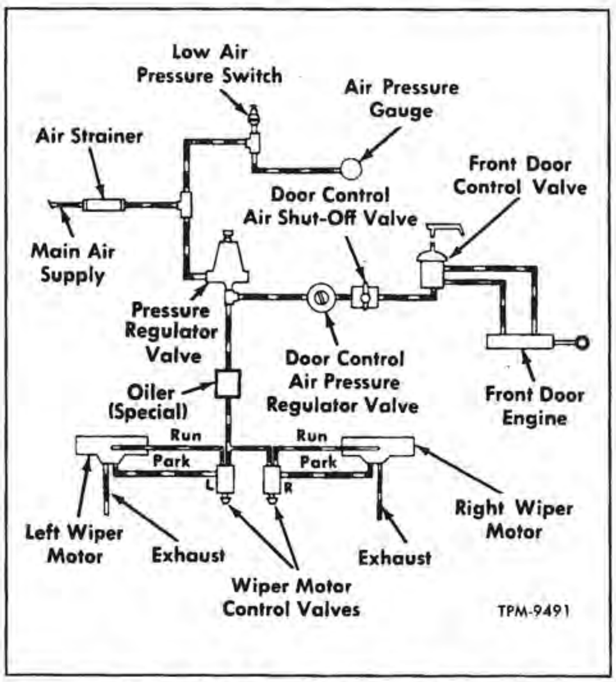


Figure 13—Schematic Air Line Diagram

Servicing of oiler device is covered in LUBRICATION (SEC. 13) of this manual. Service instructions are also located on side of oiler unit.

IMPORTANT: Before disconnecting any wiper lines or replacing any wiper unit, deplete air pressure from auxiliary air system.

Standard wiper arm arrangement at each windshield glass section consists of a single arm with provision for adjusting angle of blade (fig. 15).

Special wiper arm arrangement consists of an arm and a pantograph shaft as shown in figure 16. Blade angle is also adjustable by lengthening or shortening the pantograph shaft.

SERVICE REPAIR KIT (Arrangement Having Pantograph Shaft - Special Equipment)

Repair kits are available for arm tip and bushing assemblies "A" and "B," figure 16, and for the arm bushing and pivot pin assembly (C, fig. 16). See "SL" parts list for kit numbers.

SERVICE REPAIR KIT (Arrangement Less Pantograph Shaft - Standard)

A repair kit including arm pivot bolt, bolt

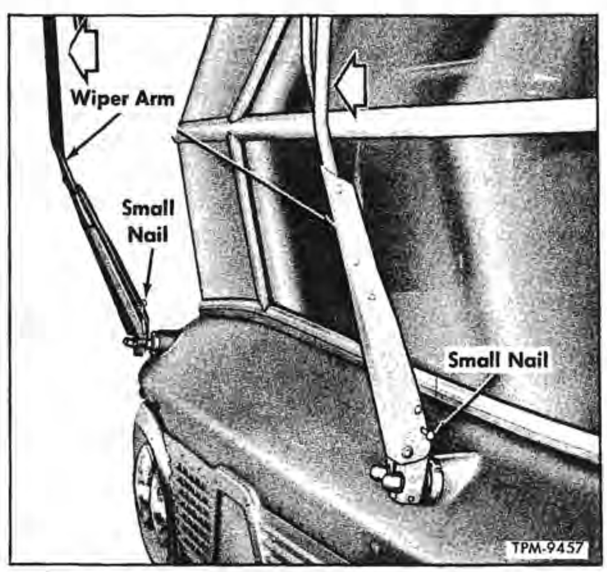


Figure 14—Windshield Wiper Arms Retained From Glass (Typical)

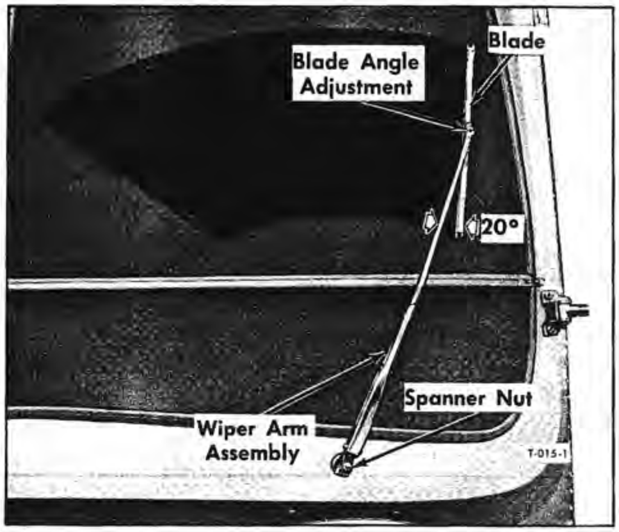


Figure 15—Wiper Arm and Blade Installed (Standard)

bushing, bushing sleeve and instructions for installing parts is available for servicing arm. See GM Coach Parts Book for kit number.

WIPER BLADE ANGLE ADJUSTMENT

ARM ARRANGEMENT LESS PANTOGRAPH SHAFT (Fig. 15)

To adjust blade position, loosen blade attaching nut, then while arm is in position shown (arms outward) locate blade vertically to obtain a 20 degree angle between lower portion of blade and the arm as shown in figure 15. After obtaining proper blade angle, tighten blade attaching nut firmly.

ARM ARRANGEMENT WITH PANTOGRAPH SHAFT (Fig. 16)

Pantograph shaft length is adjustable to allow setting wiper blade angle. Each blade should travel across windshield in a position so that when the arm is at the end of its outward sweep, the wiper blade should be parallel with edge of windshield as shown in figure 16. If necessary, adjust angle of blade as follows:

1. Loosen lock nuts on pantograph shaft (fig. 16).

2. Remove crown nut which attaches shaft arm to pivot shaft. Remove shaft arm from shaft, then while holding outer end of pantograph shaft, turn shaft arm to shorten or lengthen overall length of shaft assembly.

3. Reinstall arm on pivot shaft. Force arm and blade across wetted glass or retain arms outward with nail (fig. 14) and check angle of blade.

4. Repeat adjustment if necessary, then install crown nut on pivot shaft. Secure nut firmly. Tighten lock nuts on pantograph shaft.

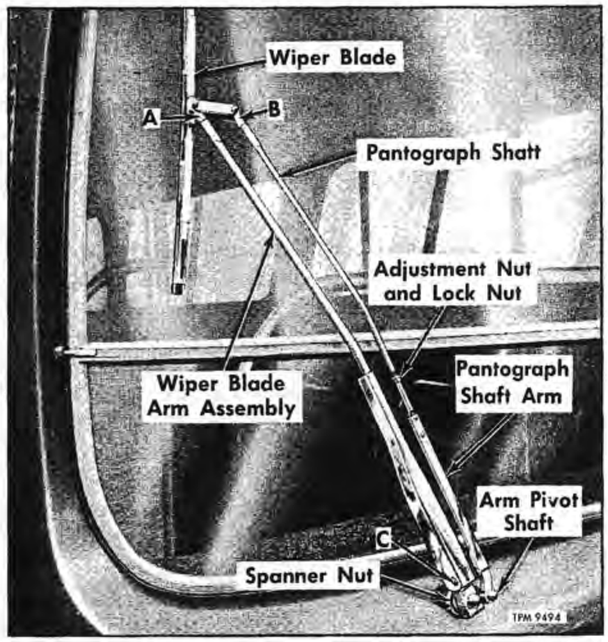


Figure 16—Wiper Arm and Blade Installed (Optional)

WIPER ARM REPLACEMENT AND REPAIR

ARM REMOVAL

1. Remove crown nut at arm shaft and the pantograph crown nut (if used).

2. Mark relationship of arm head to end of motor shaft to assure original position if arm is to be reinstalled.

3. Using a hex-wrench, loosen bolt which clamps arm head to shaft. Remove arm and pantograph shaft (if used).

IMPORTANT: Do not lose small thin shim washers (if used) on pantograph arm pivot shaft.

REPAIR (Refer to Fig. 17)

NOTE: Instructions for repairing arm assembly pivot components are included in arm pin and bushing service repair kit. However, the procedure for releasing and installing tension spring is as follows:

1. Remove small cotter pin which retains anchor pin at upper end of tension spring.

2. Drive out anchor pin to release the spring and the spring eye bushing. Spring can then be removed from link lever assembly.

3. Before installing spring, install anchor pin with bushing to arm. Install anchor pin cotter pin.

4. Using a strong hooked instrument, stretch spring to engage anchor pin.

ARM INSTALLATION

1. If arm includes special pantograph shaft,

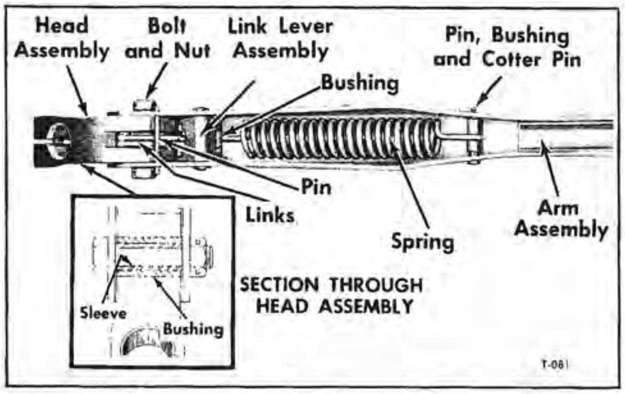


Figure 17—Wiper Arm Construction

make sure small thin shim washers are located on arm pivot shaft. NOTE: Use the required number of shims to obtain the smallest amount of arm end play on shaft when the crown nut is fully tightened. Too many washers will cause binding and eventual failure of linkage.

NOTE: Apply a small amount of special lubricant (S17) to pivot shaft. Refer to LUBRICATION (SEC. 13) for description of special lubricant S17.

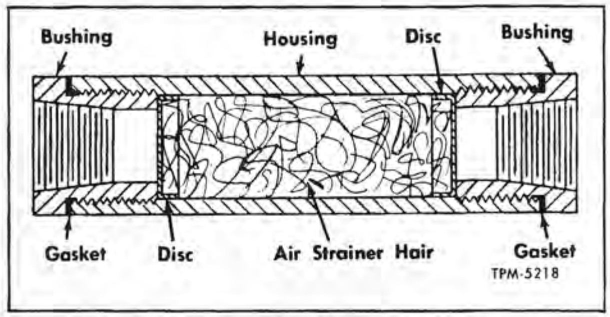
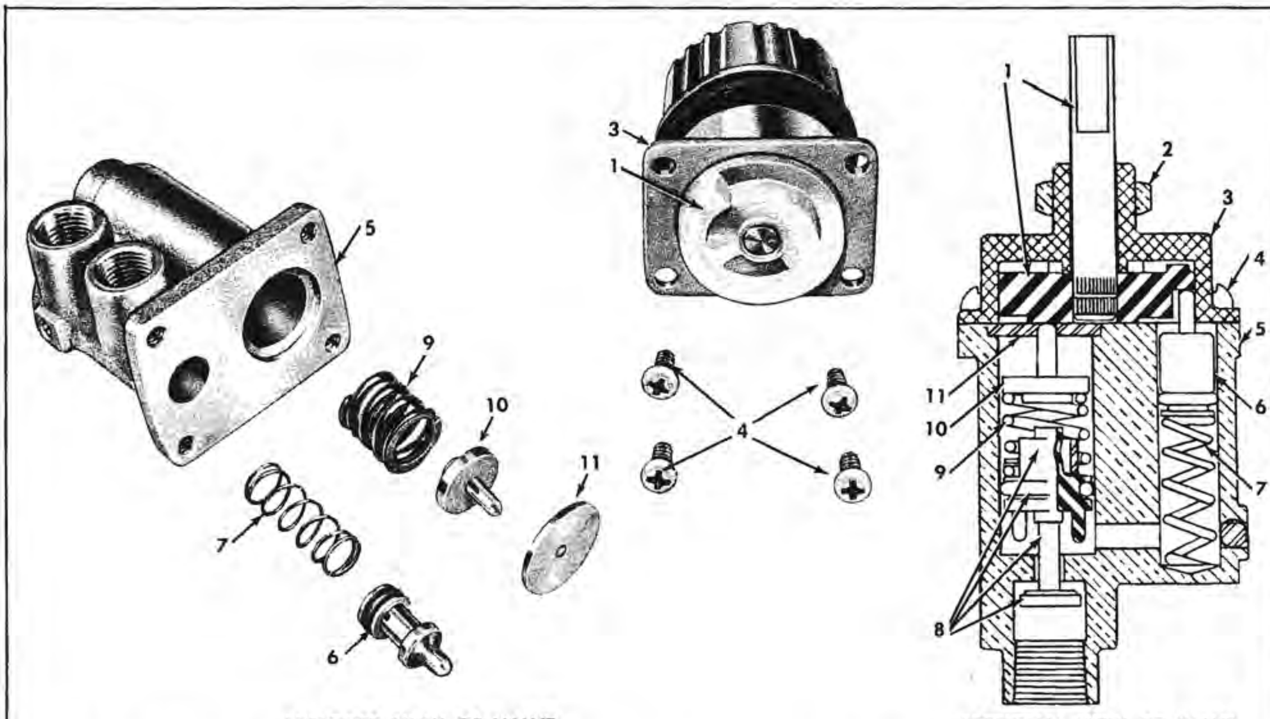


Figure 18—Windshield Wiper Air Strainer

2. Make sure wiper motor shaft is in "Park" position, then locate wiper arm components to motor shaft. If arm-to-shaft location was marked prior to removal, align these marks.

3. Tighten arm clamp screw and install cown nuts.

4. Operate wiper on wetted glass or with arms extended and blocked forward (fig. 14). Check sweep and blade angle. If necessary, reposition arm on shaft and make blade angle adjustment as explained previously. Tighten crown nuts firmly after making adjustment.



1 Cam Rod Assy.
2 Lock Nut
3 Cover
4 Cover Attaching Screws
5 Body
6 Parking Valve Stem Assy. (Incl. O-ring)
7 Spring (19/64" O.D.)
8 Valve, Seat, and Retainer Assy.
9 Spring (31/64" O.D.)
10 Pressure Regulating Ram
11 Guide Washer

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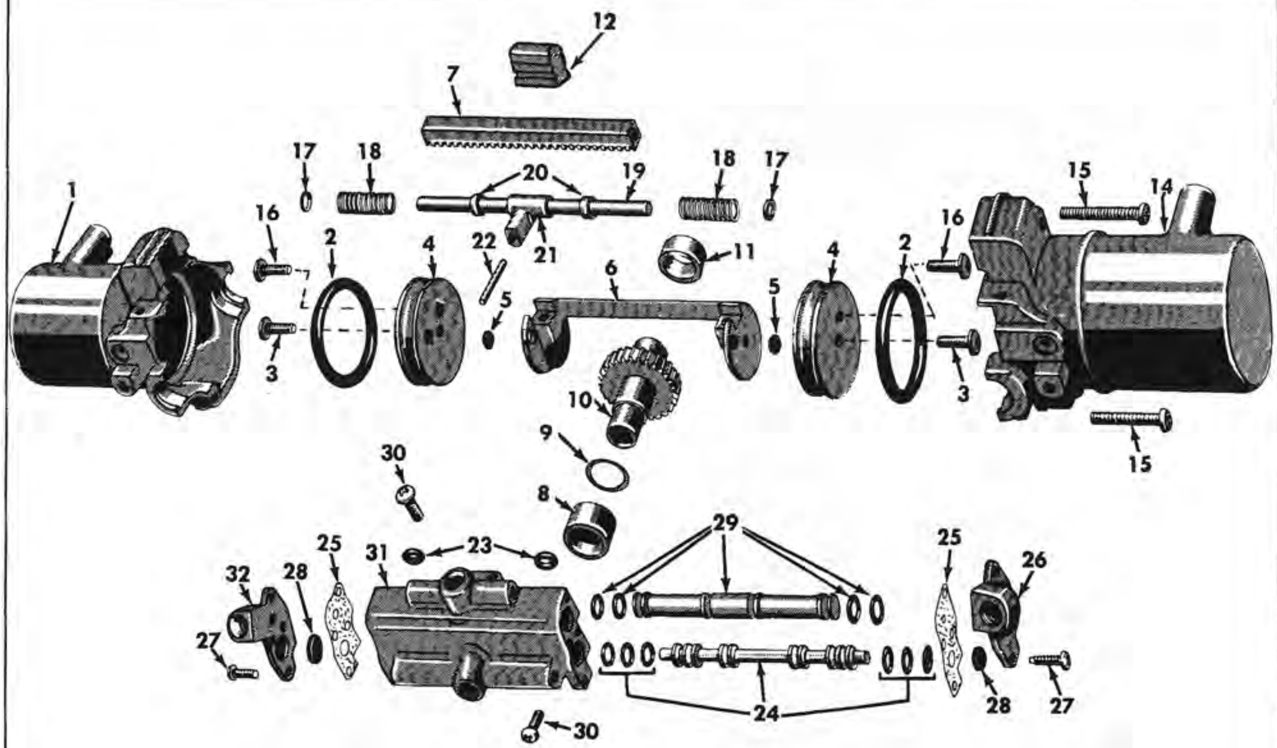
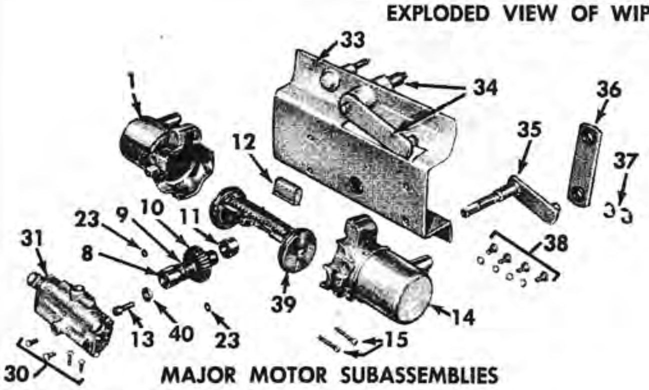
Figure 19—Windshield Wiper Hand Control Valve



EXPLODED VIEW OF WIPER MOTOR ASSEMBLY



MAJOR MOTOR SUBASSEMBLIES

1 R.H. Piston Body Assy.
* 2 Rubber O-Ring
3 Screw Assy.
* 4 O-Ring Adapter (R.& L.)
* 5 Rubber Disc
6 Piston Rack
7 Gear Rack
8 Bearing (Rear)
9 Shim Washer
10 Gear and Sleeve Assy.
11 Bearing (Front)
*12 Thrust Block
13 Shaft Retaining Screw
14 L.H. Piston Body Assy.
15 Body Attaching Screws
*16 Piston Rack Attaching Screws
17 Steel Washer
18 Spring
19 Turnbuckle Rod
20 Reverser Stop Floating Piston Tubing
21 Reverser Tee
*22 Valve Pin
*23 Valve Body O-Ring
*24 Secondary Rod Assy.
25 Gasket
26 Parking End Plate (R.H.)
27 End Plate Attaching Screw
*28 Disc
*29 Primary Rod Assy.
30 Valve Body Attaching Screws
31 Valve Body
32 Parking End Plate (L.H.)
33 Motor Mounting Bracket Assy.
34 Wiper Arm Shaft Assy.
35 Motor Shaft and Link Assy.
36 Link
37 Link Retainers
38 Motor Attaching Bolts
39 Piston Assy.
40 Washer

(*) Part of Repair Kit.

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Figure 20—Windshield Wiper Motor Assembly

WIPER MOTOR AIR STRAINER

Windshield wiper air strainer (fig. 18), mounted in air line behind panel at left of dash should be removed, disassembled, and cleaned annually. Strainer is shown installed in figure 4 under "Doors and Controls." Soak strainer filter hair in cleaning solvent to clean. Dry filter hair, then reassemble strainer. Tighten strainer end bushings firmly after cleaning.

After installing strainer, check for air leaks at line connections.

WIPER MOTOR HAND CONTROL VALVE

Individual wiper motor hand control valves (fig. 19) can be removed from vehicle for cleaning or repair if necessary. Before removing valve assembly, exhaust pressure from air supply tank.

REPAIR

NOTE: Key numbers in text refer to figure 19.

1. Remove four screws (4) which attach cover (3) to body (5). Separate cover from body as shown.
2. Pull parking valve stem (6) with rubber O-ring from valve body. Remove valve spring (7).
3. Using needle-nose pliers, pull pressure regulating ram (10) with guide washer (11) from valve body. Remove spring (9).

NOTE: Do not disassemble valve further.

4. Clean all parts in solvent, then applying air pressure into valve body ports, blow any dirt and solvent from valve body. Using a wood stick or other soft material, force valve, seat, and retainer assembly (8) back and forth within body, then repeat cleaning procedure. NOTE: If retainer assembly appears damaged, the entire hand control valve assembly should be replaced.
5. Apply small quantity of wiper motor grease to valve surfaces a nd rubber O-rings.
6. Referring to sectional view, assemble valve as shown, then install and check operation.

WIPER MOTOR REPLACEMENT AND OVERHAUL

REPLACEMENT

Removal

1. Remove wiper arm linkage at front of windshield. Remove nuts and seal washers from motor linkage shafts.
2. Exhaust pressure from air supply system.
3. Disconnect air lines at wiper motor.
4. Remove bolts which attach motor bracket to body panel. Remove motor unit.

Installation

1. Place wiper motor with assembled linkage into position and attach to body panel with bolts and washers. Also at front of vehicle install spanner nut which retains motor shaft in position. Tighten nut to 18 to 20 foot-pounds torque.
2. Connect air lines to motor valve ports.
3. Build up air supply (65 psi or more).
4. Operate motor. While observing the cycling of wiper arm shaft, turn wiper off when shaft is located in "Park" position (blades park at center of windshield). Apply small quantity of special lubricant (S17), to motor and pivot shafts. Refer to LUBRICATION (SEC. 13) for description of special lubricant S17. Engage wiper arm over serrations of shaft; at same time install pantograph shaft to pivot shaft. Tighten arm clamp screw and install crown nut to pivot shaft.

IMPORTANT: Make sure pantograph shaft arm (if used) is free to rotate on pivot shaft as too many shim washers (if used) under crown nut will cause binding of linkage.

OVERHAUL

NOTE: A kit is available including all necessary parts to properly service motor. Kit includes all items indicated by an asterisk (*) in figure 20 plus 1 oz. of recommended lubricant.

NOTE: All key numbers in following text refer to figure 20.

Separation of Major Sub-Assemblies

NOTE: Lower left view of figure 20 shows major subassemblies.

1. Remove retainer (37) which attaches link (36) to motor shaft assembly (35).
2. Remove screw (13) and washer (40) which attach motor transmission shaft (35) into wiper motor. Pull shaft assembly from motor assembly.
3. Remove four bolts (38) which attach mounting bracket assembly (33) to motor.
4. Remove four screws (30) which attach wiper control valve body (31) to motor piston body assemblies. Remove valve body and body O-rings (23). Figure 21 shows body separated.
5. Place right half of piston body (1) (half with threaded screw holes) in vise so that attaching screws are up. CAUTION: Tighten vise ONLY enough to hold body.
6. Remove screws (15) which attach piston bodies together.
7. Slowly lift off upper piston body (14).
8. Note position of alignment marks ("O") on gear (10) and gear rack (7) (fig. 22). Remove gear assembly, noting locations of thick and thin bearings and the chamfer on the rear bearing.
9. Remove thrust block (12).
10. Note position of valve reverser tee (21) in body slot, and remove the piston assembly (39).

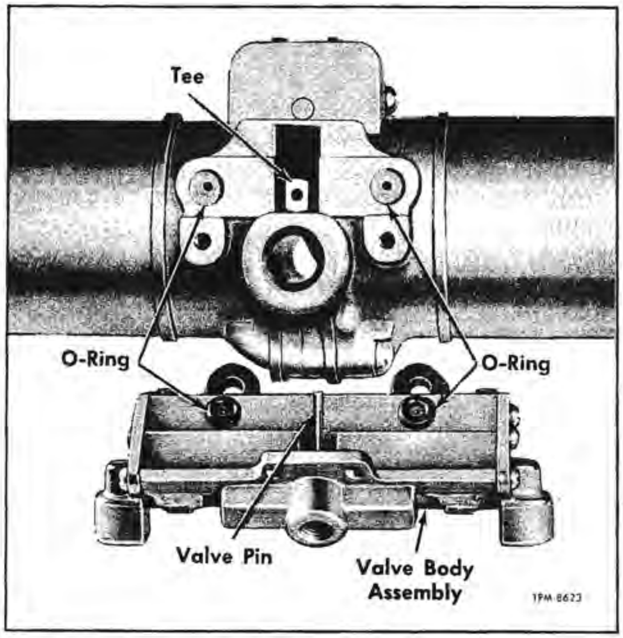


Figure 21—Windshield Wiper Motor Valve Body Removed

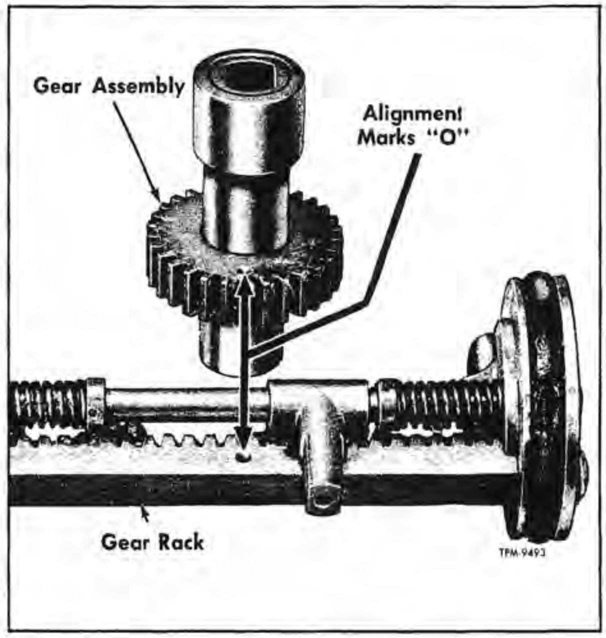


Figure 22—Gear-To-Gear Rack Timing Marks

Build-up of Major Sub-Assemblies

1. Apply clean wiper motor grease to all moving or sliding parts.

2. With right piston body assembly (1) placed in vise, install piston assembly (39) into piston body.

3. Install thrust block (12). Make sure pin notch is properly positioned to align with body attaching screw later.

4. Assemble bearings (8) and (11) with shim washer (9) on gear and sleeve assembly (10).

NOTE: Make sure shamfer on rear bearing is toward the rear. Install gear and bearings into body. Make sure alignment marks ("O") on gear and rack are aligned (fig. 22).

5. Install left piston body assembly (14) over piston assembly. Attach bodies together with screws (15). Tighten screws firmly.

6. Referring to figure 21, place O-rings (23) on bosses of valve body (31) as shown. Carefully place valve body to motor piston bodies, then install valve body attaching screws (30). Tighten screws firmly.

7. Attach mounting bracket (33) to motor with four bolts (38) and lock washers.

8. Install motor transmission shaft assembly (35) to motor, making sure shaft link is positioned to align with upper wiper arm shaft lever. Install washer (40) and shaft retaining screw (13).

9. Install link (36) to shaft and secure with retainer (37).

Wiper Motor Valve Disassembly and Assembly

1. Remove screws (27), then remove parking end plate (26 and 32) and gaskets (25) from valve body (31). Remove disc (28) from end plates.

2. Unscrew valve pin (22) projecting from valve body side.

3. Push out primary (a lum.) rod (29) and secondary (nylon) rod (24) from valve body.

4. Remove rubber O-rings from rods.

5. Clean the valve body, end plates, mounting screws and rods with solvent and wipe rubber O-rings with clean cloth. Examine all parts for wear and defects. Replace all worn and defective parts.

6. Apply wiper motor grease to valve rods and rubber O-rings.

7. Install rubber O-rings on rods, then push rods into valve body. NOTE: Make sure tapped hole in primary rod (29) is in position to align with valve pin (22).

8. Thread valve pin (22), into primary rod.

9. Make sure rubber disc (28) are installed in end plates (26 and 32). Install end plates to valve body with screws (27).

Wiper Motor Piston Disassembly and Assembly

1. Remove rubber O-rings (2) from O-ring adapters (4).

2. Remove screws (3 and 16) at each end of piston assembly, then lift off O-ring adapters (4). Remove gear rack (7).

3. Note assembled position of reverser tee (21), springs (18), and steel washers (17), then disassemble components. Reverser stop floating piston tubing (20) are retained to turnbuckle rod (19) with small pin.

4. Clean all parts thoroughly, then examine for wear and abrasion. Replace parts if required. Grease rubbe: O-rings and gear rack liberally.

5. Referring to figure 20 assemble tee (21), tubing (20), springs (18), and washers (17) on turnbuckle rod (19) as shown. Position gear rack (7) to piston rack (6), then with rubber discs (5) located in recesses at inner side of O-ring adapters (4), locate right and left O-ring adapters to piston rack and secure with screws (3) and (16). Tighten screws firmly.

MISCELLANEOUS EQUIPMENT

PASSENGER SIGNAL BUZZER AND CHIME

Either a buzzer unit or a chime unit may be used as passenger signal to driver. Figure 23 shows a buzzer unit and figure 24 shows a chime unit. Either unit is mounted to roof crown panel above driver.

Signal is sounded by switches, mounted on trim paneling at rear of front door and on driver's window rear post, and operated by pull cords at top of coach side windows.

Signal circuit, protected by number 7 circuit breaker is fed through "BUZZER" switch when "MASTER" switch is in "DAY" or "NITE" position.

"BUZZER" control switch is located on recessed switch panel at left of driver.

Refer to "Alarm and Signal Circuits Diagram," at end of this manual for additional information.

NOTE: Information pertinent to either signal unit is covered under applicable headings below.

BUZZER UNIT (Refer to Fig. 23)

Points Maintenance

Contact points of buzzer should be inspected periodically and cleaned if necessary. At regular intervals cover should be removed from buzzer and contact points inspected for corrosion or other defects.

Test

If buzzer fails to operate with either switch, remove cover from buzzer and inspect contact points. Points should be clean and in contact. Make sure terminal nuts are tight.

If buzzer still fails to operate, check circuit continuity in following sequence, using a voltmeter or a test light having a 12 volt 1.5 c.p. bulb.

1. Turn on "BUZZER" switch on recessed switch panel and place "MASTER" control switch in "DAY" or "NITE" position. With one test lead grounded, touch other lead to one and then the other buzzer terminals. If no current is indicated at either terminal, defective wiring or control switch between control panel and buzzer is indicated.

2. If current is obtained at only one terminal, points are not making contact, or coil is open circuited. Repair or replace unit.

3. If current is obtained at both buzzer terminals and buzzer does not sound, repair unit.

4. To check circuit (except buzzer), remove leads from buzzer and attach each lead to voltmeter or test light lead. If current indication is obtained when each signal cord is pulled, circuit is operating properly.

5. If current indication is not obtained, switches and wiring should be carefully checked for open circuits.

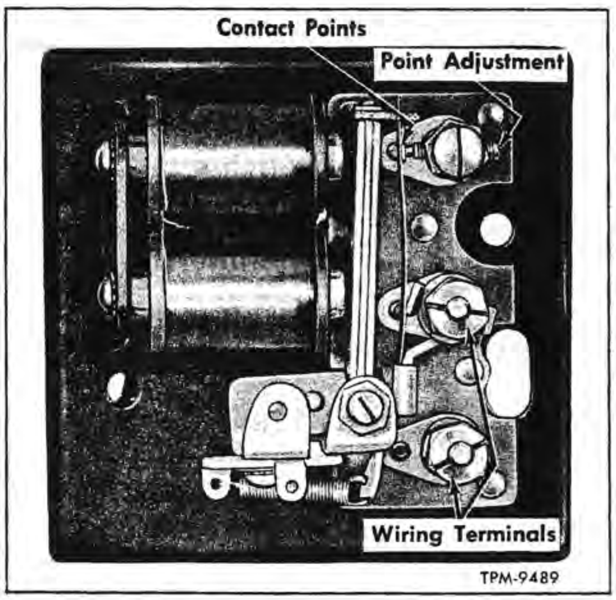


Figure 23—Passenger Signal Buzzer

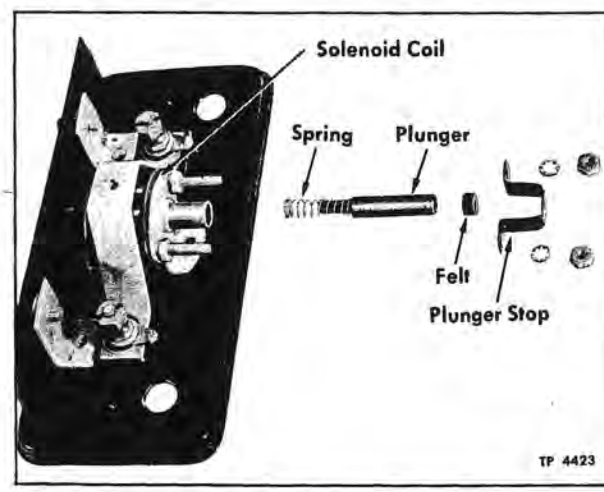


Figure 24—Passenger Signal Chime

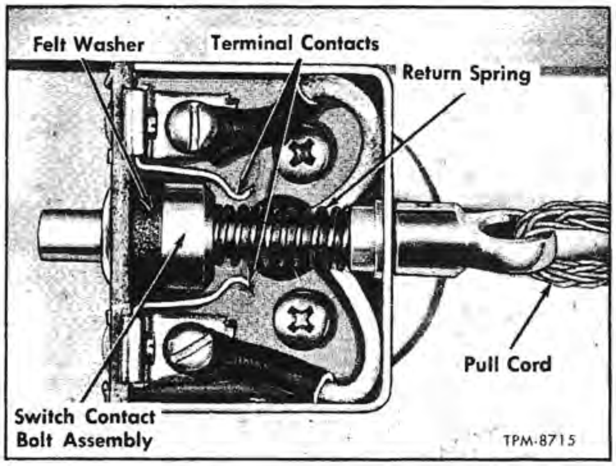


Figure 25—Passenger Signal Cord Switch Cover Removed

CHIME UNIT (Refer to Fig. 24)

Maintenance

Solenoid-type chime has no contacts and requires no regular maintenance.

If chime fails to operate, remove chime cover. With "BUZZER" switch in "BUZZER" position and with "MASTER" switch in "DAY" or "NITE" position, check for current indication at both terminals of chime. Current should be obtained at one terminal. Ground other (dead) terminal with jumper wire.

If chime now sounds, check circuit continuity from chime, through switches, to ground. If chime does not sound, make sure plunger operates freely. Disassemble chime as shown in figure 24. Failure may be due to burned out coil, or may be caused by felt positioned in such a manner as to prevent operation of plunger.

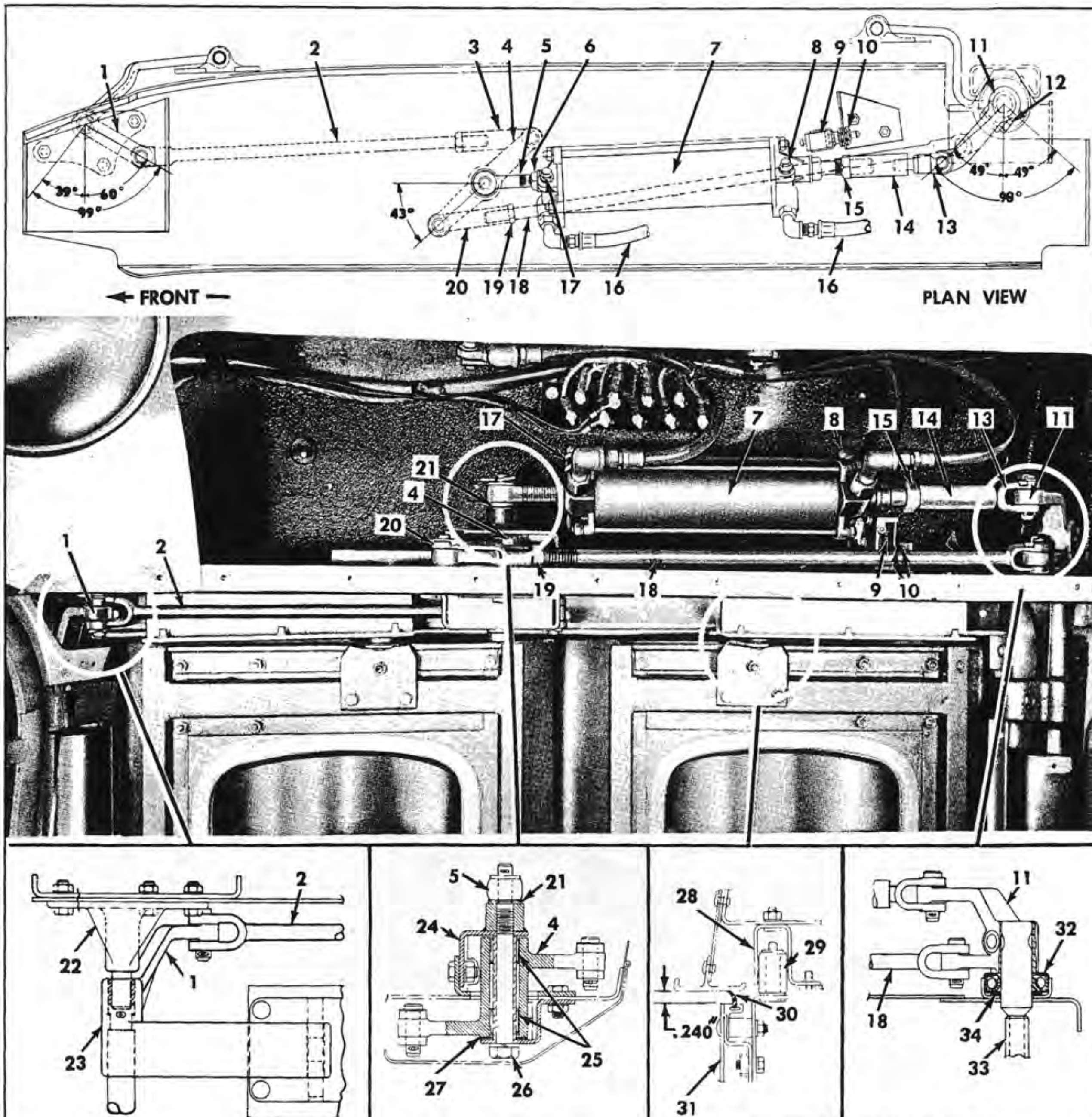
PULL-CORD SWITCH

If inspection indicates chime or buzzer is in operating condition, check continuity of current through the passenger signal pull-cord switch. If necessary, remove cover from pull-cord switch as shown in figure 25. Clean terminal and bolt contacts. Inspect switch contacts for loose connections. Operate pull cord and observe mechanism for possible disorder. A short piece of jumper wire placed to each terminal screw will check circuit continuity.

SPECIFICATIONS

Windshield Wiper Motor	
Make	Sprague Devices Inc.
Model	M516-140°
Passenger Signal Chime	
GM Part Number	2164961
Type	Single Tone
Passenger Signal Buzzer	
GM Part Number	287886
Stamped (on cover)	22983

Doors and Controls



1 Front Lever
2 Front Connecting Rod
3 Rod Yoke
4 Idler Lever
5 Eye
6 Eye Lock Nut
7 Door Engine Assembly
8 Speed Metering Screw
9 Switch Assembly
10 Switch Lock Nuts
11 Rear Lever
12 Clamp Bolt
13 Eye
14 Rod Turnbuckle
15 Lock Nut
16 Air Lines
17 Speed Metering Screw
18 Rear Connecting Rod
19 Lock Nut
20 Yoke
21 Shims
22 Shaft Upper Pivot Bracket
23 Door Shaft Assembly
24 Idler Lever Support
25 Bushings
26 Pivot Bolt
27 Washers
28 Guide Channel
29 Guide Roller
30 Door Upper Seal
31 Door Assembly
32 Bearing Assembly
33 Door Shaft Assembly
34 Shims

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Figure 1—Front Door Engine and Linkage

DOORS AND CONTROLS

STANDARD EQUIPMENT

Front doors are of the full-air operated type, whereas the rear doors are of push type. Other types of door controls used as special equipment are described later in this section. Both front and rear doors however, are controlled by door valve mounted on panel at left of driver.

When rear doors are unlocked, electrical circuit is completed to operate standard brake interlock and optional accelerator interlock (when used). Figure 1 illustrates arrangement of front door operating mechanism. Rear push type door arrangement is shown in figure 2.

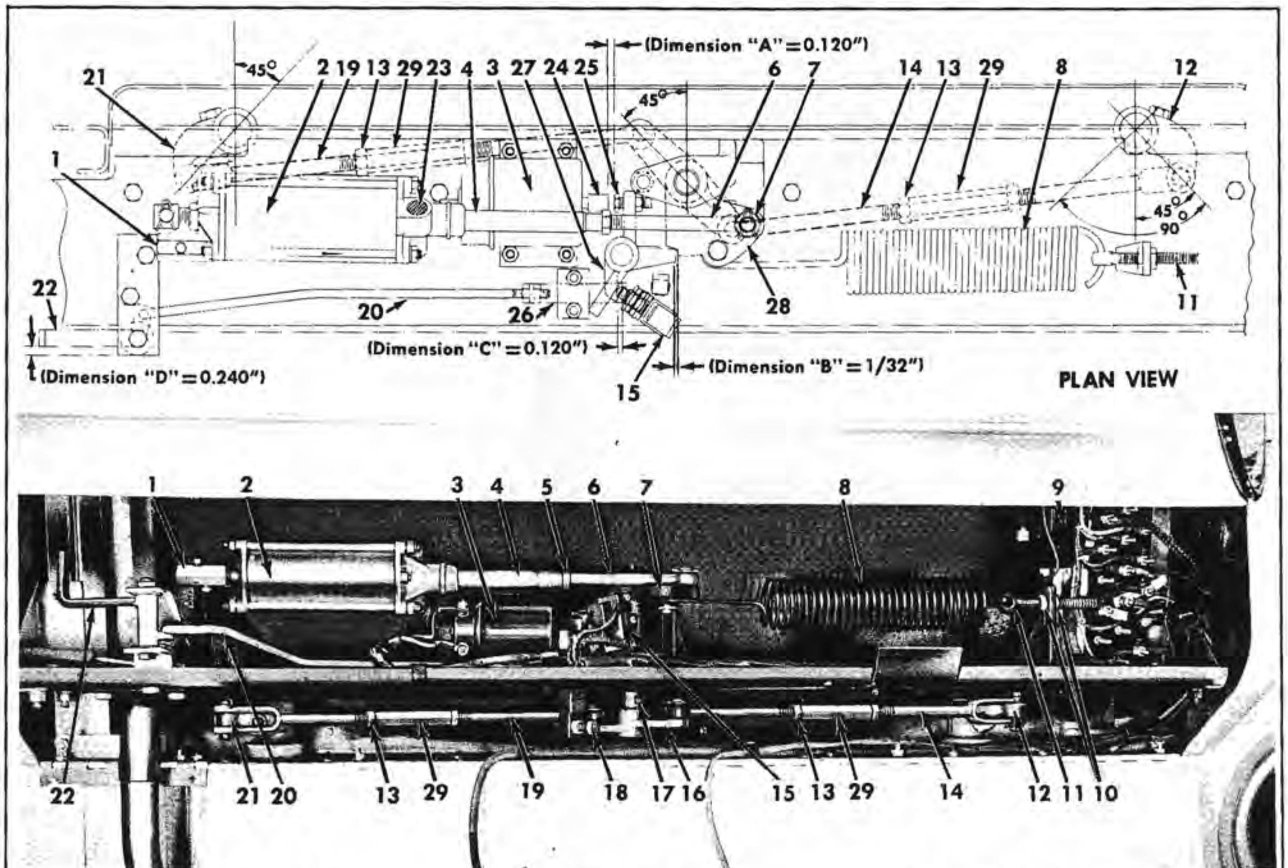
Maintenance on door controls is explained later under respective headings.

Figure 25 shows a schematic arrangement of standard door control units, lines, and wiring. Refer to figures 26 and 27 for special equipment door controls.

DESCRIPTION AND OPERATION

FRONT DOORS

Front doors are controlled by a valve which admits air pressure to one side of piston in door



1 Closing Speed Control Valve Assembly
2 Check Cylinder Assembly
3 Unlock Solenoid Assembly
4 Cylinder Piston Rod
5 Lock Nut
6 Piston Rod Eye
7 Check Cylinder Lever
8 Return Spring
9 Door Switch Relay Assembly
10 Lock Nuts
11 Return Spring Eye
12 Door Rear Lever
13 Lock Nut
14 Rear Connecting Rod
15 Rear Door Switch Assembly
16 Connecting Rod Idler Lever
17 Lubrication Fitting
18 Stop Screw
19 Front Connecting Rod
20 Emergency Manual Unlock Rod
21 Door Front Lever
22 Emergency Manual Unlock Lever
23 Check Cylinder Breather
24 Solenoid Plunger Cap
25 Adjustment Screw
26 Slide Bar
27 Cam Lever
28 Lock Cam
29 Turnbuckle

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Figure 2—Door Check Cylinder and Linkage—Push Type

engine and at same time opens port for exhausting air from opposite side of engine piston. When control valve handle is placed in position for closing door, air is admitted to opposite side of piston to reverse the action.

REAR DOORS

Rear doors are opened manually by passenger leaving coach. Doors are retained in locked-closed position by a spring-loaded lock lever which engages notch on door lock cam. Lock lever is retracted from notch in lock cam to unlock the door by plunger of door electrical solenoid when solenoid is energized. Solenoid action occurs when driver places door control valve in rear door-open position when the coach engine is running. After passenger alights from coach, doors are immediately returned to closed position by a large return spring mounted to door linkage above door. Slamming of door upon closing is prevented by a check cylinder assembly equipped with an adjustable speed control valve. Check cylinder is attached to door linkage and speed control valve is installed at pivot end of check cylinder as shown in figure 2. As doors are pushed open, piston in cylinder is pressed inward, forcing air out the speed control valve. Valve is designed with a spring-loaded check ball which allows rapid flow of exhausting air from cylinder. As the door starts to close, valve check ball seats, closing passage, and the only air which enters cylinder is drawn into cylinder by piston through small orifice at upper end of control valve. Thus door closing action is retarded.

Door linkage adjustment is explained later under "Rear Door and Linkage Adjustment." Refer to "Door Control Wiring Diagram" (fig. 25) for rear door circuits.

FRONT DOOR AIR SHUT-OFF VALVE

Air shut-off valve (fig. 3), mounted on panel at left of driver, is connected in system as shown on "Wiring and Air Line Diagram" (fig. 25).

Valve controls the supply of air to operate front door engine. When valve is turned to "OFF" position, door can be manually opened and closed. Valve is installed as shown in figure 4.

MAINTENANCE

Air shut-off valve requires no maintenance. However, if valve is disassembled due to leakage or other reasons, valve face should be cleaned, then coated sparingly with chassis grease.

REPAIR

Entry of foreign matter may cause scoring of valve face with resultant leakage. In the event of leakage, valve should be ground.

Exhaust air from system; then remove air

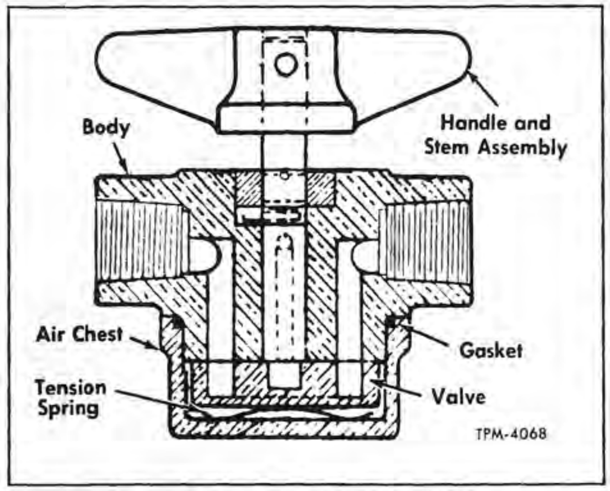


Figure 3—Front Door Air Shut-off Valve

shut-off valve. Remove air chest by unscrewing. Apply a small quantity of fine grinding compound mixed with gasoline to face of valve. Grind valve against valve face until all scores have been removed. Clean parts thoroughly in gasoline and blow out air passages with compressed air to remove all particles of compound. Apply a light film of chassis grease before assembling.

DOOR CONTROL VALVE

Door control valve (fig. 5) is mounted below window sill at left of driver (fig. 4). Valve should be lubricated semi-annually. Turn door shut-off valve handle at left of driver to "OFF" position. Remove control valve from coach then disassemble.

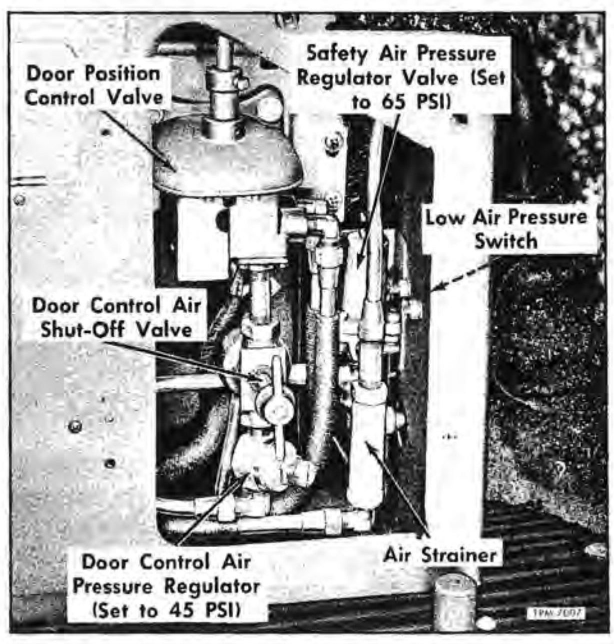


Figure 4—Door Control Units At Left of Driver

DOORS AND CONTROLS

DISASSEMBLY

NOTE: Key numbers in text refer to figure 5.

1. Remove three screws which attach air valve body (8) to valve cover assembly (1). Separate valve body from cover.

2. Remove six screws which attach valve manifold (10) to valve body. Carefully tap manifold free then remove valve springs (11), and valves (7).

3. Push valve plungers (3) from valve body. Remove O-ring seals (6) from plungers.

4. Remove three screws which attach switch body (15) to cover. Remove body then pull switch plunger (14) and spring (13) from switch body.

5. Remove set screw (18), plunger spring (17), and index plunger (16) from valve cover (1).

6. If necessary, remove two screws attaching electric switch (12) to switch body (15). Remove switch.

7. From underside of cover remove cam plate and shim washer (4).

CLEANING AND INSPECTION

NOTE: Key numbers in text refer to figure 5.

Clean all parts except electric switch in cleaning solvent. Inspect manifold gasket (9), valve springs (11) and (13), valves (7), and valve plunger O-ring seals (6). If worn, or deteriorated, replace.

ASSEMBLY

NOTE: Key numbers in text refer to figure 5.

1. Apply light film of barium-type grease to O-ring seals (6). Install seals in plunger grooves.

2. Install plungers (3) with seals into bores of valve body (8). Install valves (7), springs (11), gasket (9), and manifold (10) to valve body. Make sure valve springs are seated in recesses of manifold before tightening six manifold attaching screws and lock washers. Tighten screws evenly and firmly.

3. Apply light film of chassis grease to plunger (14), then insert switch plunger spring (13) and plunger into switch body (15).

4. If cam plate (5) was removed from valve cover (1), install shim washers (4) and cam into valve cover. Maintain 1/16" dimension as shown.

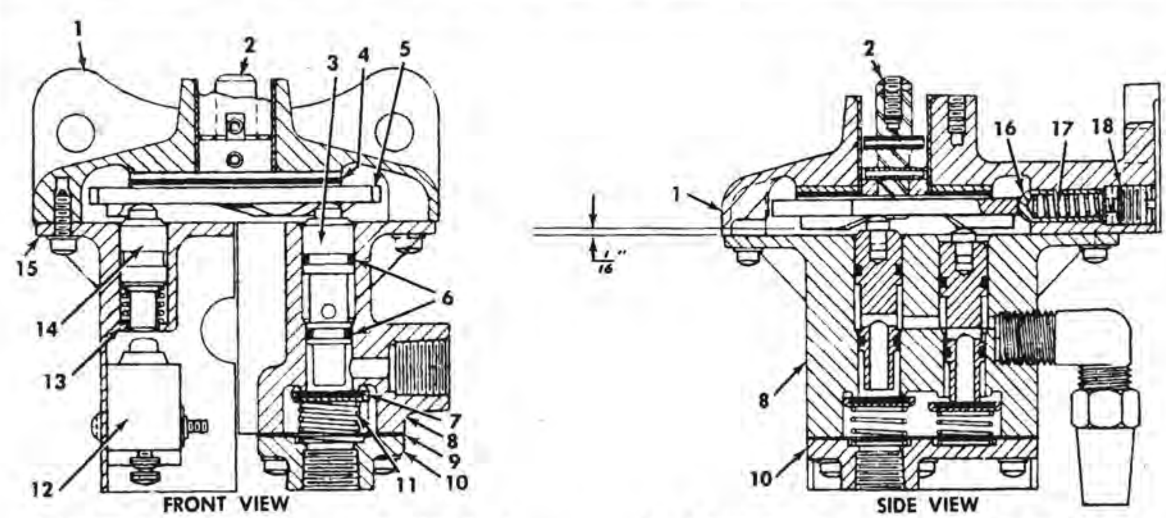
5. Insert index plunger (16), plunger spring (17), and set screw (18) into valve cover (1). NOTE: Plunger must engage detent in cam plate. Turn cam plate if necessary.

6. Install switch and valve bodies (15) and (8) to valve cover. Attach each body with three screws and lock washers.

7. Install electric switch (12) to switch body with two attaching screws. Tighten screws snug only. Place valve selector handle to rear door open-position, then press switch in toward switch plunger until a click-sound in switch is heard. Tighten switch attaching screws firmly. A click-sound in switch should be heard when selector handle is returned to center position.

LEAKAGE TEST

Apply air pressure to inlet port then apply soapy water to each closed exhaust port. Rotate



1 Cover Assembly
2 Handle Shaft
3 Plunger
4 Shim Washer
5 Cam Plate
6 O-ring Seals
7 Valve Assembly
8 Valve Body
9 Manifold Gasket
10 Manifold
11 Valve Spring
12 Electric Switch
13 Plunger Spring
14 Switch Plate
15 Switch Body
16 Index Plunger
17 Plunger Spring
18 Set Screw

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Figure 5—Sectional View of Door Control Valve

valve selector handle to check each port. Disassemble and correct cause of leakage if necessary.

DOOR SWITCHES AND RELAY

Door switch, mounted in each door engine compartment (figs. 1 and 2), is actuated by door operating mechanism. As front door starts to open, striker plate, welded to connecting rod, releases switch plunger, closing contacts of switch. Switch contacts at rear door are closed when lock cam lever is moved to door unlocked position.

Front door switch turns stepwell light and light over door on. Rear door switch energizes operating coil of rear door switch relay, which in turn completes circuit to rear door unlock light over door, the rear door tell-tale, and the interlock magnet valve when rear doors are unlocked. Refer to "Door Control Wiring Diagram" (fig. 24) for switch circuits. For information on rear door switch relay refer to "WIRING AND MISCELLANEOUS ELECTRICAL" (SEC. 7) of this manual.

FRONT DOOR SWITCH ADJUSTMENT

With circuit to door switch energized and doors closed, lights should not be illuminated. Lights should come on just as door starts to open. Relocate switch in bracket by repositioning attaching lock nuts. Tighten lock nuts firmly after making adjustment.

REAR DOOR SWITCH ADJUSTMENT

Instructions for adjusting the rear door switch which is operated by the rear door linkage are explained later under "Rear Doors and Linkage Adjustment."

FRONT DOOR ENGINE

Door engine (fig. 6) is mounted in compartment directly over door (fig. 1).

OPERATION

NOTE: Key numbers in text refer to figure 6.

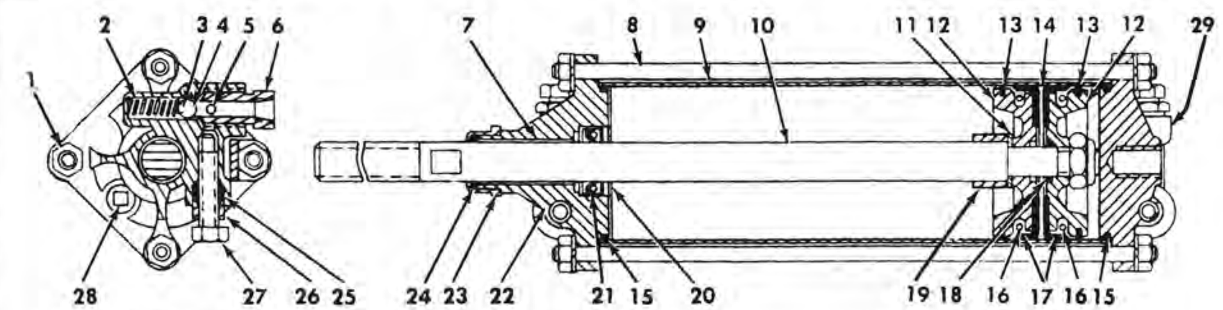
Door control valve admits air to one side of piston, while at same time exhausting pressure from other side of piston.

Air, admitted by control valve, enters adapter (6) where some flows through exhaust port (5) and through passage restricted by metering screw (27), into cylinder. Most of the air flows into cylinder through inlet port (3) after unseating check valve ball (4).

Exhausting air, however, can leave cylinder only past metering screw needle and through exhaust port (5), since inlet passage is closed by check valve ball (4). Consequently, adjustment of metering screw affects only exhausting air.

SPEED ADJUSTMENT (Fig. 6)

Operating speed of door engine is controlled by a metering screw (27) at each end of engine. Screw meters exhausting air only; therefore screw in piston rod end controls opening speed of door and screw at fixed end controls closing speed.



1 Clamp Bolt Nut
2 Check Valve Spring
3 Inlet Port
4 Check Valve Ball
5 Exhaust Port
6 Adapter
7 Piston Rod Bushing
8 Clamp Bolt
9 Cylinder
10 Piston Rod
11 Special Washer
12 Piston Follower
13 Felt
14 Piston Center Plate
15 O-ring Gasket
16 Cup Expander Spring
17 Piston Cup
18 Rod O-ring Seal
19 Piston Stop Sleeve
20 Air Seal Washer
21 Air Seal
22 Front Cover
23 End Cap
24 Felt Washer
25 Metering Screw Seal
26 Metering Screw Lock Nut
27 Metering Screw
28 Lubrication Plug
29 Rear Cover

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Figure 6—Front Door Engine, Also Rear With Folding Doors

1. Loosen lock nut (26), then turn screw (27) into bottom.

2. While operating engine, turn screw out (counterclockwise) until desired speed is obtained.

3. Tighten nut (26) only enough to stop air leakage; overtightening may crack casting.

REMOVAL AND DISASSEMBLY

NOTE: Key numbers in text refer to figure 6.

1. Turn air shut-off valve at left of driver to "OFF" position, then disconnect and remove two air lines to engine.

2. Loosen lock nut on end of piston rod; then unscrew yoke end from piston rod.

3. Remove nuts from clamp bolts (8) and remove bolts.

4. Remove end covers (22 and 29) and withdraw piston from cylinder (9).

5. Remove end cap (23) and felt washer (24) from front cover (22).

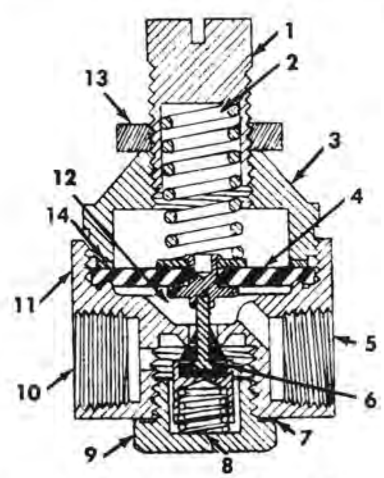
6. Remove adapter (6) from covers, catching ball (4) and spring (2) in hand.

7. Loosen nut (26); then unscrew metering screw (27). Remove metering screw seal (25).

8. Unscrew nut from piston rod and remove piston parts from rod.

CLEANING AND INSPECTION

Clean all parts thoroughly, then inspect cylinder walls and piston cups. Replace damaged or worn parts.



1 Adjusting Screw	8 Valve Spring
2 Adjusting Spring	9 Plug
3 Valve Cap	10 Inlet Port
4 Diaphragm	11 Valve Body
5 Outlet Port	12 Diaphragm Chamber
6 Valve Assembly	13 Adjust Screw Nut
7 Plug Gasket	14 Washer

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Figure 7—Front Door Air Pressure Regulator Valve

ASSEMBLY AND INSTALLATION

NOTE: Key numbers in text refer to figure 6.

1. Install check valve spring (2); ball (4), and adapter (6) in each cover; then install seal (25), nut (26), and metering screw (27). If air seal (21) was removed from front cover, make sure seal is properly positioned. Install air seal washer (20) and retain in cover by staking in three places. Install new O-ring seal (15) on each cover. Install felt washer (24) and end cap (23) on front cover.

2. Install cup expander springs (16) in groove of piston followers (12). In follower (12) which is last to be installed, place new O-ring seal (18) in counterbore of follower. Place special washer (11) on piston rod, then install followers (12) piston cups (17), and piston center plate (14) on rod. Retain parts in place with rod nut.

3. Apply thin coat of lubricant to piston rod; then insert piston rod with piston stop sleeve (19) installed on rod, through air seal and bushing in front cover.

4. Apply light coat of SAE 10W engine oil to piston and inside of cylinder; then insert piston in cylinder.

5. Position rear cover to cylinder (9). NOTE: Make sure O-ring seals (15) seat in cover grooves.

6. Position clamp bolts (8) through covers. Start nuts and washers on bolts.

7. Tighten nuts alternately and evenly.

8. Remove lubrication plugs (28) from each end cover. Insert 1/2 ounce of SAE 10W engine oil in each end of cylinder. Install plugs then operate piston by hand several times. Turn piston, while operating, to insure even distribution of oil.

9. Test on bench by applying 25 pounds air pressure to one adapter (6) while noting leakage from other adapter. Check opposite end in same manner. Leakage, if any, should be slight. With pressure applied, coat joint of cover and cylinder with soapsuds to check leakage.

10. Install yoke end on piston rod.

11. Install engine into compartment.

12. Install air lines to engine.

13. Adjust linkage as directed later under "Front Door and Linkage Adjustment." Turn air shut-off valve to "ON" position.

FRONT DOOR AIR PRESSURE REGULATOR VALVE

Pressure regulator valve (fig. 7), connected in air system is mounted in back of driver's control panel (fig. 4). Valve regulates air pressure (45 psi) to front door engine. Adjustment of valve is described later under "Air Pressure Adjustment."

OPERATION

NOTE: Key numbers in text refer to figure 7.

Air, entering inlet port (10) flows past valve stem into diaphragm chamber (12). As pressure increases to valve setting, diaphragm (4) is raised against pressure of adjusting spring (2), permitting valve spring pressure to seat valve (6). Any pressure drop in chamber (12) will cause diaphragm to unseat valve, permitting further flow of air into diaphragm chamber.

TEST

1. Exhaust air pressure from system; then open driver's control panel for access. Connect test gauge in place of outlet line; then loosen knurled lock nut.

2. Build up pressure in system while noting reading of gauge. If pressure gradually increases beyond valve setting, valve is not seating properly. Cause is probably dirt on valve or seat, or worn valve.

3. Apply soap suds around knurled lock nut. If bubbles appear, diaphragm is leaking and must be replaced.

4. If tests show valve to be operating properly, exhaust pressure from system, disconnect gauge and connect outlet line. Build up pressure in system; then adjust valve, as described below under "Air Pressure Adjustment."

5. If tests show valve to be defective, remove for repair.

AIR PRESSURE ADJUSTMENT

NOTE: Access to valve for adjusting is through hole in trim panel at left of driver.

1. Using a 3/4 inch socket wrench, loosen lock nut on valve and back off adjusting screw, using large screwdriver, until pressure is insufficient to open both doors completely.

2. Turn adjusting screw in slowly until doors open completely (approx. 45 pounds). Tighten knurled lock nut firmly.

REMOVAL

1. Exhaust air pressure from line to valve.

2. Remove trim panel at left of driver over valve assembly.

3. Disconnect lines at each end of valve, then remove valve.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 7.

1. Unscrew plug (9) and remove valve (6), with spring (8).

2. Remove adjusting screw (1), with lock nut (13) and remove adjusting spring (2).

3. Unscrew cap (3) from body (11) and remove diaphragm (4) and washer (14).

4. Clean metal parts in suitable solvent and wipe dry. Wipe diaphragm and valve clean with cloth dampened with cleaning solution.

5. Examine diaphragm and valve carefully. Replace, if parts are not in good condition.

ASSEMBLY

NOTE: Key numbers in text refer to figure 7.

1. Position diaphragm (4) and washer (14) in body (11); then screw cap (3) into body.

2. Position adjusting spring (2) in cap; then start screw (1) with lock nut (13) in cap.

3. Position valve spring (8) and valve (6) in plug (9). Install plug with gasket (7) in body, tightening plug firmly.

4. Adjust valve to 45 pounds pressure, using gauge connected to valve outlet.

INSTALLATION

Valve must be connected so that air flow is in direction of arrow stamped on side of valve. NOTE: Arrow should point upward as shown in figure 4. Reversed installation will result in slow action of doors with full system pressure, and slamming of doors at low system pressure.

After installation, adjust valve setting as described earlier under "Air Pressure Adjustment."

REAR DOOR CHECK CYLINDER

Rear door check cylinder (fig. 8) is installed in compartment above door (fig. 2). When doors are pushed open, air is forced from cylinder past check ball in speed control valve mounted at pivot end of cylinder. As doors close, air is drawn into cylinder, past the speed adjustment needle of the speed control valve. Control valve meters the incoming air to control speed of closing door.

MAINTENANCE

Check cylinder should be disassembled and internal parts lubricated annually. External lubrication of push rod can be accomplished by applying 2 to 3 drops of clean engine oil to push rod when doors are closed.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 8.

1. Mark both front and rear covers (3 and 15) in relation to cylinder tube (7) to assure proper positions of parts at reassembly.

2. Remove nuts and washers from four tie-bolts (17) which retain cylinder assembly together. Remove tie-bolts and separate tube (7) and covers. Pull push-rod (8) and piston from tube.

3. Mark position of eye (13) and lock nut (12) on push rod, then remove eye and lock nut. Remove push rod from front cover.

4. Remove O-ring seals (4) from groove in front and rear covers.

5. Turn piston follower (22) from push rod, then remove piston cup (21), cup expander (20),

DOORS AND CONTROLS

piston (18), and washer (6) from push rod. Remove O-ring seal (5) from counterbore in piston and remove seal (19) from groove in piston.

6. Pry seal cap (11) with seal (14) from front cover (15). Remove seal from cap.

7. If bushing (10) is worn excessively, press from front cover. Remove washer (9) from cover.

CLEANING AND INSPECTION

NOTE: Key numbers in text refer to figure 8.

Wash all parts in cleaning solvent. Press felt parts dry. Examine all parts for wear, giving particular attention to piston cup. O-ring seals (4 and 5), felt seals (14 and 19), and push rod bushing (10) in front cover. If worn, replace.

ASSEMBLY

NOTE: Key numbers in text refer to figure 8.

1. Coat inner wall of cylinder tube (7) with thin film of chassis lubricant.

2. If bushing (10) was removed from front cover (15), press new bushing flush in cover, then burnish to size which will allow free movement of push rod.

3. Install felt seal (14) in seal cap (11). Press cap on front cover (15). Install washer (9) into counterbore at inner side of front cover.

4. Install O-ring seal (5) into counterbore of piston (18) and install seal (19) in outer groove of piston.

5. Referring to illustration, install washer (6), piston (18), cup expander (20), piston cup (21), and follower (22) on push rod (8) as shown. Tighten follower firmly on rod.

6. Install O-ring seals (4) in grooves of front and rear covers (3 and 15).

7. Insert end of push rod (8) through front cover (15) then install eye (13) with lock nut (12) on push rod to mark made prior to disassembly. Tighten lock nut firmly.

8. Being careful not to damage piston cup (21), force push rod with piston parts through cylinder tube (7).

9. Align rear cover (3) with tube and front cover to marks made prior to disassembly, then install tie-bolts (17). Tighten bolt nuts evenly and firmly.

10. Force push rod in and out to check for binding or any restriction. Install closing speed control valve to rear cover with adjustment screw at top side. Install eye rod with lock nut to rear cover.

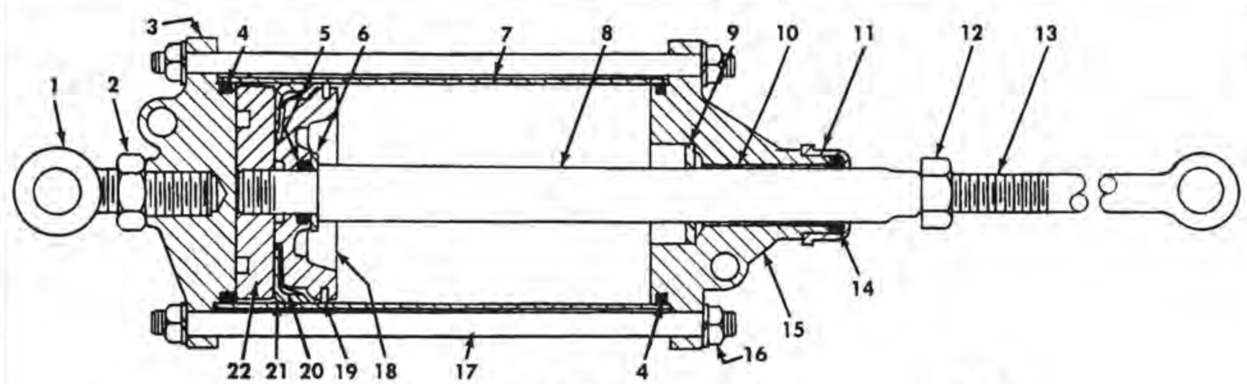
FRONT DOORS AND LINKAGE ADJUSTMENT

NOTE: Refer to figure 1 which illustrates door linkage shown in door-closed position.

1. Exhaust air pressure from system by placing door shut-off valve lever in "OFF" position.

2. Check door rear lever angle position on door shaft. Door rear lever angle position should be as shown in figure 1. If checks necessitates adjustment, loosen clamp bolt, then rotate lever to specified angle. After making adjustment, tighten clamp bolts to 20 to 25 foot-pounds torque.

3. With doors still closed, check position of



1 Eye
2 Lock Nut
3 Rear Cover
4 O-ring Seal
5 O-ring Seal
6 Washer
7 Cylinder Tube
8 Push Rod
9 Washer
10 Bushing
11 Seal Cap
12 Lock Nut
13 Eye
14 Seal
15 Front Cover
16 Nut
17 Tie-Bolt
18 Piston
19 Seal
20 Cup Expander
21 Cup
22 Follower

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Figure 8—Rear Door Check Cylinder—Push Type Doors

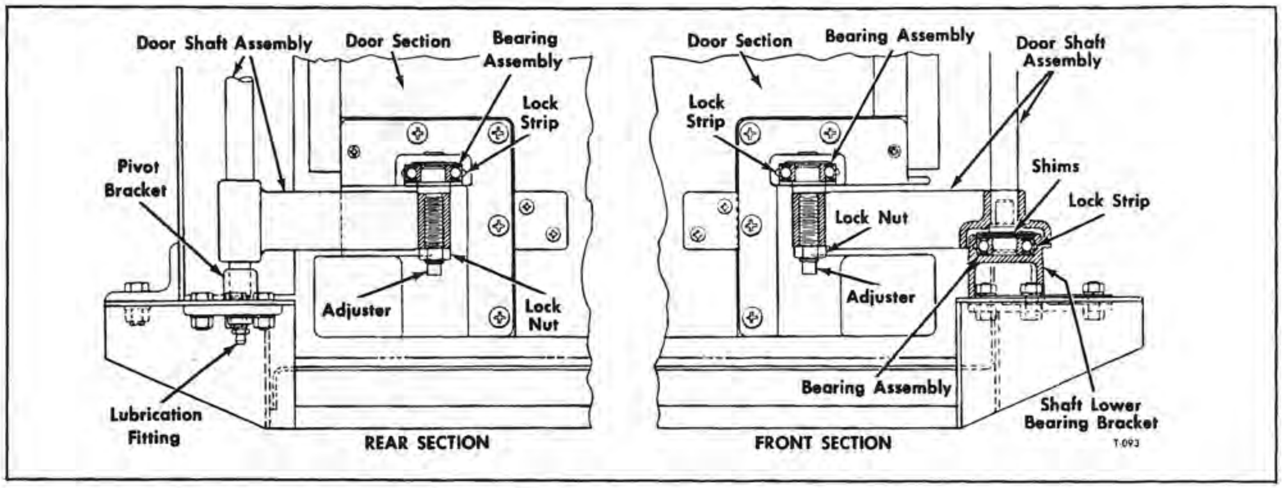


Figure 9—Front Door Lower Pivot Bearings Installed

idler lever which should be located at a 43° angle. Disconnect and lengthen or shorten connecting rods to obtain correct idler lever angle. Adjust rods as necessary to provide free pins. Operate doors by hand to check adjustment.

4. With doors completely closed, and piston in door engine fully retracted, adjust length of door engine and engine rod to a dimension 1/8 inch shorter than distance between lever pin center and idler lever pivot bolt. Install engine and yoke pins with anti-rotation retainers on each pin. Operate doors by hand to check travel to complete closed and open positions. If operation is satisfactory, operate doors using air pressure. Make sure doors open and close completely. Tighten engine rod lock nut firmly after making final adjustment.

5. Height of door halves in coach opening is adjustable (fig. 9). A threaded adjustable pin is used at locations indicated.

REAR DOORS AND LINKAGE ADJUSTMENT

The following adjustment procedure, if performed as directed, will assure safe and proper operation of the rear door operating mechanism.

NOTE: Key numbers in following text refer to figure 2.

1. Carefully disengage door return spring (8), then disconnect the check cylinder rod eye (6) from cylinder lever (7).

2. Loosen wedge bolts which clamp door front and rear levers (21 and 12) to door shafts.

3. Prop or clamp door panels in fully closed position.

4. Check and if necessary adjust connecting rods (14 and 19) to measure 13-15/16-inch center-to-center of pin holes. To adjust, loosen lock nuts (13), then turn rod turnbuckle (29).

5. With lock cam lever (27) engaged fully in lock cam (28), tighten door shaft lever clamp bolts to 20 to 25 foot-pounds torque.

6. Remove prop or clamp from door panels.

7. Carefully hook up the door return spring (8).

8. Check and if necessary, adjust the tension of door return spring (fig. 10). Adjustment is obtained by repositioning two eye bolt nuts (10) at spring anchor bracket. Proper spring tension exists when a push-type spring scale applied at the inside front face of the door panel indicates no more than 10 pounds to start doors moving away from completely closed position.

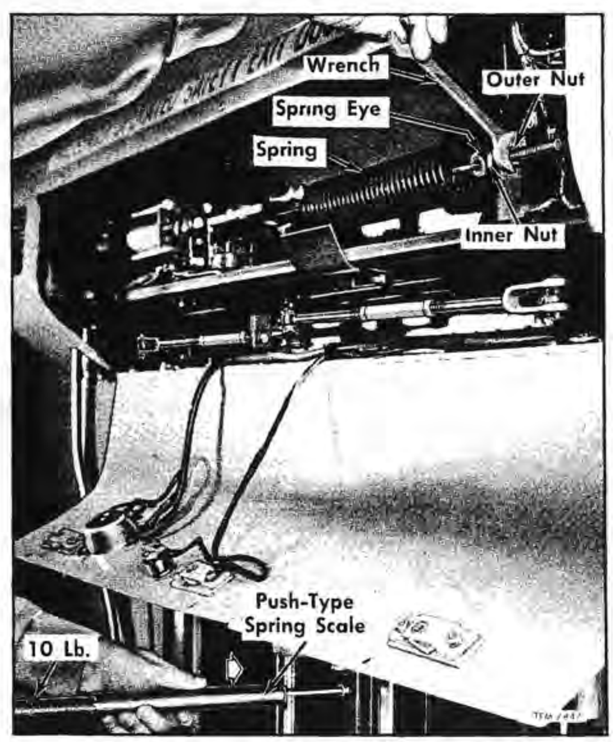


Figure 10—Adjusting Push-Type Rear Door Return Spring Tension

DOORS AND CONTROLS

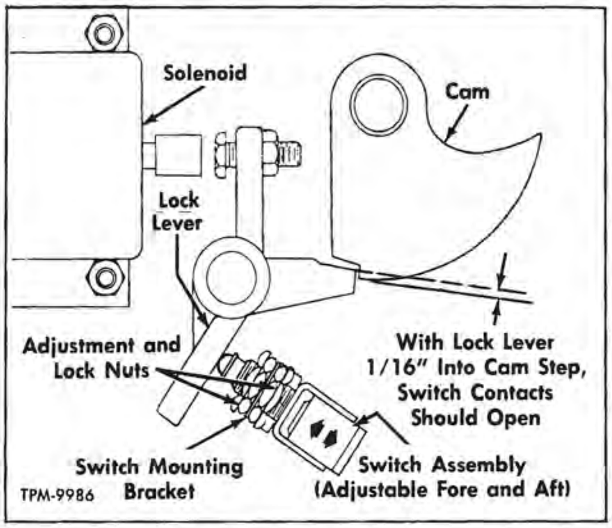


Figure 11—Rear Door Switch Adjustment Points

NOTE: If spring scale is not available, adjust tension to allow doors to swing free without binding when coach blowers are operating with windows and doors closed.

9. With doors closed and locked, there must be a clearance of 1/32-inch "B" between the forward edge of lock cam lever (27) and lock cam (28). A fine adjustment to secure this dimension is made by slight adjustment of connecting rods (14 and 19).

10. Adjust solenoid striker adjusting bolt (25) on cam lever to provide a minimum space of 1/8-inch "A" between head of bolt and solenoid plunger when the solenoid is de-energized.

11. Adjust door stop screw (18) to contact idler lever (16) when doors, in full-open position, are at a 90 degree angle to front edge of step.

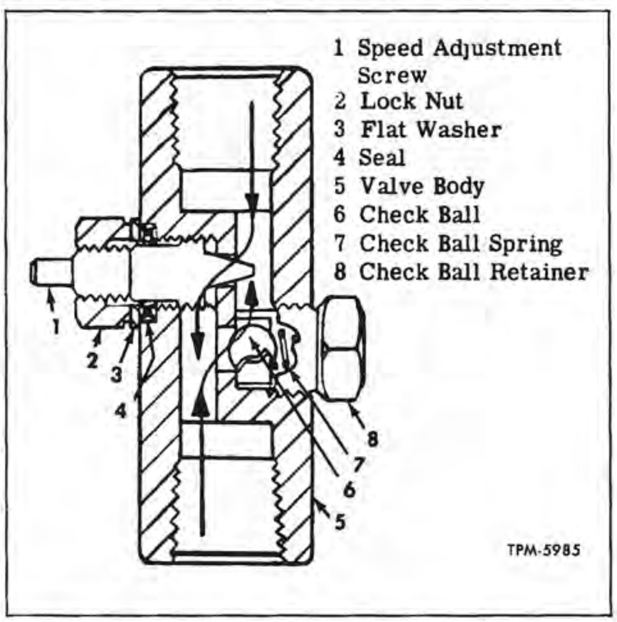


Figure 12—Rear Door Closing Speed Control Valve

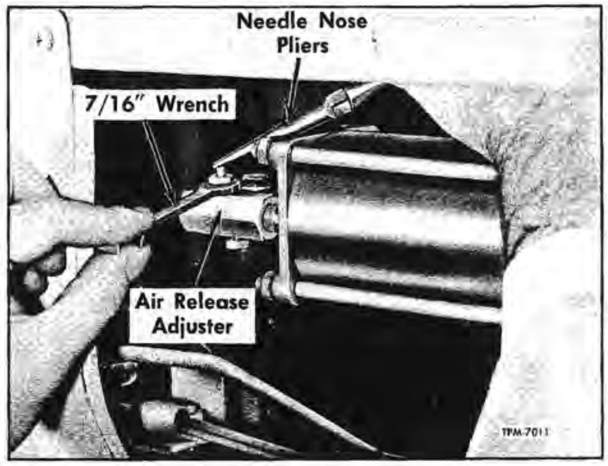


Figure 13—Adjusting Rear Push Type Door Closing Speed

> **NOTE**
>
> If additional door opening clearance is desired, stop screw may be adjusted with doors set at a 95 degree angle to front edge of step.

12. Before installing door check cylinder piston rod to lever (7), force the piston rod to bottom in check cylinder. With doors in full-open position, adjust length of cylinder piston rod until rod eye will drop freely on pin of cam lever (7).

> **IMPORTANT**
>
> Do not move cylinder piston out during this procedure.

13. Adjust the door closing speed as directed later under "Rear Door Closing Speed Control Valve."

14. Check door opening and locking action, make final adjustments if necessary, then tighten all adjustment lock nuts, and install linkage retainers and cotter pins.

15. Adjust rear door (micro) switch (15) to break light and interlock circuits when lock cam lever (27) has moved approximately 1/16-inch into the step of lock cam (28) as shown in figure 11. By means of switch mounting nuts, switch can be located fore and aft in mounting bracket as necessary. Secure switch position by tightening lock nuts against mounting nuts.

> **IMPORTANT**
>
> Proper switch adjustment is necessary as the interlock system as well as door signal lights will be affected.

REAR DOOR CLOSING SPEED CONTROL VALVE

Rear door closing speed control valve (fig. 12), mounted to pivot end of door check cylinder serves to control closing speed of door. Valve is constructed as shown. Air flow through valve is explained previously under "Description and Operation" - "Rear Doors."

SPEED CONTROL ADJUSTMENT (Fig. 12)

Adjust metering to cushion door on closing by loosening lock nut (2) then turning speed adjusting screw (1) as shown in figure 13. Turning screw clockwise increases cushion effect or turning screw counterclockwise lessens cushion effect. Adjust to prevent door slamming. Tighten adjustment screw lock nut firmly after making adjustment.

DISASSEMBLY (Fig. 12)

1. Remove lock nut (2) then turn speed adjusting screw (1) with nut, flat washer (3), and seal (4) from valve body (5).
2. Remove check ball retainer (8) from valve body. Remove check ball (6) and spring (7).

CLEANING AND INSPECTION

Clean all parts in a cleaning solvent, then inspect check ball for pitted condition and inspect ball seat in valve body for worn condition. If either condition exists, replace complete valve assembly.

Examine speed adjustment screw for grooved condition at needle and also check for worn condition of needle seat in valve body. Replace entire assembly if either condition exists.

ASSEMBLY (Fig. 12)

1. Install check ball (6) check ball spring (7) and retainer (8) into valve body (5). Tighten retainer firmly.
2. Assemble seal (4), flat washer (3), and nut (2) on speed adjustment screw (1), then thread screw into valve body. Turn screw in until screw contacts seat lightly, then back off screw 1/4 turn. Tighten lock nut. Install valve assembly with arrow on valve pointed toward check cylinder, then make speed adjustment as described previously under "Speed Control Adjustment."

REAR DOOR LOCK SOLENOID

Lock solenoid is used to disengage door lock cam lever from notch of door lock cam whenever driver places control lever in door unlock position.

SOLENOID MAINTENANCE

Solenoid requires no periodic maintenance other than keeping the terminals clean and tight. Always check action of solenoid if it has been removed. If unit fails to function, first check wiring before condemning the solenoid. Solenoid winding can readily be checked for current draw, open circuit, or shorts.

Refer to "Door Control Wiring Diagram" (fig. 25) for wiring circuits.

BRAKE INTERLOCK

Brake interlock (standard equipment - transit coaches) is connected to the door controls and functions to supply air pressure to the rear brakes, thus applying brakes, whenever doors are open or unlocked. To prevent throwing vehicle into a skid by accidentally unlocking or opening doors and thus applying rear brakes while vehicle is in motion; full air pressure is not applied. Instead, pressure is reduced to 35-40 pounds by means of a pressure regulating valve.

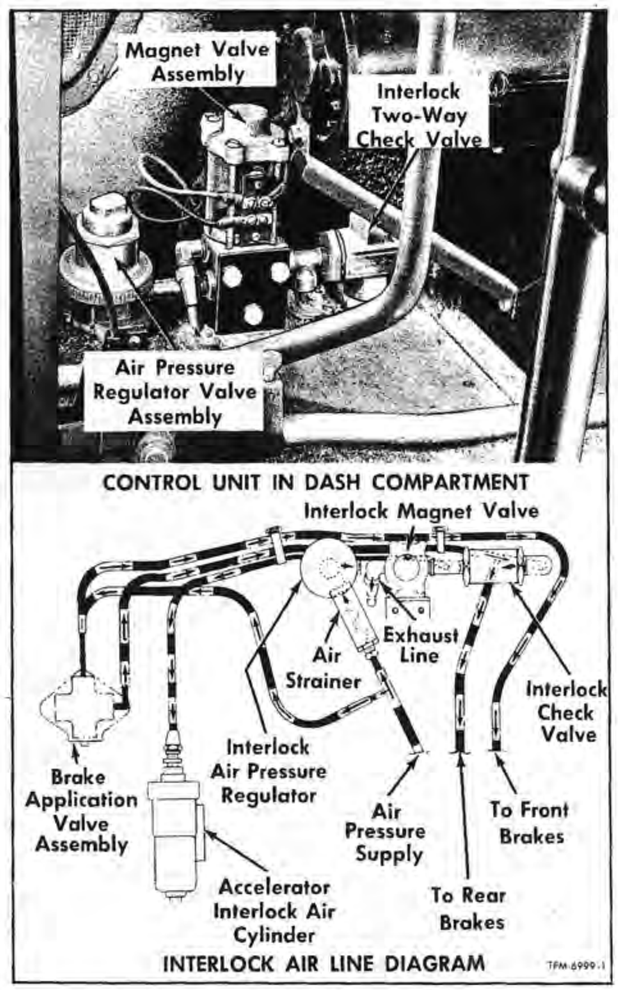
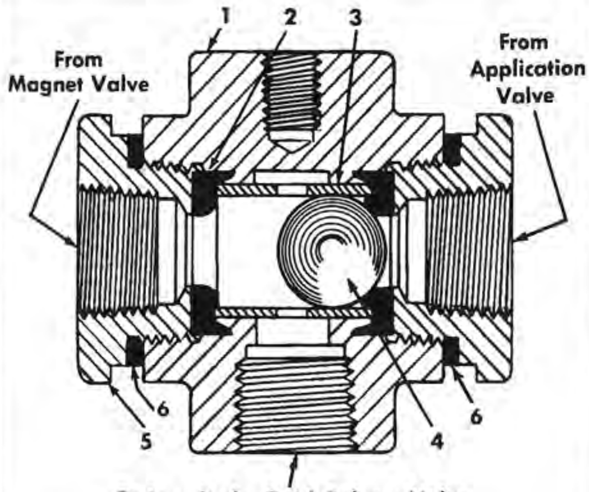


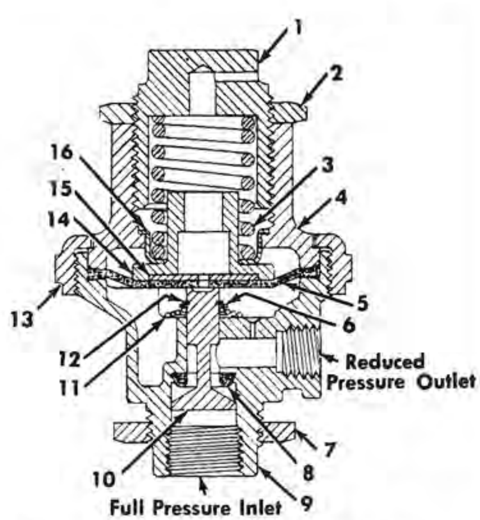
Figure 14—Brake Interlock Mechanism and Air Lines



1 Body
2 Seal
3 Sleeve
4 Ball
5 End Cap
6 Gasket

TPM-7003

Figure 15—Brake Interlock Double Check Valve



1 End Plug
2 Cover End Nut
3 Diaphragm Spring
4 Valve Body
5 Diaphragm
6 Valve Spring Washer
7 Valve Mounting Nut
8 Valve Seal
9 Valve Cover
10 Valve Plunger
11 Valve Spring
12 Valve Spring Washer Snap Ring
13 Valve Cover Clamping Ring
14 Diaphragm Support
15 Diaphragm Support Plate
16 Diaphragm Spring Retainer

TPM-4151

Figure 16—Brake Interlock Air Pressure Regulator Valve

OPERATION

Operation of interlock is automatic and driver has no direct control. However, if failure in door control electrical system causes interlock to apply brakes, driver may shut off door electrical circuits at door master switch. Switch is located on recessed switch panel at left of driver. Turning switch off should release interlock pressure from brakes; if pressure does not release, do not operate coach.

MAINTENANCE

The brake interlock consists of door switches and wiring, air strainer, pressure regulating valve, interlock magnet valve, and double check valve (fig. 14).

Electrical circuits are shown on "Door Control Wiring Diagrams" (figs. 25, 26, and 27).

BRAKE INTERLOCK DOUBLE CHECK VALVE

Brake interlock double check valve (fig. 15) is installed in air system as shown in figures 25, 26, and 27. Purpose of valve is to direct flow of air pressure from either brake application valve or brake interlock magnet valve into air line leading to rear brake valve. Figure 14 shows valve installed in dash compartment.

OPERATION (Fig. 15)

When brake treadle is depressed, air pressure from application valve forces ball against seal at inlet from magnet valve. Air flows out through holes in sleeve and into air line leading to rear brake valve. With brake treadle released, air pressure from application valve is shut off. When door is unlocked, magnet valve admits air pressure to check valve. Air forces ball against seal at inlet from application valve and flows out through holes in sleeve into air line to rear brakes only. It is important that check valve ball seats properly, since any air leakage past ball will escape through open exhaust port of valve (application or magnet) which is not applying brakes.

TEST (Fig. 15)

To check for leakage past valve ball, disconnect air line from magnet valve at check valve. Apply soap suds to open end of check valve and manually apply brakes. Appearance of bubbles indicates leakage. Reconnect air line from magnet valve to check valve using aviation type sealing compound on threaded fitting. Disconnect air line from application valve at opposite end of valve. Apply rear brakes through magnet valve by unlocking rear door and check for leakage indicated by bubbles. If leakage is evident, remove and clean valve. If leakage is not indicated, reconnect air line to valve, using sealing compound on fitting.

DISASSEMBLY (Fig. 15)

Check valve is disassembled by unscrewing end cap from each end of valve and removing seals, ball, and sleeve.

INSPECTION (Fig. 15)

Wash all parts, except seals and gaskets, in cleaning solvent and wipe or blow dry. Examine parts and replace with new parts if necessary.

ASSEMBLY (Fig. 15)

Position sleeve and ball in body; then install seals. Position gaskets on end caps; then install end caps in body, tightening caps firmly.

BRAKE INTERLOCK AIR PRESSURE REGULATOR VALVE

Brake interlock air pressure regulator (fig. 16) is mounted in dash compartment as shown in figure 14.

Valve regulates air pressure of 35 to 40 psi to the interlock magnet valve. Periodically, pressure permitted through valve should be checked with an air gauge.

CHECKING AIR PRESSURE

Pressure can be checked on bench or on vehicle. When testing on vehicle, temporarily close off air pressure to regulator.

NOTE: Key numbers in text refer to figure 16.

1. Install air gauge in reduced-pressure line fitting or to line to rear brakes or accelerator air cylinder then apply air pressure to valve inlet. Pressure should be 35 to 40 psi.

2. Loosen cover end nut (2) and turn end plug (1) until correct pressure registers on gauge. If pressure is not correct when check is started, inspect diaphragm (5), and replace as instructed later under "Replacement of Diaphragm."

REPLACEMENT OF DIAPHRAGM

Diaphragm can be replaced without completely disassembling the valve or disturbing pressure adjustment.

NOTE: Key numbers in text refer to figure 16.

1. Cut off source of air supply to regulator by disconnecting full-pressure line.

2. Turn valve cover clamping ring (13) until regulator assembly is separated.

3. The diaphragm (5) is then exposed. Diaphragm support (14) and plate (15) are loose.

4. Replace diaphragm if damaged.

5. Insert the support (14) into spring. Position support plate (15) over diaphragm.

6. Insert valve body (4) through valve cover clamping ring (13). Screw clamping ring over body. Turn firmly. Reconnect full pressure line and make reduced pressure check.

REPLACEMENT OF VALVE

NOTE: Refer to figure 14.

1. Shut off air supply to pressure regulator valve or exhaust pressure from coach air system.

2. Remove dash closure panel, then remove attaching screws retaining mechanism to floor. Prop up mechanism, then disconnect inlet line down through floor. Valve can then be turned from magnet valve nipple.

3. Apply small quantity of sealing compound to threads of line fittings when installing valve. Tighten connections firmly.

DISASSEMBLY OF VALVE

Key numbers in text refer to figure 16.

1. Separate the assembly by unscrewing valve cover clamping ring (13). Diaphragm (5) support (14) and support plate (15) can then be removed.

2. Remove cover end nut (2). Remove end plug (1). Spring (3) can then be removed.

3. If valve plunger (10) or spring (11) must be replaced, remove snap ring (12). Plunger (10), spring (11) and seal (8) can then be removed.

ASSEMBLY OF VALVE

Key numbers in text refer to figure 16.

1. Place plunger (10) and seal (8) into body. Apply a small amount of clean grease on plunger at assembly.

2. Install spring (11), washer (6), and snap ring (12). Try spring and plunger action.

3. Install spring (3) into end plug (1).

4. Thread end plug into body. Insert diaphragm support (14) into spring.

5. Position diaphragm (5) into place. Place diaphragm support plate over diaphragm.

6. Position valve body and spring assembly over diaphragm. Tighten clamping ring securely.

7. Install cover end nut (2) loosely.

8. Check reduced pressure by attaching air source to full pressure connection and air gauge to reduced pressure fitting.

9. Turn end plug (1) until pressure regulator delivers 35 to 40 psi. Tighten cover end nut (2) after pressure a djustment is made.

BRAKE INTERLOCK MAGNET VALVE

Brake interlock magnet valve (fig. 17) is mounted on floor in dash compartment (fig. 14). Actuated by door control valve switch through the switch in compartment above doors, valve applies air pressure to rear brakes and accelerator air cylinder. Purpose of valve is to prevent movement of coach when doors are opened or unlocked. Schematic position of magnet valve in system is shown in figures 25, 26, and 27.

DOORS AND CONTROLS

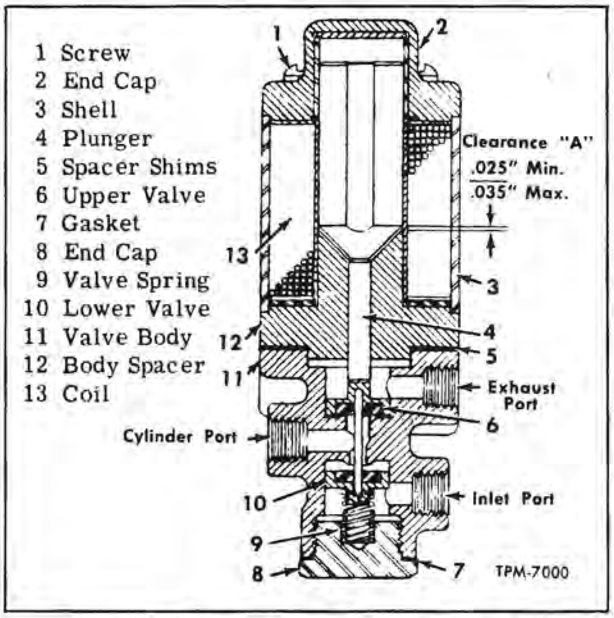


Figure 17—Brake Interlock Magnetic Air Valve

OPERATION

Energized magnet valve admits air, at reduced pressure, to brakes and accelerator interlock cylinder (when used). This action applies brakes and locks accelerator in idling position. When doors close, magnet valve is de-energized. Pressure in brake chambers and accelerator interlock cylinder exhausts through magnet valve, releasing interlock.

MAINTENANCE

Foreign substances, present in compressed air system, may enter magnet valve and damage valve faces and seats sufficiently to permit air leakage. Magnet valve can readily be tested on vehicle or on bench by applying soap suds and noting if air bubbles appear as valve is operated. A leaking or sticking valve should be immediately removed for repair or replacement.

DISASSEMBLY (Fig. 17)

1. Remove four screws (1) and lift off solenoid coil section being careful to avoid damaging spacer shims (5).

NOTE: Shims should be checked for total thickness to assure proper replacement to maintain clearance "A." See illustration.

2. Remove end plug (8) and spring (9) from valve body (11). Remove upper and lower valves (6 and 10).
3. Wipe, then inspect valves carefully. Replace if worn or damaged.
4. Clean valve body (11) in solvent and blow passages out with compressed air.
5. Remove plunger (4) from solenoid section clean and wipe dry.

ASSEMBLY (Fig. 17)

1. Place lower valve (10) in valve body (11), add spring (9), gasket (7), and end plug (8). Tighten end plug securely.
2. Place upper valve (6) in body section and place all spacer shims (5) in position. NOTE: Care must be taken that original shims are reinstalled to assure specified clearance "A." Otherwise valve will not operate properly.
3. Position body spacer (12), coil (13), and shell (3) on valve section.
4. Place plunger (4) into position, then install end cap (2). Install four screws (1) with lock washers attaching cap to body. Tighten screws evenly until reasonably snug.

SPECIAL CONTROLS AND DOORS

Following pages contain information on doors and controls available as special equipment. As special equipment, many coaches are equipped with outward folding four leaf rear doors, sometimes called "jack-knife type." Controls for this type door are illustrated in figure 18.

In addition to special doors, coaches are usually equipped with one or more safety devices such as accelerator interlock, sensitive edge door reversing mechanism, treadles, and rear door emergency release. NOTE: Brake interlock is standard equipment on transit coaches.

FOLDING REAR DOORS

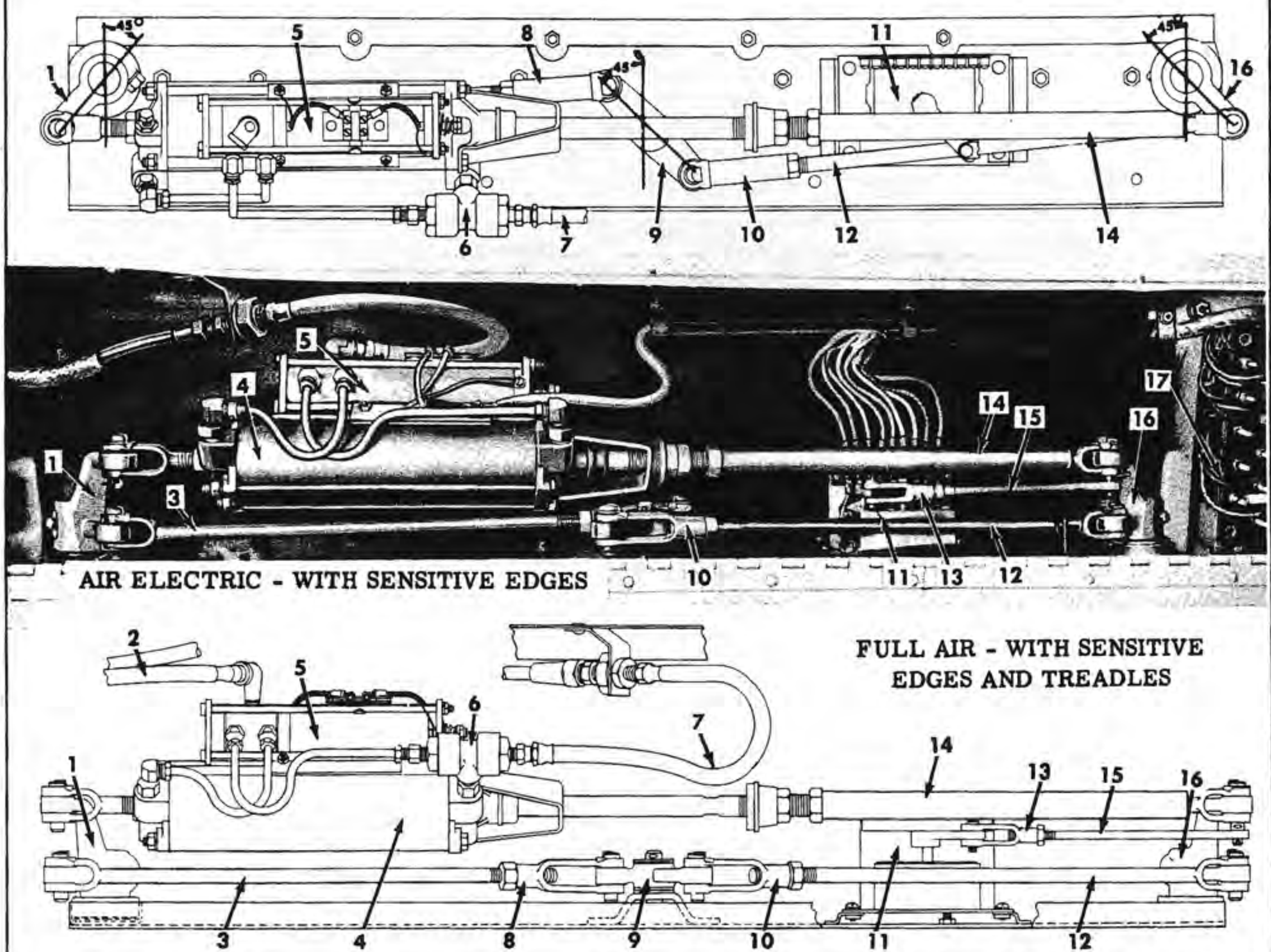
Operation of four leaf folding "jack-knife" doors is similar to standard push-type doors previously covered in this section, that is, each is controlled by the operator and use "full air" or "Air-electric." Typical air-electric door operating mechanism is shown in figure 18.

DOOR ENGINE

Rear door engine, used with folding doors, is the same type as illustrated in figure 6, therefore information previously given under heading "Front Door Engine" is also applicable to door engine used with rear folding doors.

FOLDING DOOR LINKAGE ADJUSTMENT

Whenever it becomes necessary to adjust linkage due to new parts being installed or if adjustments have been disturbed, proceed as follows:



1 Door Lever - Front
2 Air Line - Closing
3 Connecting Rod - Front
4 Door Engine
5 Solenoid Valve
6 Double Check Valve
7 Air Line - Opening
8 Adjustable Yoke - Front
9 Connecting Rod Idler Lever
10 Adjustable Yoke - Rear
11 Door Cam Switch
12 Connecting Rod - Rear
13 Adjustable Yoke - Cam Switch
14 Door Engine Rod
15 Cam Switch Rod
16 Door Lever - Rear
17 Wiring Junction Block

TPM-9509

Figure 18—Four-Leaf Folding Rear Door and Linkage

1. Close doors completely.

2. Check angle of front and rear door levers to be sure they are set at 45° angle (fig. 18). If necessary, loosen clamp bolt and reset lever to proper angle and re-tighten clamp bolt to 20-25 foot-pounds.

3. With doors completely closed install forward and rearward connecting rods to idler lever and front and rear levers. Adjust rods as necessary to provide free pins, then operate doors by hand to assure proper adjustment. Door levers and idler lever must travel an equal amount on either side of center.

4. With doors still closed connect engine to door front lever, then extend door engine and adjust rod to 1/4" greater than distance between front and rear levers. Collapse engine sufficiently to install clevis pin.

DOOR ENGINE SOLENOID VALVE

Solenoid valve consists of two intake valves and two exhaust valves, actuated by a dual solenoid (fig. 19). Solenoid coils are alternately energized by movement of door sensitive edge switch or by driver's control valve, with resultant valve action admitting air to one side of door engine, while exhausting air from other side.

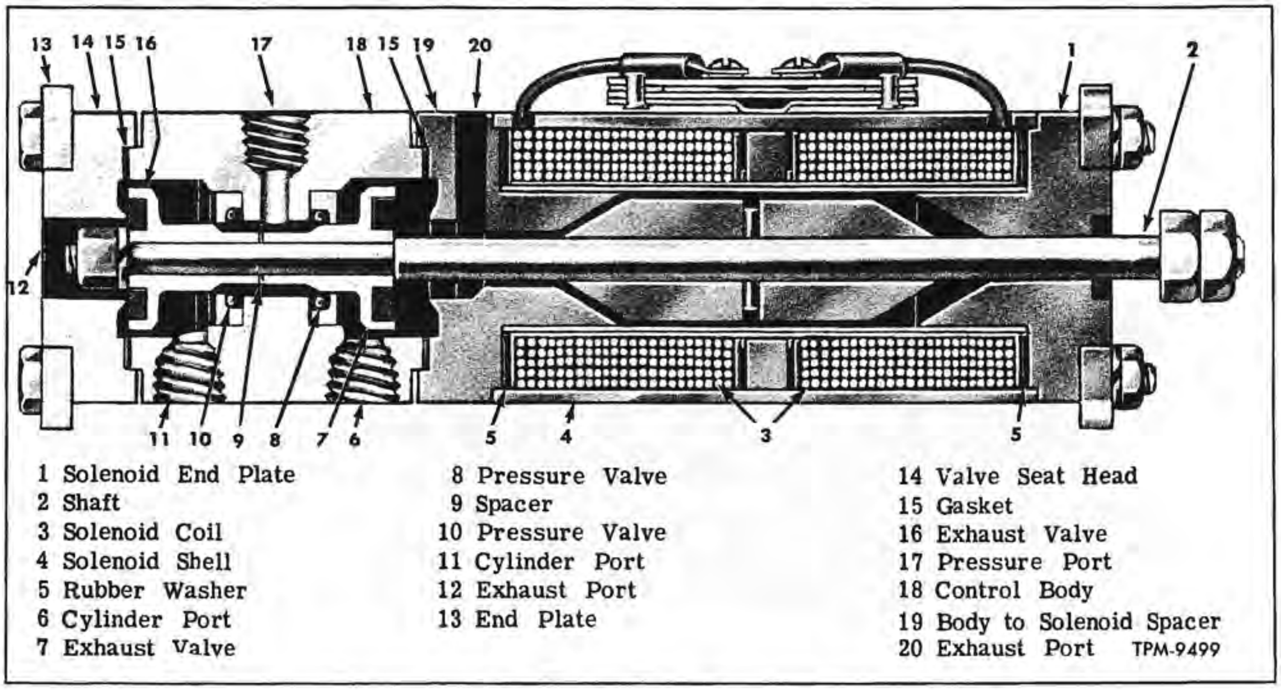


Figure 19—Rear Door Engine Solenoid Valve

OPERATION

NOTE: Key numbers in text refer to figure 19.

In position shown in figure 19, exhaust valve (16) is closed, pressure valve (10) is open, exhaust valve (7) is open, and pressure valve (8) is closed. Consequently, air entering pressure port (17) flows through open valve (10), into that end of door engine connected to cylinder port (11). At the same time, pressure in that end of cylinder connected to cylinder port (6) is exhausted past valve (7) and out exhaust port (20).

If right-hand solenoid coil (3) is now energized, shaft (2) begins moving to right. After initial movement begins, effect of air pressure is sufficient to complete movement of shaft. Consequently, solenoid coil need not be energized during entire movement of shaft.

When shaft completes movement, valve (7) is seated, while valve (8) is opened, thus permitting flow of air into end of cylinder connected to port (6). At same time, valve (16) is unseated, while valve (10) closes, permitting air from end of cylinder connected to port (11) to exhaust through port (12).

TEST ON VEHICLE

If solenoid appears to operate improperly check air pressure applied to the valve and then the solenoid coils and wiring as follows:

1. A test light or voltmeter connected between each terminal and ground while the control switch is operated in both positions will indicate current supplied to the coils. If test indicates that current is present at the solenoid terminals during the various positions of the door control switches, proceed as follows in step 2.

2. Disconnect feed wires from the solenoid and test for continuity of the coils either with a 9 ampere fuse in series with each coil while it is energized or with an ohmmeter. If the fuse flows (shorted coil) or abnormal resistance is indicated (2.2 to 2.3 ohms normal) the coil is defective. If the fuse does not blow an ammeter may be used to indicate current draw of the coil (3.8 to 4.0 amperes at 12V). A test light connected between the feed wires and the coils will indicate continuity of the coil but will not detect an internally shorted coil. The location of a short can be determined only by either the resistance or current draw methods. With the exception of the resistance test the door switches must be operated in the normal manner during tests. Low current draw will indicate either high resistance in the coil circuits or excessive voltage drop across the switches, circuit breaker or defective wiring.

3. Remove clamps, which attach solenoid valve to door engine; then remove valve.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 19.

1. Coils may be tested on bench, to determine necessity for replacement, in same manner as described under "Test on Vehicle," earlier.

2. Mark valve sections with punch to facilitate alignment at assembly.

3. Remove two nuts (if used) from end of shaft (2). Remove nuts and lock washers; then remove four long bolts. Slide end plate, solenoid end plate (1), and solenoid shell (4) from shaft (2). Coils can now be replaced without further disassembly of unit.

4. Remove end plate (13) and seat head (14).

5. Clamp solenoid plunger flats in vise. Unscrew nut from shaft; then slide exhaust valve (16) and control body (18) from shaft. Remove remaining valve (7) with spacer (9) from shaft; then remove body and solenoid spacer (19), with gasket (15).

INSPECTION

NOTE: Key numbers in text refer to figure 19.

1. Wipe parts with clean, soft cloth. Use solvent, if necessary, only on all-metal parts.

2. Examine valve seat surfaces of valve seat head (14) and solenoid spacer (19). Make sure seats are clean and free from nicks.

3. Insert valves (7 and 16) into O-rings (8 and 10) in control body (18). Valves must be a slide fit in rings. Replace O-rings, if cut or damaged.

4. Polish solenoid plunger with fine emery cloth and wipe clean.

ASSEMBLY

NOTE: Key numbers in text refer to figure 19.

1. Clamp flats of solenoid plunger in vise, with small end of shaft at top.

2. Referring to illustration, install solenoid spacer (19), new gasket (15), valve (7), spacer (9), control body (18), and valve (16). Install lock washer and nut, tightening nut firmly.

3. Install new rubber washer (5) on each end of solenoid shell (4). Insert shaft through solenoid body and position solenoid end plate over shaft and into solenoid body.

4. Install end plate; then install two nuts on end of shaft, locking outer nut firmly against inner.

5. Install gasket (15) in valve seat head (14) and position head to control body (18). Position end plate (13) to head and install four long bolts through end caps.

6. Install lock washers and start nuts on tie bolts. Align punch marks, made at disassembly; then tighten four nuts alternately and evenly.

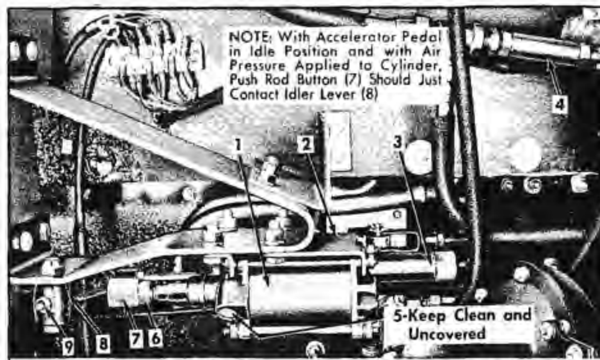
INSTALLATION

1. Position valve on door engine; then install mounting clamps. Do not tighten clamps.

2. Connect air lines between valve and door engine. Connect air supply hose to top of valve. Tighten mounting clamps firmly.

3. Connect wires to proper leads, according to markings made at removal.

4. Turn air valve, at left of driver, counterclockwise, to operating position.



1 Interlock Cylinder Assy.	5 Cylinder Breather (KEEP CLEAN)
2 Interlock Mounting Bracket	6 Lock Nut
3 Interlock Accelerator Linkage Spring Assy.	7 Push Rod Button
4 Air Strainer Assy.	8 Accelerator Linkage Idler Lever
	9 Lubrication Fitting

Figure 20—Accelerator Interlock Linkage

ACCELERATOR INTERLOCK

Accelerator interlock is employed as a safety device to prevent movement of coach while exit door is open and passengers are alighting.

OPERATION

Accelerator interlock on transit coaches, is employed in connection with brake interlock and is connected to rear doors only.

Interlock functions to prevent engine exceeding idling speed when rear doors are unlocked. Interlock air cylinder (fig. 20) is supplied with full reservoir air pressure through interlock magnet valve (fig. 14). A single magnet valve supplies air pressure to both brake and accelerator interlocks. Accelerator interlock air cylinder is mechanically connected to accelerator control rod when air pressure is applied to cylinder.

Driver has no direct control of accelerator interlock, since operation is automatic. However, if failure in door control electrical circuits causes accelerator interlock to function, driver may shut off door electrical circuits at door master switch.

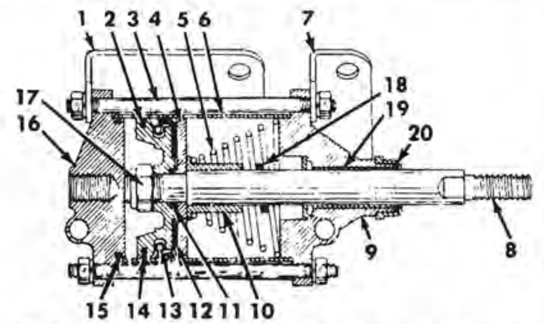
Repair information on the various interlock units, is explained below under respective headings.

Figures 25, 26, and 27 illustrate interlock units installed in system.

ACCELERATOR INTERLOCK AIR CYLINDER

MAINTENANCE

Interlock air cylinder should be removed from coach annually for inspection and lubrication.



1 Rear Bracket	*11 Rod O-ring Gasket
2 Piston Follower	*12 Piston Cup
3 Tie-Bolt	13 Cup Expander Spring
4 Piston Plate	*14 Piston Felt
5 Return Spring	*15 Cover O-ring Gasket
6 Cylinder Tube	16 Rear Cover
7 Front Bracket	17 Push Rod Nut
8 Push Rod	18 Piston Rod Washer
9 Front Cover	*19 Bushing
10 Piston Stop Spacer	*20 Felt Washer

*Part of Repair Kit. TPM-7004

Figure 21—Accelerator Interlock Air Cylinder Assembly

DISASSEMBLY AND ASSEMBLY OF INTERLOCK AIR CYLINDER

NOTE: Key numbers in text refer to figure 21.

1. Mark both front and rear covers in relation to cylinder tube to reassure proper position of parts at reassembly.

2. Remove four nuts which attach front bracket (7) to front cover (9). Remove bracket. Pull front cover with push rod assembly from cylinder tube (6).

3. Pull cylinder tube (6) from rear cover (16). Remove O-ring gasket (15) from rear cover.

4. Remove nut (17) from push rod (8), then pull piston parts and return spring (5) from push rod. Remove O-ring gasket (11) from piston follower (2). Remove felt (14) from piston follower (2).

NOTE: Further disassembly of cylinder is generally not necessary.

5. Wash all parts in solvent, then carefully examine parts for signs of wear, giving particular attention to piston cup (12) and gaskets (11 and 15). Replace worn parts as necessary.

6. Coat entire inside wall of cylinder tube (6) with a light film of chassis lubricant.

7. Place piston rod washer (18) on piston rod. With front cover (9) on push rod, position return spring (5), piston stop spacer (10), and piston plate (4) on push rod.

8. Install O-ring seal (11) into counterbore of piston follower and felt (14) into groove of follower. Place cup expander spring (13) and piston cup (12) over follower. See illustration for position of parts.

9. Install follower with piston cup on push rod and retain with nut. Tighten nut firmly.

10. Install O-ring gasket (15) into groove of rear cover (16).

11. Being careful not to damage piston cup (12), install cylinder tube (6) over piston parts.

12. Apply engine oil to felt seal in front cover then assemble front and rear covers to cylinder tube with location marks made prior to disassembly aligned. Install tie-bolts (3) and mounting brackets (1 and 7). Tighten tie-bolt nuts evenly and firmly. If push rod end yoke was removed, reinstall.

INTERLOCK LINKAGE ADJUSTMENT

Linkage at front of coach is accessible from underneath coach (fig. 20). When door control valve is placed in any door unlocked or open position, air pressure is applied to the interlock air cylinder which in turn forces accelerator linkage to the idle position.

Interlock linkage is properly adjusted when the following three conditions occur:

a. Accelerator pedal and linkage returns to idle position.

b. Air pressure is applied to interlock air cylinder (rear doors unlocked or open).

c. Button (7, fig. 20) just contacts accelerator idler lever (8, fig. 20).

If adjustment is necessary, loosen lock nut (6, fig. 20) and reposition push rod button (7, fig. 20). After making adjustment tighten lock nut firmly.

DOOR SENSITIVE EDGES

DESCRIPTION AND OPERATION

Sensitive edges are a safety device, designed to reopen doors in the event they should touch a passenger while closing. Although sensitive edges can be installed on entrance door, most common application is on exit door. Sensitive edges are frequently combined with other special devices, such as brake interlock, accelerator interlock, and treadles.

Sensitive edges incorporate electrical contacts actuated by pressure on rubber edges of doors. Micro-switch, mounted near top of door, is operated by rod. Pressure against sensitive edge deflects vertical cable on edge, operating rod to close micro-switch contacts (fig. 22).

If door closes upon passenger or other obstruction, electrical contact immediately reverses movement of door. Door opens completely, then automatically closes if obstruction has been removed. Otherwise door repeats cycle of partly closing and fully opening until obstruction is removed, or until driver opens door with control switch.

When door closes completely, sensitive edge control of door becomes inoperative. If an object is not inserted between sensitive edges, doors remain closed, but driver is warned of this condition by ringing of bell mounted on dash panel at left of steering column.

Operation of sensitive edges is automatic, and driver has no direct control of this equipment. However, if failure of electrical control circuits results in improper operation, driver may shut off door safety circuits with door master switch.

INSPECTION

Sensitive edges should be checked daily as a safety precaution. Both edges of door should be checked to make sure that both edges operate. With doors in closed position, door bell should ring when pressure is applied to either door edge. Slight pressure against door edge, with doors closing should immediately reverse motion and open doors.

In the event a sensitive edge becomes inoperative, cause of trouble may sometimes be found in electrical cable which connects to micro-switch. Flexing of wire as doors are opened and closed may in time break electrical wire without affecting appearance of outer insulation.

Inspect all electrical connections periodically to make sure connections are clean and tight. Refer to applicable Wiring and Air Line Diagram.

ADJUSTMENT

When test indicates necessity for adjustment, sensitivity can be increased or decreased by tightening or loosening bottom cable nut. Nut is accessible from under lower end of sensitive edge (fig. 22). Cable should be so adjusted so that a 1-inch deflection near center of door will close switch contacts. With doors closed a 2-inch block thrust between rubber door edge, should operate both switches.

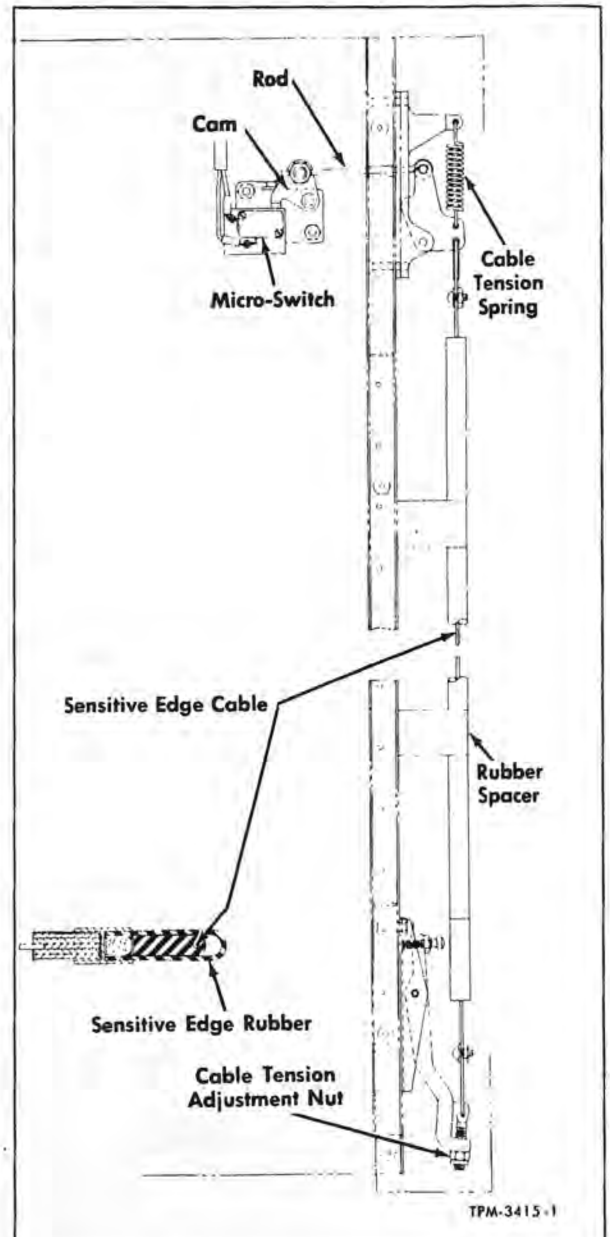


Figure 22—Door Sensitive Edges

DOOR CONTROL CAM SWITCH

Cam switch, used with sensitive edges, is mounted in compartment above exit door, as typically shown in figure 18. Requiring no maintenance, switch consists of one double-throw and two or three single-throw micro-switches, and a nine-post junction block. Actuated by cams mounted on a common shaft, switches are operated by door engine linkage. Figure 23 shows positions of individual switches identified by letters A through D on Wiring and Air Line Diagrams at end of this group. Switches require no attention, except for correct adjustment of switch linkage, whenever any other door linkage adjustments have been changed.

LINKAGE ADJUSTMENT

Door engine linkage must be properly adjusted, as directed previously in this manual, before adjustment of switch linkage is attempted.

1. With exit doors closed, lengthen switch linkage until switch (B), shown on applicable Wiring and Air Line Diagrams, closes. This can be determined by means of a trouble light or voltmeter, or when "EXIT DOOR" tell-tale lights.

2. Shorten switch linkage until switch (B) opens. Tighten clevis lock nut.

3. Unload air from door engine by turning air valve, at left of driver, to "OFF" position.

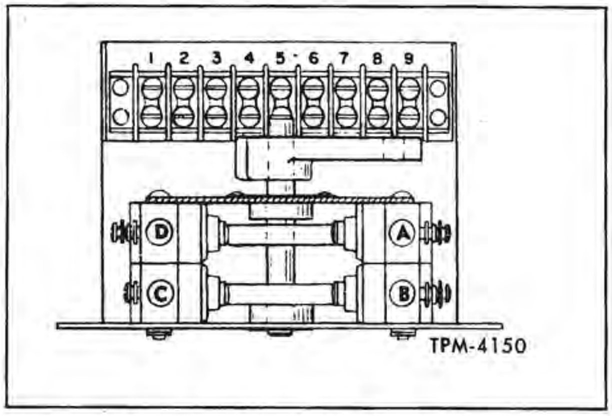


Figure 23—Door Control Cam Switch

4. Connect test light to Nos. 1 and 9 terminals on switch. Open doors slowly by hand, noting door position when test light indicates closing of switch. Doors should be approximately 3/4 open when switch closes.

DOOR SENSITIVE EDGE BELL

Door bell, used in connection with door sensitive edges, is mounted on dash panel at left of steering column.

Operation of bell (fig. 24) should be checked daily, as a safety measure, by applying pressure to sensitive edges.

Contacts of bell, should be inspected periodically, and cleaned if necessary. Contacts are accessible after removal of bell from base.

In the event of failure, check bell terminals and make sure current indication is obtained before replacing bell. Door bell electrical circuits are shown on applicable wiring and air line diagrams shown at rear of this section.

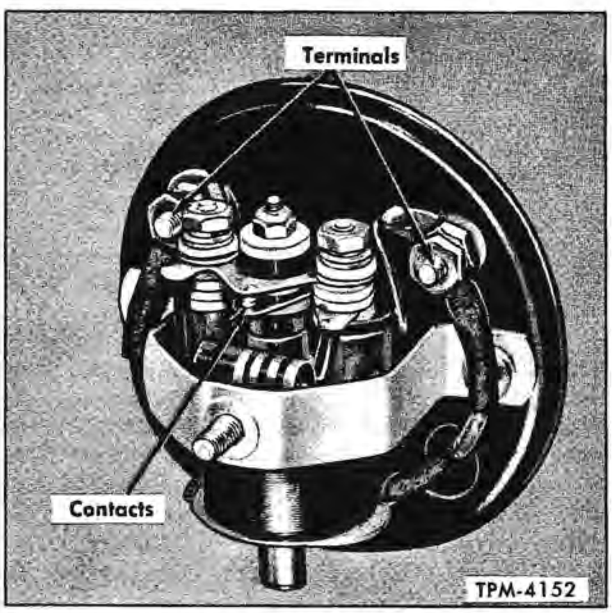


Figure 24—Door Sensitive Edge Bell

TREADLES

Operating-type treadles used on some transit type vehicles are generally used only at rear door. Weight of passenger standing on treadle closes normally open electrical contacts.

In operation, driver does not open and close doors, this being done automatically. When passenger desires to leave coach, driver pre-sets treadle circuit either by moving door control lever to rear door position or by opening front door.

Door opens when passenger steps on treadle, remaining open until passenger's weight is removed from treadle. If passenger fails to step on treadle, driver can open door by turning on by-pass switch mounted on windshield ledge.

In the event of door failing to close due to accident or failure of controlling device, driver can close door by turning door master switch off. However, in the event a passenger steps on top treadle and is not desirous of leaving coach, and another is alighting from coach lower treadle, rear door will remain in open position. Operator can then close door, by turning off treadle interrupter switch, located on control panel and placing door control valve in closed position. Interrupter switch breaks electrical circuit to door magnet valve which in turn reacts to close door. Refer to figure 27 for diagram of electrical circuits and connections.

REAR DOOR EMERGENCY RELEASE MECHANISM

Various types of emergency release mechanism may be used on transit coaches to allow passenger to open or unlock rear doors under emergency conditions. Two common types are described below:

Release mechanism used with push-type doors consist of a pull rod with catch which disengages the door lock cam when pulled. Doors can then be opened manually after rod is pulled.

Release mechanism used with air-electric operated doors when pulled, will shut off air supply to door engine and doors will open automatically.

Regardless of release mechanism used, the operation of mechanism should be checked at beginning of each days run.

NOTE: If release handle is located behind glass, the glass can be slid out of box glass channels providing access to handle. Make sure glass is fully seated in box channels after making check.

EMERGENCY DOOR

Emergency door incorporates an inside bar-type safety lock. Switch, mounted on door latch pillar and operated by the door lock bar, lights telltale in instrument panel and sounds alarm buzzer to indicate door is not closed and locked. Door should be inspected regularly to make sure of proper operation of door locking mechanism, telltale and buzzer. Refer to WIRING AND MISCELLANEOUS ELECTRICAL (SEC. 7) for information on alarm buzzer and to wiring diagram at rear of manual for checking of electrical circuits.

Door can be adjusted for tightness to body when closed, by repositioning lock bar on serrated lock shaft. Remove screw retaining lock bar flat washer to lock shaft. Reposition lock bar on shaft and check operation. Reinstall flat washer and retaining screw.

LUBRICATION

Parts listed below require periodic lubrication.
- Front and rear door engine
- Rear door check cylinder (push-type doors)
- Front and rear door upper bearings
- Front and rear door lower bearings
- Accelerator interlock (SL) lever shaft
- Accelerator interlock (SL) linkage
- Emergency door hinge pins and release bar

Refer to LUBRICATION (SEC. 13) of this manual for proper lubricant, intervals, and method of application.

SPECIFICATIONS

Door Control Air Pressure Regulator Valve	
GM Part Number	2417152
Make	Midland
Model	M2-23
Stamped	N-15685-D
Pressure Setting	45 psi
Rear Door Lock Solenoid	
GM Part Number	1119921
Make	Delco-Remy
Stamped	1119921
Volts	12
Interlock Magnet Valve	
GM Part Number	2336345
Make	Midland
Stamped	N-2991
Type	Pressure
Interlock Air Pressure Regulator Valve	
GM Part Number	2336347
Make	Midland
Midland Number	N-13680-C
Pressure Setting	35-40 psi
Interlock Two-Way Check Valve	
GM Part Number	2336346
Make	Midland
Stamped	N-12488-C
Exit Door Bell	
GM Part Number	2318065
Make	Faraday
Faraday Number	K-336197

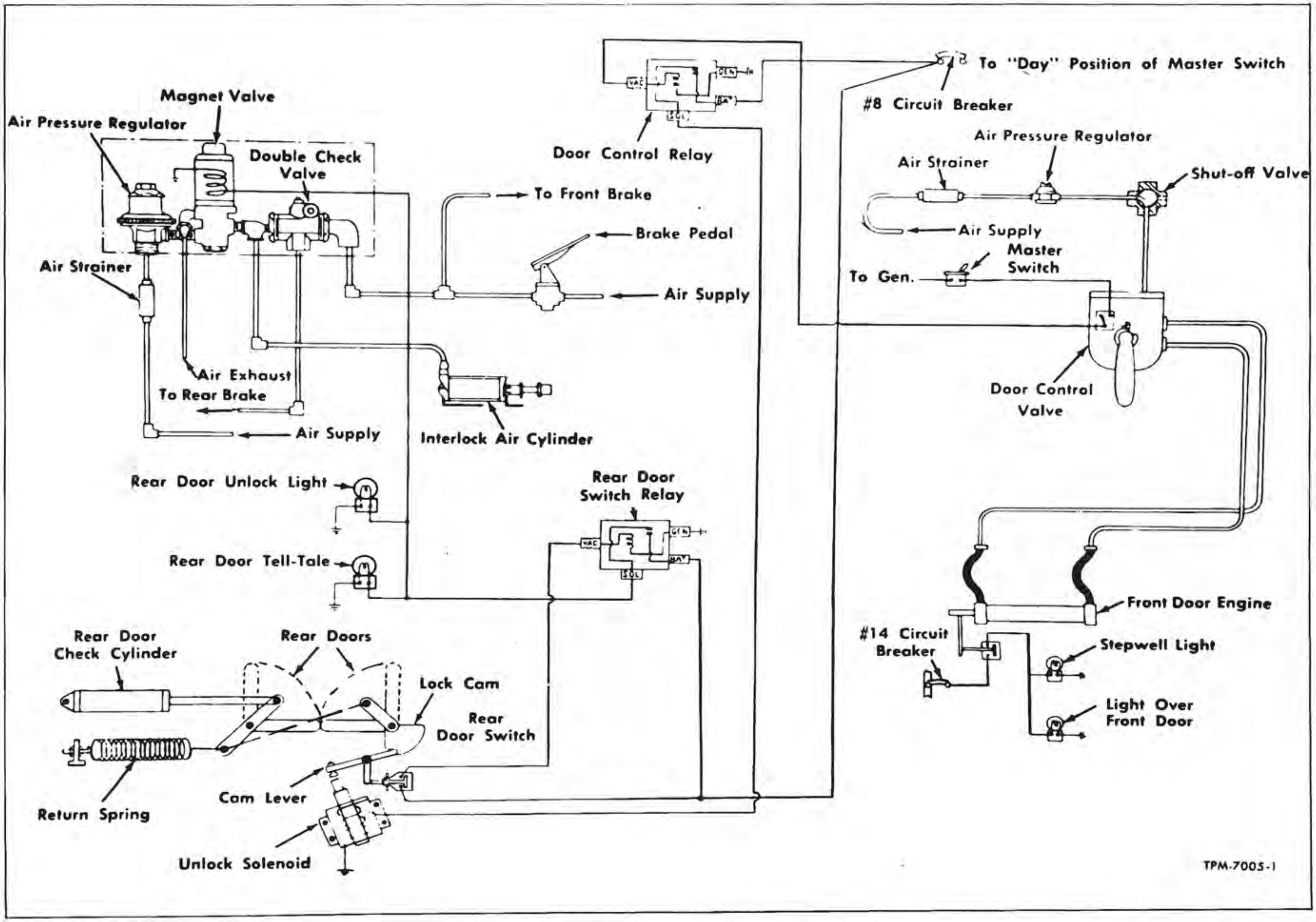
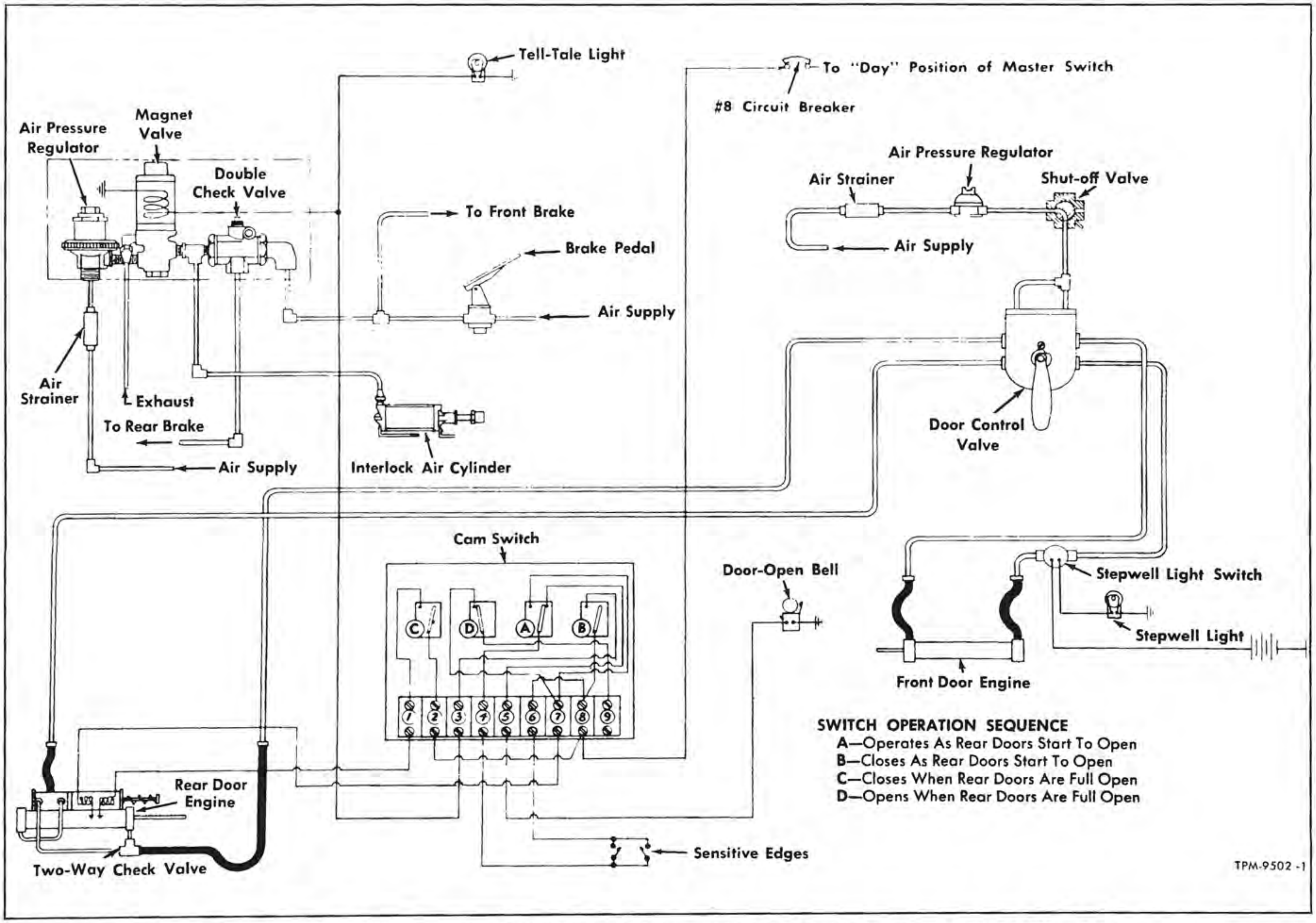


Figure 25—Schematic Arrangement of Door Controls, Air Lines, and Electrical Circuits—Push Type



SWITCH OPERATION SEQUENCE
A—Operates As Rear Doors Start To Open
B—Closes As Rear Doors Start To Open
C—Closes When Rear Doors Are Full Open
D—Opens When Rear Doors Are Full Open

Figure 26—Schematic Arrangement of Door Controls, Air Lines, and Electrical Circuits—Front and Rear Air—Folding Type

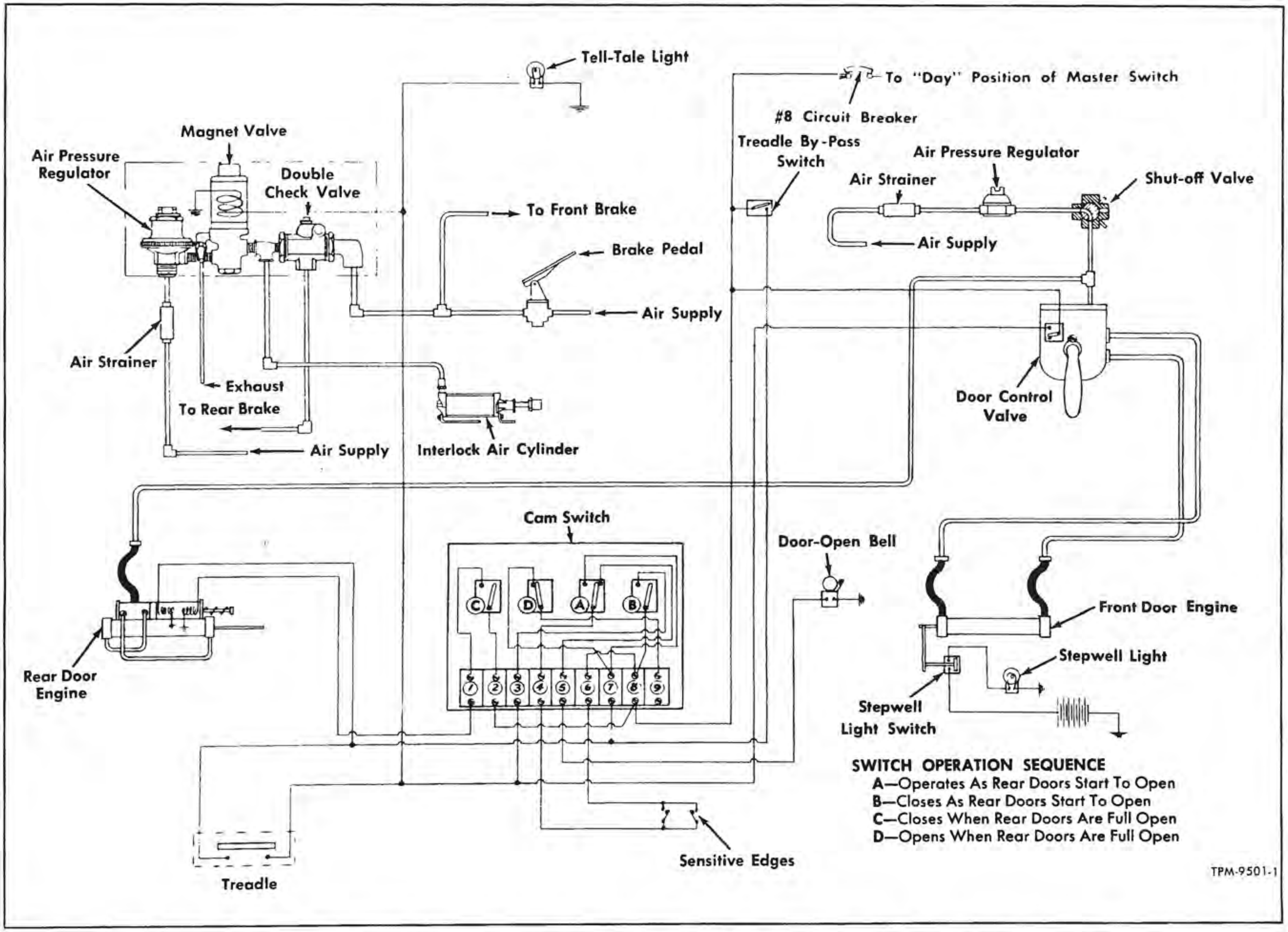


Figure 27—Schematic Arrangement of Door Controls, Air Lines, and Electrical Circuits—Front Air, Rear Air Electric—Folding Type

Heating and Ventilation

The underfloor heating compartment containing the heating core, air filters and blowers is shown in figure 1. On coaches having air conditioning, the cooling evaporator coil is located between the heater core and the filter screens.

The heating system water lines and control units are shown schematically in figure 2. Heated, outside, and recirculated air flow, within the coach, are shown schematically in figure 3.

Wiring diagram covering the electrical phase of heating system is located at rear of this manual.

DESCRIPTION

The heating system units and controls consist of the following:

1. The Grad-U-Stat, a thermostatically-operated air pressure control valve, which is mounted in recirculated air inlet on the floor under seats at right side of aisle on transit models and under the raised floor on suburban models.

2. The modulation valve, an air pressure operated water flow valve, which is installed in heater supply line on floor at rear of left rear wheelhouse on transit models and under the raised floor on suburban models.

3. The air pressure regulator valve, mounted underneath coach on bulkhead at right side of coach next to right blower motor, controls the air pressure required for operating the Grad-U-Stat and modulation valve.

4. The underfloor heater core unit, consisting

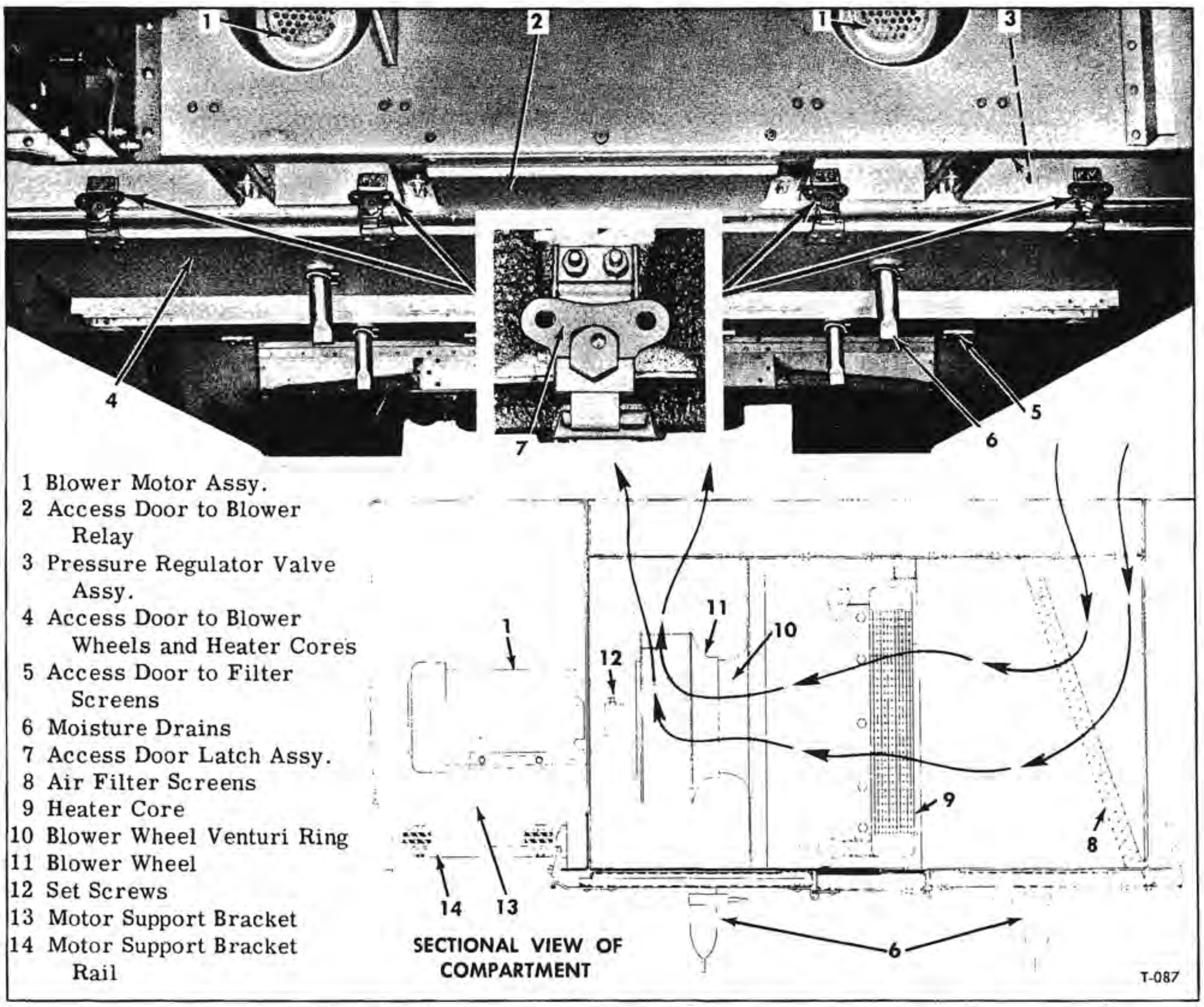


Figure 1—Underfloor Heating Compartment (Less Air Conditioning)

of two separate cores bolted together at ends, is located underfloor near center of coach.

5. Two electrically-driven motors and blowers located at rear of underfloor heater compartment.

6. The heating system water pump located in heater supply line on floor at rear of left rear wheelhouse on transit models and under the raised floor in same general position on suburban models. Water pump circulates water through the heating lines and cores.

7. Three screen type air filters located forward of the heater core unit in the underfloor heater compartment. Screens filter all the air passing through the compartment.

8. A dash heater unit, for the purpose of supplying heated air to driver, or to the windshield for defrosting, is located behind dash center closure panel.

NOTE: Most of the heating system units and controls are contained in or near the underfloor heating compartment as shown in figure 1. Access to filters is obtained by lowering hinged door (5, fig. 1) directly below filters.

To gain access to core unit and blower wheels it is necessary to lower access door (4, fig. 1) latched directly below compartment.

SYSTEM OPERATION

As previously stated, the control of heating system is entirely automatic, and the system operates only while the coach engine is running.

Wiring diagrams at the rear of this manual should be referred to when following system operation.

On coaches not equipped with air conditioning, "BLOWER" switch located on recessed switch panel at left of driver will control the underfloor blowers when positioned as follows:

"ON"	- (Standard) will cause blowers to operate whenever the generator is charging.
"AUTO"	- (Standard) blowers will operate only when the Grad-U-Stat (thermostat) calls for heat.
"NORMAL"	- (Special Equipment) will cause blowers to operate whenever the generator is charging.
"OFF"	- (Special Equipment) blowers will not operate regardless of demands of automatic controls.

On coaches equipped with air conditioning, the underfloor blower motors are controlled by the "VENTILATION" switch on control panel at left of driver whenever the generator is charging. Switch need not be rotated to "BLOWER" - "HI" or "LO" position for heating system to operate, as heater blower motors will run at low speed whenever the Grad-U-Stat calls for heat. The switch can be positioned to "HI" or "LO" as desired to provide added ventilation regardless of the demands of thermostat.

NOTE: Whenever extra ventilation is not required, "BLOWER" switch should be returned to "OFF" position.

The water modulation valve switch is of the two-position type and the units which are actuated in either switch position are shown on "Heating and Ventilation Wiring Diagram" in back of this manual.

Defroster heater fan motor is controlled by a three-position switch marked "DEFROST" on control panel at left of operator. Motor will operate at either "HI" or "LO" speed and will stop in "OFF" position.

AIR CIRCULATION

Air flow through heating system is shown in figure 3. A small portion of circulating air is outside air, admitted through grilled intakes below windows at each side of coach. This outside air replaces air exhausting from around door openings.

Both outside and recirculated air are drawn into underfloor heating compartment and distributed through longitudinal ducts along each side at base of wall and vertical wall ducts along seats.

Small outlets, located in longitudinal ducts at floor, allow heated air to flow under passenger seats. Outlet consists of a slider and a slider plate, as shown in figure 4.

Air to left side of driver's seat is admitted from duct at base of left wall by manually controlled damper which also acts as a deflector.

Air forced through defroster heater core may be recirculated air or outside air, as desired, by manual positioning of outside air inlet damper (fig. 5), at right side of heater core accessible after opening compartment door at right of dash. With damper closed (as shown), outside air will be admitted; with damper open, inside air will be recirculated.

NOTE: Excessive use of defroster heater will cause high temperature at front end of coach, thereby satisfying the Grad-U-Stat and leaving the balance of coach cold.

WATER CIRCULATION (Fig. 2)

Hot water from the cooling system is forced to the heater supply line by the engine water pump. Electrically operated pump forces water through the coach heating system. Actual flow of water through the heater cores is controlled by the modulation valve (see figs. 6 and 7), which in turn, is controlled by the Grad-U-Stat thermostat.

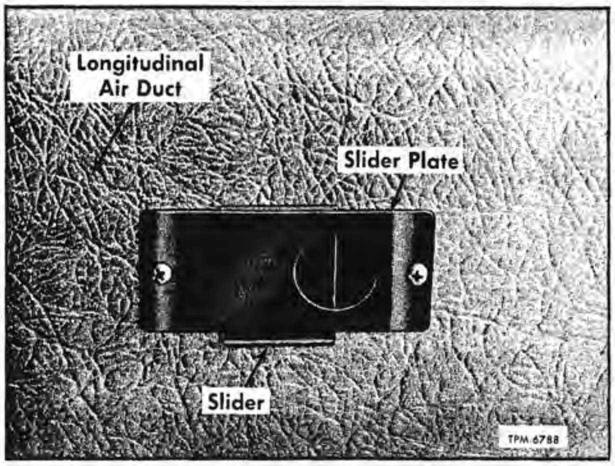


Figure 4—Air Duct Slider

Flow of water through the dash heater core is controlled by the manually adjusted control valve (fig. 8). Water modulation valve is air-operated, the air pressure delivered to it being graduated by the Grad-U-Stat, which is sensitive to inside coach temperature. After circulating through heater cores, water flows through the return line to the suction side of the engine water pump. Shut-off (gate) valve (figs. 7 and 9), located in return line provides manual means of closing or opening line circuit, to permit working on engine system without draining heating system (or vice versa). Valve is located underneath floor ahead of engine bulkhead at left side of transit coach or behind floor aisle riser on suburban coach.

Heating system water pump is energized to circulate water through the defroster heating system, when the following occurs:

1. When "DEFROST" switch on control panel at left of driver is placed in "HI" or "LO" position and engine is running.
2. When the water modulation valve is in any open position, the Grad-U-Stat is calling for heat, and the engine is running.

MAINTENANCE

GENERAL

1. Heating system should be flushed semi-annually, following same general procedure as used for flushing main engine cooling system.
2. At regular intervals, examine heater pipe joints and fittings, and heater cores for leakage and make the necessary repairs. Clean all dirt from heater cores.
3. Check for proper operation of heater blower motors, Grad-U-Stat, water modulation valve, and blower motor relays at regular intervals.

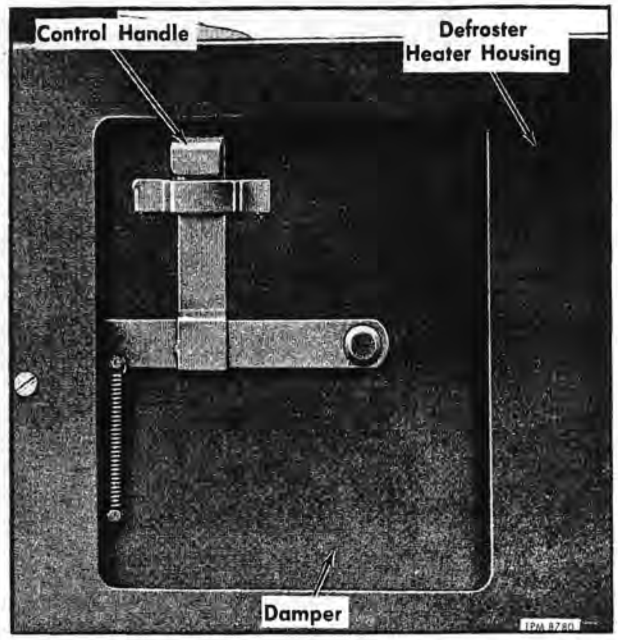
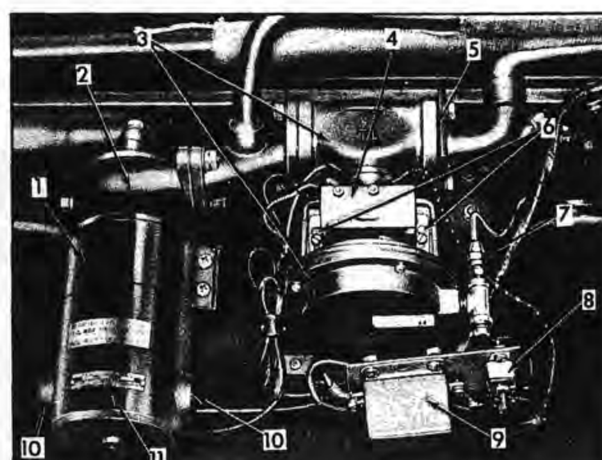


Figure 5—Outside Air Inlet Damper

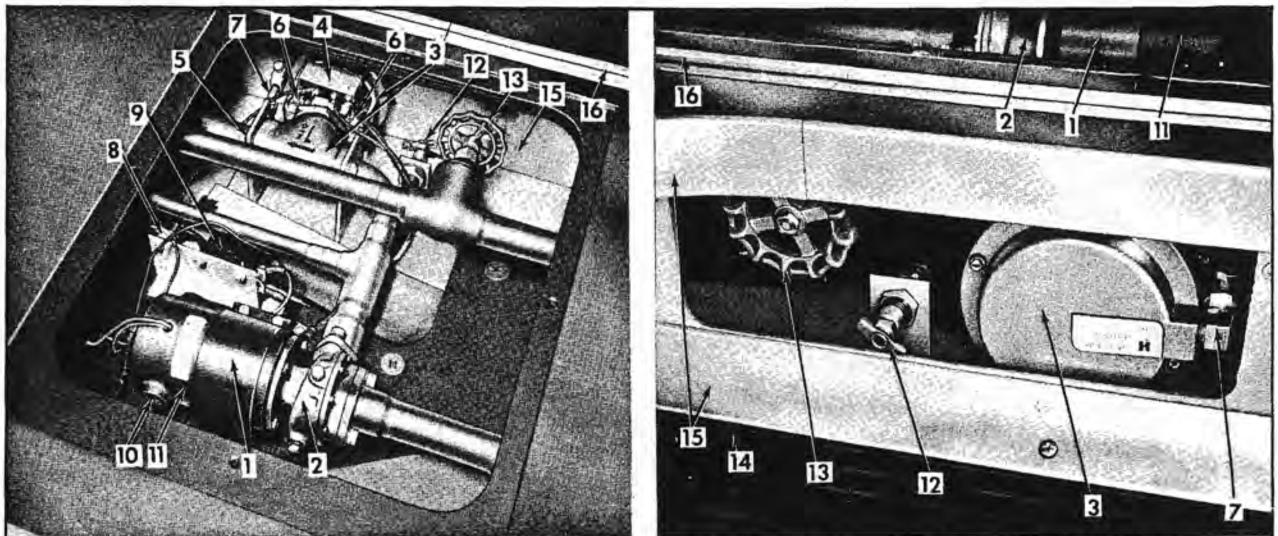
4. Drain plug is provided at bottom of pressure regulator valve, for draining moisture. Pressure regulator valve is located at rear of underfloor heating and cooling compartment on bulkhead at right side. Valve should be drained at regular intervals.



1 Motor Clamp
2 Pump
3 Water Modulation Valve Assembly
4 Pump Switch Assy.
5 Gasket
6 Slotted Holes for Switch Adjustment
7 Air Line from Grad-U-Stat
8 Circuit Breaker
9 Pump Motor Relay
10 Brush Cap
11 Motor Assembly

Figure 6—Modulation Valve and Water Pump Installed—Transit Model

HEATING AND VENTILATION



1 Motor Clamp	6 Slotted Holes for Switch Adjustment	11 Motor Assembly
2 Pump	7 Air Line From Grad-U-Stat	12 Drain Cock
3 Water Modulation Valve Assembly	8 Circuit Breaker	13 Shut-off (Gate) Valve
4 Pump Switch Assembly	9 Pump Motor Relay	14 Aisle Floor
5 Gasket	10 Brush Cap	15 Seat Riser
		16 Seat Track

TPM-9462

Figure 7—Modulation Valve and Water Pump Installed—Suburban Model

5. Possible causes of improper heating are listed later under "TROUBLE SHOOTING."

6. Clean underfloor heater filters at least once a week. Replace underfloor heater air filters whenever they appear restricted.

DRAINING

1. If heating system is to be drained without draining engine cooling system, close shut-off (gate) valve (figs. 7 and 9) located underneath floor ahead of engine bulkhead at left side of transit coach or behind aisle riser on suburban coach.

NOTE: Engine cooling system, likewise, can be drained separately from the heating system.

2. Make sure water modulation valve is open, by closing off air pressure supply at air pressure

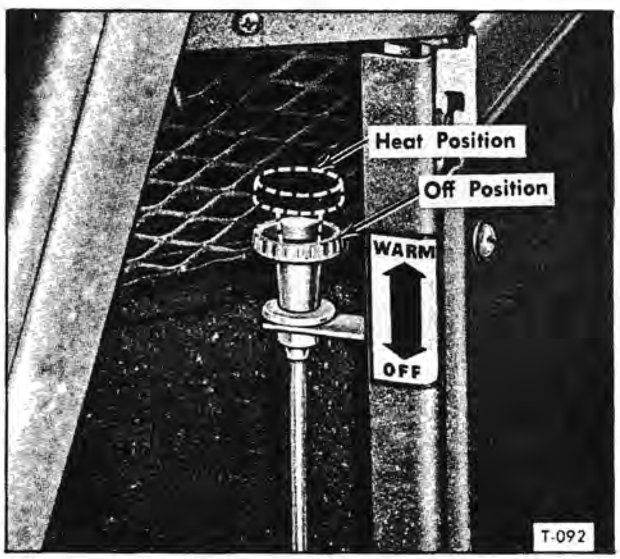


Figure 8—Driver's Heater and Defroster Valve Control

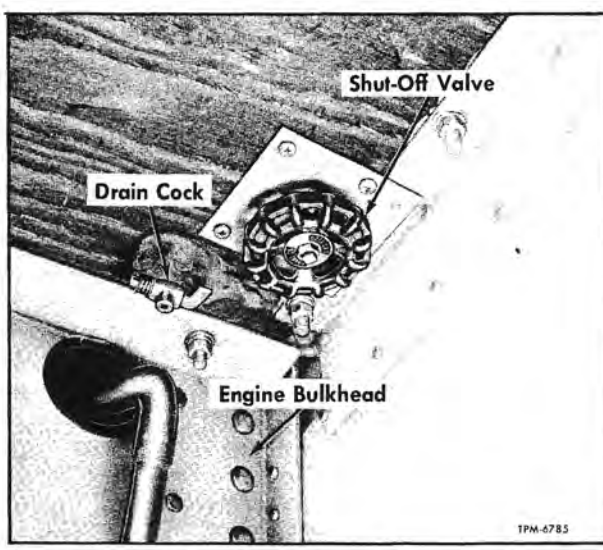


Figure 9—Shut-Off Valve and Drain Cock At Engine Bulkhead (Transit Model)

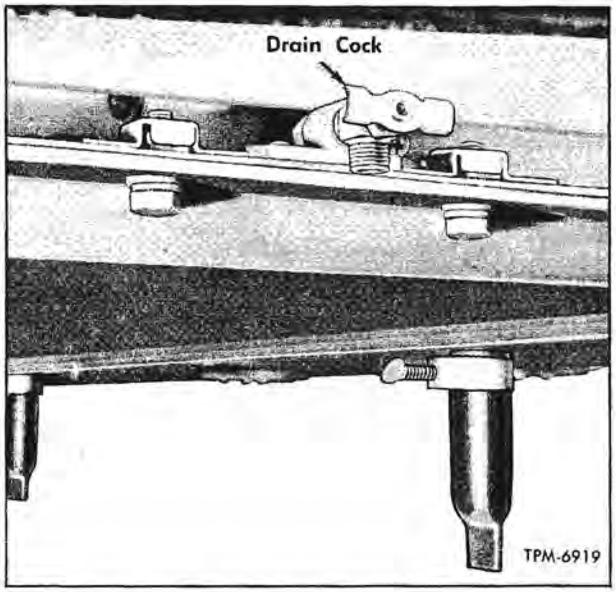


Figure 10—Underfloor Heater Core Drain Cock

regulator valve, which is located on bulkhead at right of underfloor heater compartment.

3. Open drain cock (fig. 10) at lower right side of underfloor heater compartment to drain heater cores.

4. On a transit coach, drain cock (fig. 9) near heater line shut-off valve, to drain supply line between engine and heating system pump.

5. Open drain cock (fig. 11) just above coach batteries, to drain defroster heater line midway between front and rear wheelhouses.

6. On a transit coach, open drain cock (fig. 12) underneath floor just to rear of left rear wheelhouse, to drain supply line connecting modulation valve and under-floor heater core. This same drain cock on suburban coaches is located behind floor aisle riser (fig. 7).

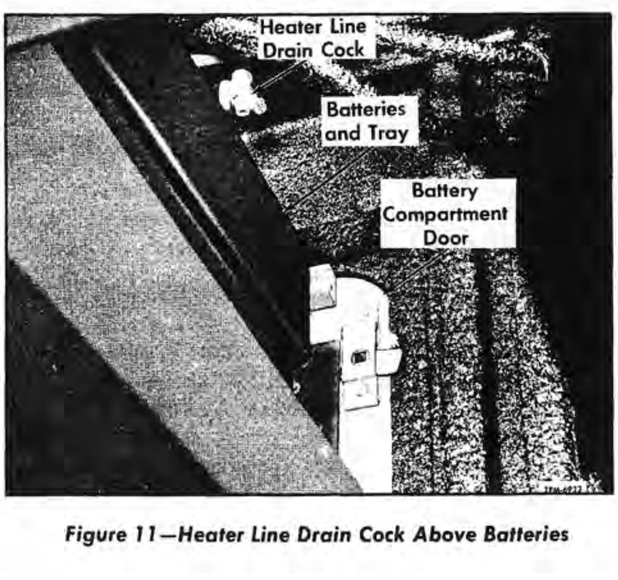


Figure 11—Heater Line Drain Cock Above Batteries

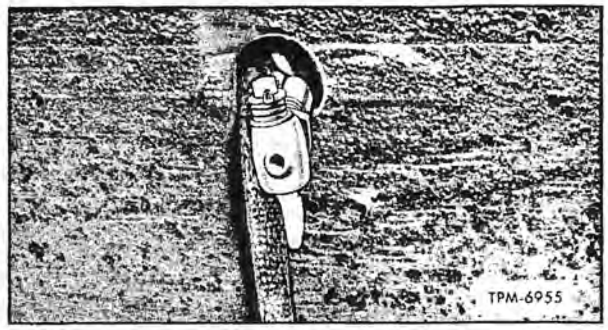


Figure 12—Heater Line Drain Cock At Rear Of Left Wheelhouse (Transit Model)

7. Open two drain cocks (fig. 13) in defroster heater lines. Drain cocks are accessible from underneath driver's compartment.

8. Open radiator surge tank to allow system to vent.

FILLING

1. Make certain all drain cocks mentioned previously under "Draining," are closed, that heater line shut-off valve (figs. 7 and 9) underfloor and defroster heater valve (fig. 8) are open.

2. Fill heating system in same conventional manner as for filling engine cooling system.

3. After initial filling, heating system water pump can be energized to assist in circulating water through heating system, by first running engine and then placing "DEFROST" switch on control panel at left of driver to "HI" or "LO" position.

4. Set air pressure regulator valve as explained later under "Air Pressure Regulator Valve."

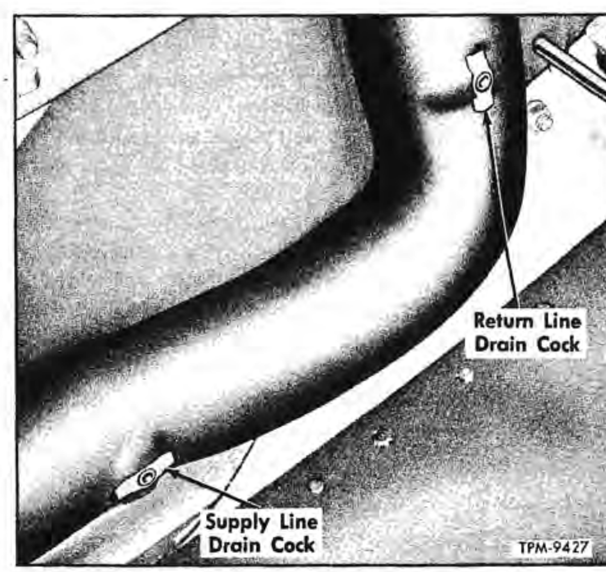


Figure 13—Defroster Heater Line Drain Cocks

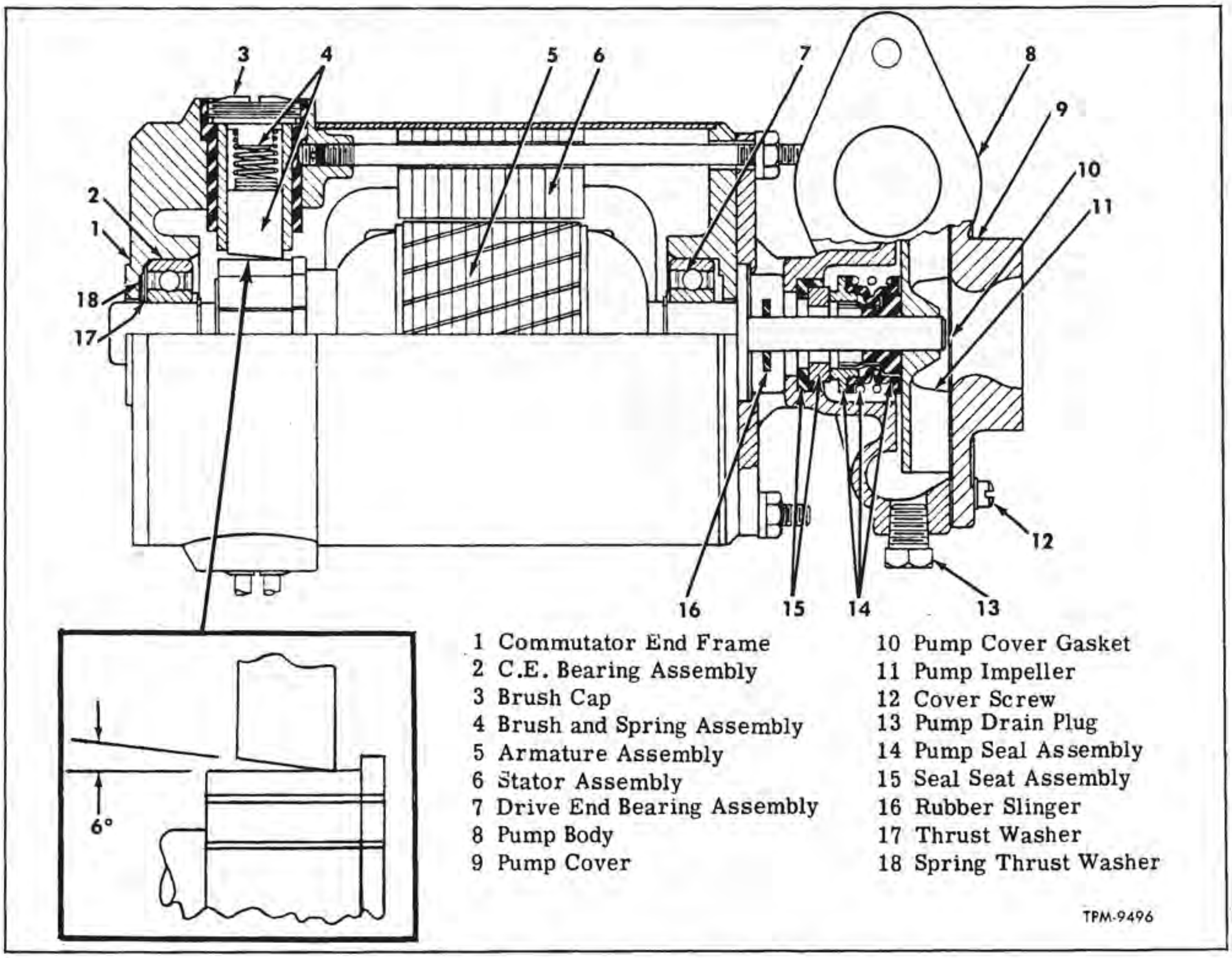


Figure 14—Heating System Water Pump and Motor

BLEEDING

Whenever engine cooling or coach heating system has been drained and refilled, when systems have run low and water is replenished, or whenever sufficient air has accumulated in system to retard normal flow of water, heating system should be bled to expel air.

Before bleeding system, make sure all drain cocks are closed and that heater line shut-off valve is open, and that shut-off valve to defroster is open. Open vent screw at upper portion of defroster heater. Close vent when all air is expelled.

Operate heating system water pump for short period of time, as directed previously under "Filling," to bleed heating system.

HEATING SYSTEM WATER PUMP

Heating system water pump (integral with motor) is mounted under last, left-side seat with water modulating valve, at rear of left rear wheelhouse as shown in figures 6 and 7.

On transit coaches, access to unit attaching bolts can be readily gained after removing the screw-retained access cover from portion of longitudinal heater duct located directly over the unit attaching bolts and the box-type cover over the modulation valve.

On suburban coaches, screw-retained access cover in floor must be removed.

Pump operation is explained previously under "Water Circulation."

IMPORTANT: Never operate pump dry, as pump seal will be destroyed.

Wiring diagram is located at rear of this manual.

Adjustment of control switch, mounted on the water modulation valve, is explained later under "Switch Adjustment at Water Modulation Valve."

Remove pump with motor as a unit, when necessary, for servicing.

NOTE: Motor brushes can be replaced without having to remove entire unit.

REMOVAL (Refer to Figs. 6 and 7)

1. Drain heating system to slightly below pump level as explained previously under "Draining."

2. Disconnect motor electrical wiring at relay and circuit breaker.

3. Disconnect water lines at flange connections, at pump inlet and pump outlet.

4. Remove screws, nuts, and lock washers which attach pump motor clamp to motor mounting bracket. Remove pump with motor.

DISASSEMBLY (Refer to Fig. 14)

1. Remove two brush caps (3) and two brush and spring assemblies (4).

2. Remove pump cover (9) by removing eight fillister head screws. Remove cover carefully to prevent damage to gasket (10).

3. Remove gasket (10).

4. Remove two hex nuts, and lock washers which attach pump assembly to motor.

5. Remove pump from motor in the following manner:

a. Install puller tool assembly (80-0202) to pump body (8) using four of the screws which were removed from the pump cover (9).

b. Tighten the puller screw which will press the motor shaft out of the impeller hub. The pump proper is now free of the motor.

6. Remove the puller tool.

7. Remove the impeller (11) and components of seal (14 and 15) assembly. (CAUTION: Do not damage the raised shoulder of the seal washer.)

8. Remove the floating seal seat (15) from the pump body by gently pressing from the motor side of the body.

CAUTION: Do not scratch or mar the sealing surface of this seat.

INSPECTION (Refer to Fig. 14)

Compare components with new parts to determine degree of wear.

Brushes

1. When removing brushes note the position of the brush in the tube. Brush life is shortened if brushes are not replaced properly.

2. Brushes should be examined for:

a. Wear. Replace if less than 25% of the usable brush is left (less than .300 of an inch).

b. Chipped Edges. Chips can be caused by improper handling or installation. Badly chipped brushes should be replaced regardless of length.

c. Annealed Brush Spring. Can be detected by noting the resiliency of the spring. Annealing is caused by failing to tighten brush caps properly, thus not providing a good low resistance contact between the terminal and brush tube. Brushes evidencing annealed springs should be replaced.

d. Frayed or Broken Pigtail. An improperly installed brush may have the pigtail (shunt) pinched under the terminal or between the coils of the spring.

3. When replacing brushes the following items are important:

a. The face of a new brush is carefully cut to cause proper seating during the "wear-in" period.

b. Improper installation can harm both the brush and the commutator.

c. Replacement brushes should be of the proper grade.

d. New brushes have a 6° angle on the brush face. The brush should always be inserted so the angle is open away from the pump end of the assembly (see fig. 14).

e. Brush performance is degraded if the spring and terminal are not properly placed in the tube. The spring should be free over its entire length and the terminal should make good contact with the metal brush tube insert.

Bearings

1. Rotate motor shaft. If ball bearings show evidence of wear, they should be replaced.

2. When removing armature from motor, the number of washers and their arrangement should be noted. Improper number or installation of washers can cause improper tracking of brushes, excessive preloading of bearings and noisy operation.

3. The use of bearing puller tool is recommended when removing bearings, to prevent damage to the armature winding or commutator.

4. Replacement bearings should be pressed to the same exact loca tion as the original installation.

5. The use of a suitable sealant (such as Loctite or equivalent) is recommended between the shaft and bearing if the fit does not seem tight enough to prevent the shaft from spinning inside the inner race.

6. After replacing bearings, the position of the commutator in the motor can be checked by looking down the brush tube. Neither the riser nor the edge of the commutator should be visible.

Commutator

1. Commutator is a precise assembly. Although solidly built of fairly tough material it is easily ruined by careless handling.

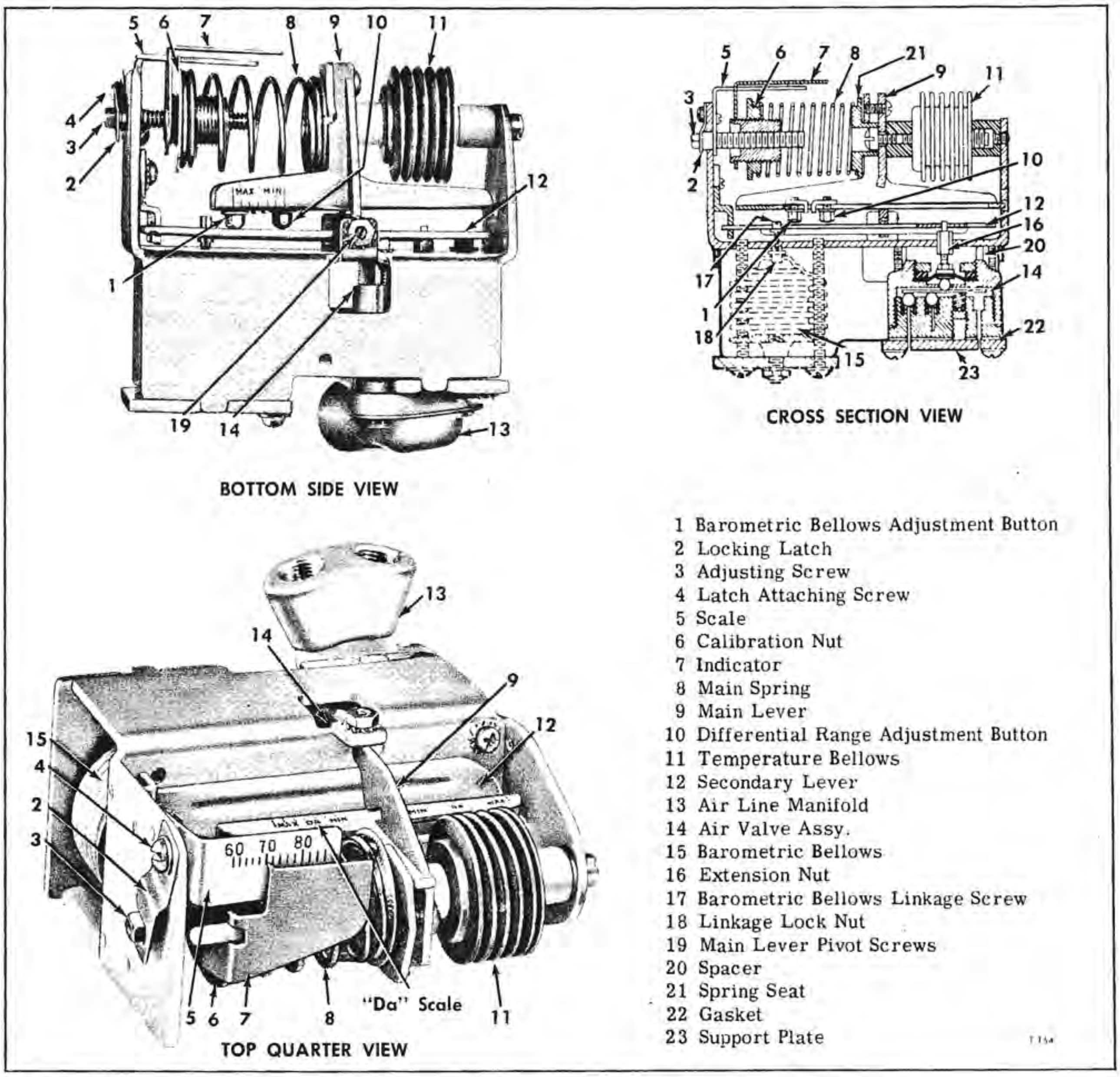
2. Refinishing should be done only on equipment which will provide good concentricity and the proper finish.

3. Refinishing should be done if a micrometer reading shows a difference between "in track" and "off track" diameter of .187" or more.

4. The commutator should be carefully undercut with a .025" or less slot width.

5. A 25 to 50 microinch finish is desirable on a new or refinished commutator.

6. Commutator should not be touched with the



1 Barometric Bellows Adjustment Button
2 Locking Latch
3 Adjusting Screw
4 Latch Attaching Screw
5 Scale
6 Calibration Nut
7 Indicator
8 Main Spring
9 Main Lever
10 Differential Range Adjustment Button
11 Temperature Bellows
12 Secondary Lever
13 Air Line Manifold
14 Air Valve Assy.
15 Barometric Bellows
16 Extension Nut
17 Barometric Bellows Linkage Screw
18 Linkage Lock Nut
19 Main Lever Pivot Screws
20 Spacer
21 Spring Seat
22 Gasket
23 Support Plate

Figure 15—Heating System Grad-U-Stat Assembly

fingers as sweat and body oils rapidly discolor and oxidize the surface.

Miscellaneous

1. Check the rubber shaft slinger (16) to make sure it is tight on the motor shaft. If it slips on the shaft it should be replaced.

2. Inspect the seal (14 and 15) assembly to determine wear. If the seal has leaked, or is badly worn, installation of a complete new assembly is recommended. However, in an emergency, or if a completely new seal assembly is not at once available, a new component may be installed to replace the damaged member. This procedure should be followed only when a complete new seal assembly is not available.

3. The impeller (11) is a press fit on the armature shaft. This press fit must be maintained to prevent the impeller from slipping. Install a new impeller if necessary.

ASSEMBLY (Refer to Fig. 14)

1. Install floating seal seat (15) in the pump body (8) in the following manner:

a. Clean seat in gasoline or some cleaning solvent to remove any dust or dirt.

b. Insert the seat in the proper recess in the pump body. This is a snug fit, but a drop of machine oil or a small amount of clean grease applied only to the neoprene ring and to the body cavity will insure easy installation. Be sure the seat bottoms in the pump body around its entire circumference.

2. Install slinger (16) on motor shaft.

3. Assemble body (8) to motor.

4. Lubricate pump shaft with a small amount of light oil then slip seal bellows and washer assembly (14) onto shaft so that the seal washer contacts the seal seat (15) in the pump body (8).

5. Install impeller (11) in the following manner:

a. Place impeller on flat surface with vanes against the flat surface.

b. Invert motor and pump body assembly and pilot pump shaft into impeller bore. DO NOT HAMMER on the motor shaft extension at rear of motor.

c. Press motor and pump body until the machined face of pump body is flush with the face of flat surface on which the impeller is resting. The face of impeller vanes must now be flush with machined face of the pump body.

6. Install gasket (10). This gasket is .010" thick and serves both to seal the cover and to establish proper clearance between the face of the impeller and the pump cover.

7. Attach cover (9) to pump body using eight fillister head screws (12).

8. Install motor brushes (4) and brush caps (3).

INSTALLATION OF PUMP AND MOTOR (Figs. 6 & 7)

1. Apply gasket cement to pump body line adapter and to line flanges. Position pump and motor assembly to mounting bracket and secure with clamp.

2. Reconnect lines to pump using new gaskets. Make sure connections are tight.

3. Connect electrical wiring.

4. Fill heating system as previously instructed under "Filling."

SWITCH ADJUSTMENT AT WATER MODULATION VALVE

Switch (4), which is mounted to water valve (3, figs. 6 and 7) must be located on valve to activate switch contacts, when water valve opens. When valve opens, switch tab engages valve stem to activate switch. Switch position is adjustable by means of two screw slots (6) at switch bracket (figs. 6 and 7). Loosen two screws which attach switch bracket and reposition switch as required. Tighten screws firmly after making adjustment.

NOTE: Closing and opening of switch contacts during adjustment can be checked by referring to circuits shown in "Heating Wiring Diagram" at rear of manual.

GRAD-U-STAT

DESCRIPTION

Grad-U-Stat (fig. 15), which is a thermostatically operated air control valve, is installed in recirculated air inlet located under seat, midway on right side of coach (View A, fig. 16) on transit models and under the raised floor on suburban models. Two air lines connect to the unit. Main air line, connected to front port, is the main feed line from air pressure regulating valve, which limits the air pressure to 17 pounds; rear line carries air pressure from the unit to the water modulation valve.

Vapor filled temperature bellows in unit is sensitive to inside coach temperature. Expansion and contraction of bellows, caused by increasing and decreasing coach temperatures, is transmitted to air control valves in lower portion of unit through levers.

An auxiliary bellows, unaffected by temperature changes, opposes the effect of altitude changes on the temperature sensing bellows.

OPERATION

NOTE: Key letters in text refer to figure 17, however, throughout explanation of Grad-U-Stat operation, reference is made to simplified diagrams shown in figure 18 which illustrate reaction of Grad-U-Stat under varied temperature conditions.

As temperature in coach rises, bellows (A) expands and exerts downward force on secondary lever (C) through main lever (B) and adjusting button (D). Downward movement of secondary lever is transmitted to lever (E) in air control chamber (F) of unit, increasing air pressure delivered to water modulation valve as shown in diagram A, figure 18. This increased air pressure at the modulation valve, causes the valve to close, reducing the flow of water through the underfloor heater core.

When temperature in coach lowers, the bellows (A) contract and relieves pressure exerted in air control valve lever (E). Air valve then exhausts air pressure from water modulation valve, increasing the flow of water through the underfloor heater core as shown in diagram B, figure 18. The air pressure delivered by the Grad-U-Stat varies in proportion to the inside coach temperature acting upon the bellows; thus, flow of water through underfloor heater core is graduated as required in accordance with inside coach temperature. Diagram "C" figure 18, shows status of Grad-U-Stat when temperature in coach is approximately equal to temperature setting on Grad-U-Stat.

The differential range adjustment button (10, fig. 15) on the main lever, is set at the factory to provide a 6°F. differential between fully closed and fully opened position. This setting has been found satisfactory for most operations and it is

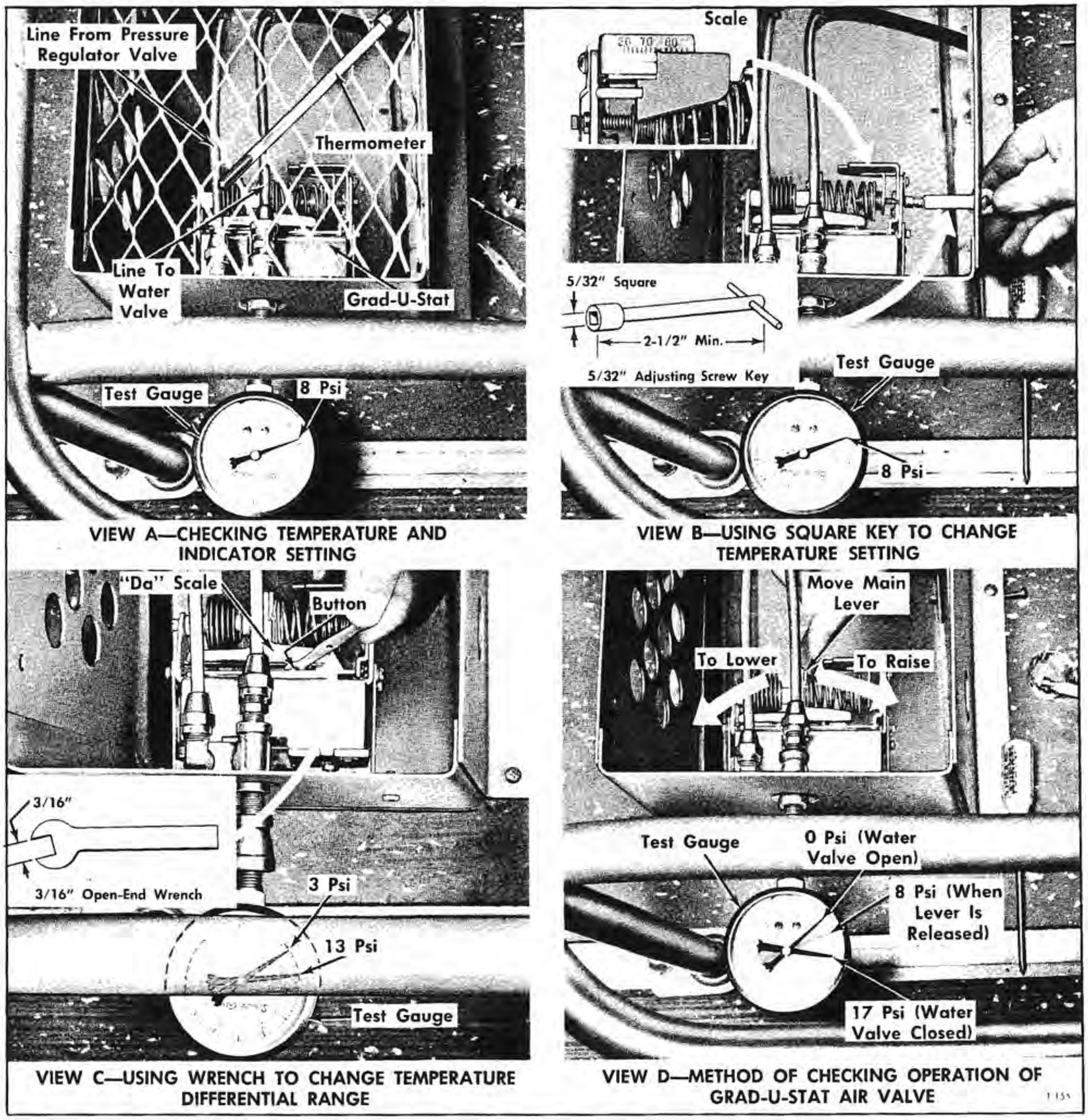


Figure 16—Grad-U-Stat Adjustment Views and Service Tools

recommended that setting not be changed.

Grad-U-Stat is also altitude compensated, providing uniform temperature control when coach is operating at various elevations. An auxiliary bellows (15, fig. 15), unaffected by temperature changes, opposes the effect of altitude changes on the temperature-sensing bellows by retarding action of the secondary lever.

If air inlet screen, under seat, becomes clogged, flow of air over coils of Grad-U-Stat will effect efficiency of unit.

A Grad-U-Stat that is malfunctioning will cause conditions indicated in "Trouble Shooting" chart on page 87.

MAINTENANCE

1. Brush away all loose dirt or dust. If operation is restricted by corrosion or foreign material that cannot be brushed away, clean unit with a solvent, such as trichlorethylene. Recalibrate the Grad-U-Stat if the adjustments have been disturbed. See "Test and Adjustment" later.

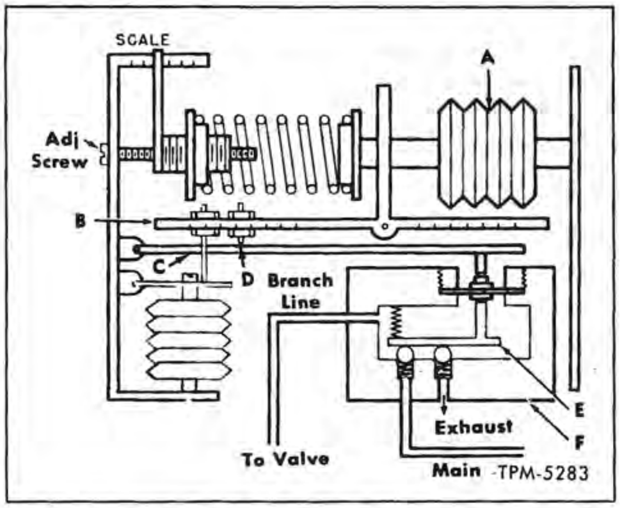


Figure 17—Grad-U-Stat Diagram

2. Inspect the bellows. Dust will insulate the bellows and cause sluggish action.

3. Check the adjustment screw (3, fig. 15) for binding; if it turns hard, clean, then coat it lightly with lubricant. Reset adjustment screw after lubricating.

TEST AND ADJUSTMENT

NOTE: Grad-U-Stat can be tested and adjusted in coach as follows or it can be removed from coach and shop tested as directed later under "Grad-U-Stat Shop Test."

Key numbers in text refer to figure 15.

1. Shut off air supply to Grad-U-Stat at pressure regulator valve located underneath coach at right of blower motors (fig. 19). Turn adjusting knob completely counterclockwise to shut off air.

2. Remove plug from line elbow at Grad-U-Stat, then install air pressure test gauge (fig. 16).

3. Open air supply to unit by turning air pressure regulator valve adjusting knob clockwise, until pressure gauge at air pressure regulator valve indicates 17 pounds pressure.

4. With engine warmed up to normal operating temperature, the blowers operating, doors and windows closed, and with defroster blower off check the air temperature at the bellows with an accurate thermometer (View A, fig. 16).

> IMPORTANT: Do not touch the bellows with hand while performing the following operation, as body heat will affect both units and erroneous readings and adjustments will be obtained.

5. Through opening in side of air inlet riser, on transit models (remove screen from seat riser in aisle on suburban models), loosen locking latch screw (4), disengage latch (2), from adjusting

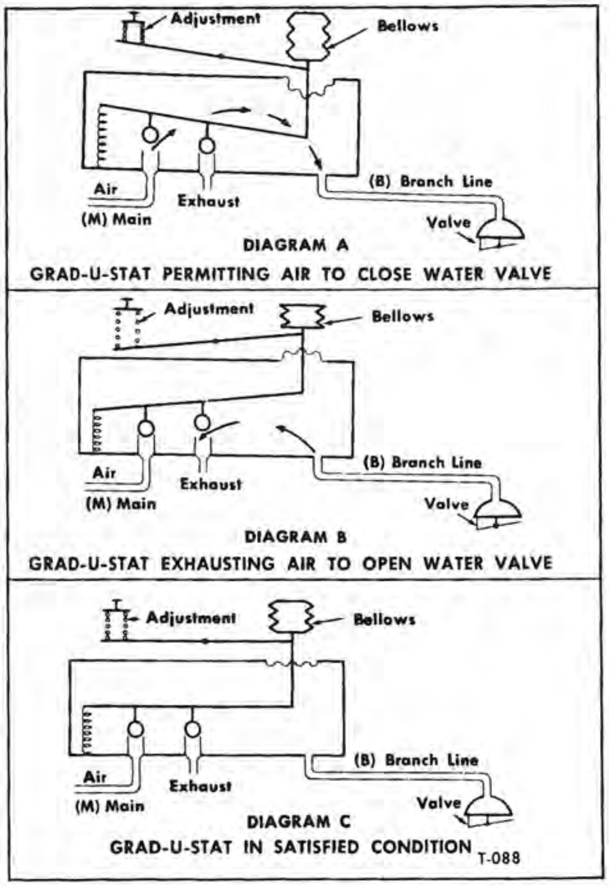


Figure 18—Grad-U-Stat Operational Diagram

screw (3), then turn the adjusting screw to set the indicator at the temperature shown on the thermometer (View B, fig. 16).

6. Observe pressure reading on air pressure test gauge. If reading is 8 pounds, no adjustment is required. If pressure is above 8 pounds, turn the calibration nut (6) and main spring (8) to short-

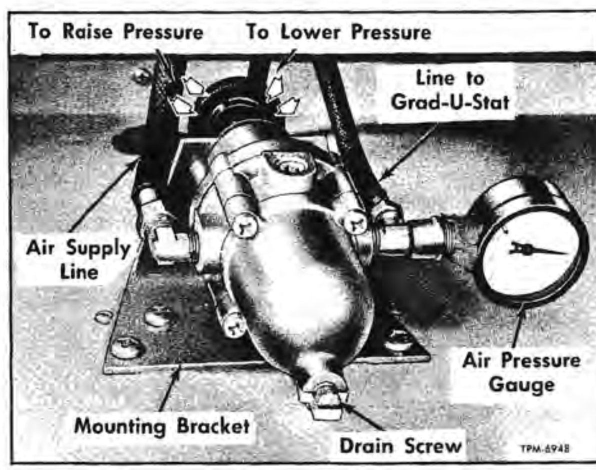


Figure 19—Air Pressure Regulator Valve Installed

en the spring until the correct reading (8 pounds) is obtained. NOTE: Compress spring when turning nut against increased spring compression. Release hand pressure on spring when checking readings. If pressure is below 8 pounds, turn calibration nut and main spring in opposite direction to lengthen the spring (spring compression not necessary).

7. After correct adjustment is obtained, turn adjusting screw (3) to set the indicator at desired operating temperature (75 F. is factory setting), place locking latch (2) over adjusting screw, and tighten latch screw (4).

8. To check the differential range, find the temperature setting on scale (5) at which the pressure in line to water valve is 3 psi and the temperature setting at which line pressure is 13 psi. The number of degrees the setting must be changed to raise line pressure from 3 to 13 psi is the approximate differential range. For example: At 3 psi, the temperature indicator may point to 75°F. and at 13 psi it may point to 71°F. If this were the case, the differential range would be 4 degrees.

IMPORTANT: If the differential range is adjusted too low, hunting or cycling from hot to cold will occur. If necessary change as follows:

a. Using a small open-end wrench, loosen the differential range button (10) as shown in View C, figure 16 between the "MAX." and "MIN." positions. Move the button to the desired position on its scale, and retighten range button. NOTE: To perform this operation on transit models, remove the screen from air inlet riser.

b. Make sure differential range button is between the "MAX." and "MIN." markings on side of main lever (9). Maximum range is 10 degrees, minimum range is 3 degrees.

NOTE: After making the above check and adjustment reset the temperature indicator to 75°F. on scale (5).

9. To check the valve unit and levers, move the free end of the main lever (9) first to one stop and then to the other as shown in View D, figure 16, releasing it each time and watching the air pressure gauge. When the lever is moved against its stop the gauge should show a decisive and immediate air change from 8 pounds to either 0 pounds or 17 pounds, depending on which direction the lever was moved. If the above tests indicate that the Grad-U-Stat is faulty, proceed to remove the unit from coach for disassembly as the air valve assembly (14) is most likely the cause of trouble.

10. To check operation of air valve only when unit is installed proceed as follows:

a. Mark the location of differential range button (10) so that it can be returned to original location later, and loosen and move the button to "MAX." on the direct-acting "DA" side of the main lever (9). Move the main lever (9) from one stop to the other while observing the time required for the air pressure, as shown on air pressure gauge, to build up and bleed down. The build-up and bleed-down time should be the same. Adjust the extension nut (16), if necessary, until these conditions are met. Check the timing as outlined above with the differential range button at "MIN." In each case, build-up and bleed-down time should be the same. Continue checking and adjusting the extension nut (16) until the timing on both settings is equal. If adjustment of the extension nut does not provide equal build-up and bleed-down timing, remove Grad-U-Stat and replace air valve assembly as directed later. If equal timings are obtained, seal the extension nut in place with household cement or fingernail polish, taking care to keep the sealer out of the air valve assembly (14). Move the differential range button (10) to its original position on "DA" side of main lever (9), as indicated by mark previously made, and tighten in place.

b. Recalibrate Grad-U-Stat as outlined previously in steps 5, 6, and 7.

11. The barometric bellows (15) will seldom need attention. If it becomes ruptured, it may cause overheating. The bellows may be checked by removing it from Grad-U-Stat, as outlined later under "Disassembly of Grad-U-Stat," and applying pressure gently while holding it under water. Bubbles will indicate leaks and the barometric bellows should be replaced.

It will not be necessary to readjust the barometric bellows (15) unless the barometric bellows linkage screw (17) or button (1) has been turned or a new bellows is installed.

a. To adjust the barometric bellows (15), first loosen the barometric linkage locknut (18) using small open-end wrench and small screwdriver, then back off the barometric bellows linkage screw (17) until the bellows adjustment button (1) no longer touches the secondary lever (12). Then calibrate the Grad-U-Stat as described previously in steps 5, 6, and 7. NOTE: In order to gain access to lock nut with wrench, it is necessary to remove the Grad-U-Stat mounting bracket at the end of Grad-U-Stat.

b. Loosen barometric bellows adjustment button and position midway between "MAX." and first mark below "MAX." on secondary lever (12). Tighten button in place.

c. Hold the main lever (9) against its bottom stop to compress the temperature bellows (11) to its maximum.

d. Adjust the length of the barometric bellows (15) by turning the barometric bellows linkage screw (17) until the barometric button (1) just touches the secondary lever (12), then lengthen barometric bellows linkage screw (17) one full turn. The friction fit barometric linkage locknut (18) is then tightened.

12. Remove test gauge, then install plug in air line tee.

13. Install screen in recirculated air inlet (on transit models).

14. Open air supply to Grad-U-Stat.

REMOVAL OF GRAD-U-STAT (Fig. 16)

1. Shut off air supply to Grad-U-Stat at regulator valve (fig. 19) by turning regulator knob completely counterclockwise.

2. Remove screen from over Grad-U-Stat on transit models or from seat riser in aisle on suburban models. Mark lines in relation to fittings, then disconnect air lines from unit.

3. Remove screws which attach unit to recirculated air inlet riser.

4. Remove screws which attach unit to mounting brackets.

DISASSEMBLY OF GRAD-U-STAT

NOTE: Key numbers in text refer to figure 15.

1. Place a bellows clamp on the temperature bellows (11) to prevent over-expansion of the bellows (fig. 20) when it is removed. NOTE: Clamp can be fabricated locally using dimensions shown in figure 20.

2. Loosen locking latch screw (4), disengage latch (2), from adjusting screw (3), then turn adjusting screw clockwise until the indicator (7) is at its low end and the tension on the main spring (8) is relieved. Slip out the main spring (8) spring seat (21) and indicator assembly (7). If necessary, loosen scale (5) mounting screw.

3. Temperature bellows (11) may be removed by removing bellows mounting screw on both ends of bellows.

4. Loosen main lever pivot screws (19) and lift out main lever (9).

5. Remove the two screws holding the secondary lever (12) and lift out secondary lever. It may be necessary to loosen the indicator bracket screw before lifting out the secondary lever if the lock washer under this screw overlaps the lever. Remove barometric linkage screw (17) with small flat washer, bellows cover and flat disc. These components are shown in figure 21.

6. Mark air line manifold (13), air valve assembly (14), support plate under air valve assembly and Grad-U-Stat frame, to ensure proper placement in assembly (fig. 22).

7. Remove air line manifold (13) by removing two mounting screws, taking care not to damage sealing surfaces.

8. Remove air valve assembly (14) by unscrewing two screws holding valve and its support plate (23) to Grad-U-Stat frame. Remove U-shaped spacer (20).

9. Remove air valve assembly (14) from its support plate by removing two attaching screws,

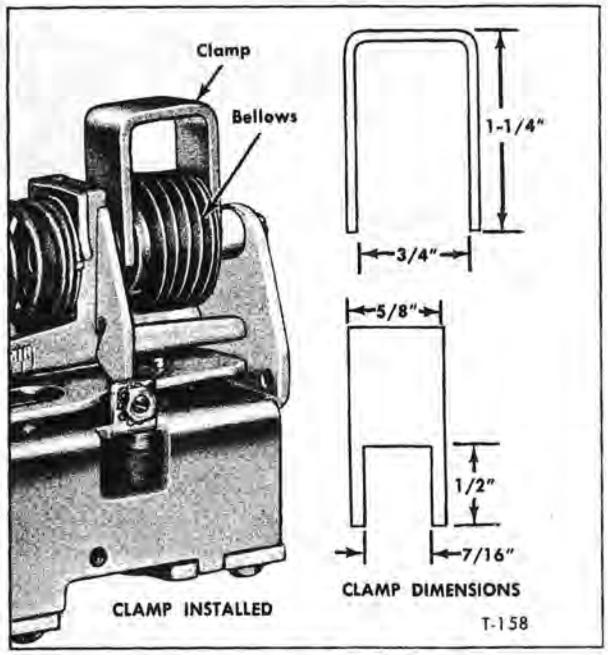


Figure 20—Bellows Clamp Installed

taking care not to damage sealing surfaces.

10. Remove barometric bellows (15) with base plate by unscrewing the two screws that hold it in place. Figure 21 shows bellows removed.

NOTE: Bellows can be checked as directed previously under "Tests and Adjustments." See step 11.

ASSEMBLY OF GRAD-U-STAT

NOTE: Key numbers in text refer to figure 15.

1. Clean and inspect all parts before assembling Grad-U-Stat.

2. Lubricate pivot points.

3. Assemble secondary lever (12) and tighten two brass attaching screws. NOTE: Make sure lever is mounted at bottom of screw slots.

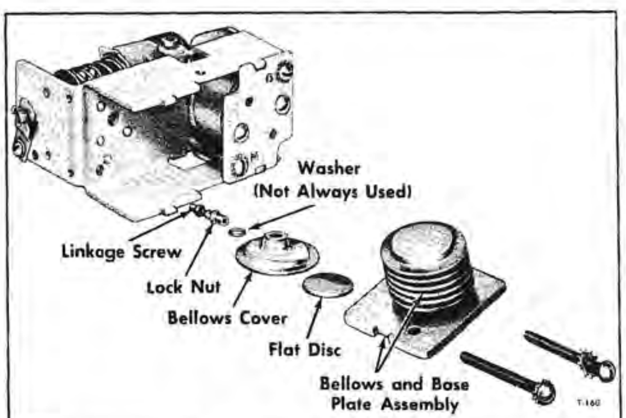


Figure 21—Barometric Bellows Components

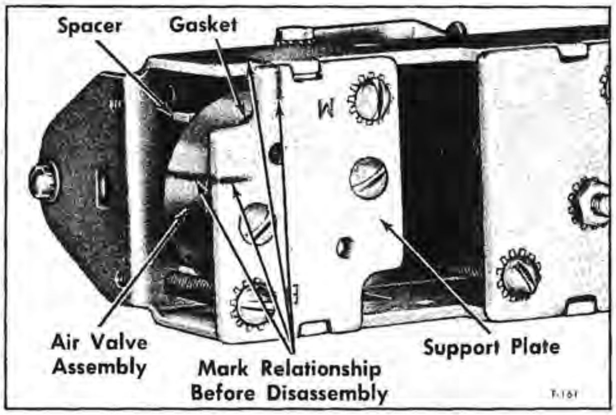


Figure 22—Grad-U-Stat Air Valve Installed

4. Install the main lever (9) in place and secure by tightening main lever pivot screws (19). The main lever pivot screws should allow from 0.005" to 0.010" side play of main lever to prevent binding.

5. Install temperature bellows (11) in place using attaching screw with internal-teeth lock washer at stationary bracket and regular lock washer at main lever screw. DO NOT REMOVE BELLOWS CLAMP.

6. Slip main spring (8) with main spring seat (21), and indicator assembly (7) in place.

7. Remove bellows clamp.

8. Install the air valve assembly (14) and its support plate and spacer (20) in the Grad-U-Stat frame with four screws, to alignment marks made at disassembly. Make sure the pin on the extension nut (16) goes through the hole in the secondary lever (12). Don't force the air valve assembly in place; screw down extension nut, if necessary. If pin does not fit loosely in secondary lever hole, realign secondary lever (12) by pressing on one side with screwdriver.

NOTE: The valve unit spacer (20) should be installed with the open end of horseshoe shape facing out as shown in figure 22. Purpose of spacer is to prevent distortion of valve support plate that would cause leaking.

Should a replacement air valve assembly (14) be installed, place a new gasket (fig. 22) on bottom of air valve. Make certain that new unit is properly oriented by observing relationship between mark made on old unit in disassembly and holes in bottom of air valve assembly. Place mark on new unit to match mark on old unit to insure proper installation of new air valve assembly with its support plate, air line manifold (13) and Grad-U-Stat frame.

9. Using a new gasket if required, install air line manifold (13) by aligning marks made at disassembly. Tighten two mounting screws evenly to prevent air leakage.

10. Install barometric bellows (15) by inserting barometric bellows linkage screw (17) with lock nut into hole in secondary lever (12). Install bellows cover, flat disc, and bellows with base plate. Install two screws that hold barometric bellows base plate to Grad-U-Stat frame. Figure 21 shows components removed.

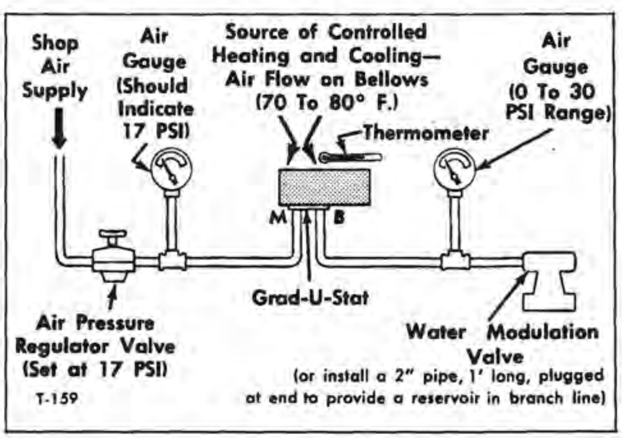


Figure 23—Grad-U-Stat Shop Test Arrangement

Grad-U-Stat can be shop tested before installing in coach if desired, as directed below:

GRAD-U-STAT SHOP TEST

If the coach system is inoperative and there is no way to simulate operational conditions, a shop test will be required to check Grad-U-Stat. Figure 23 shows typical arrangement of equipment necessary to shop test unit.

1. Install Grad-U-Stat in shop test equipment as shown in figure 23.

2. A heat fan and an ordinary cooling fan or source of controlled ambient temperatures are necessary to check Grad-U-Stat.

3. Proceed to make checks and adjustments in same manner as directed previously under "Tests and Adjustment" when Grad-U-Stat is installed in coach.

INSTALLATION OF GRAD-U-STAT (Fig. 16)

1. Attach Grad-U-Stat to mounting bracket with screws; then install unit with mounting bracket to recirculated air inlet riser.

2. Connect lines to Grad-U-Stat elbows. Adjust extension nut (16, fig. 15) and barometric bellows, linkage screw (17, fig. 15) as directed previously under "Tests and Adjustments." See steps 11 and 12.

3. Test Grad-U-Stat operation, and adjust if necessary. Complete the installation as previously directed under "Test and Adjustment."

WATER MODULATION VALVE

Water modulation valve (fig. 24) is an air operated water control valve installed in heater water lines. Valve is accessible after removing access cover mounted on floor above valve (fig. 6) on transit models and after removing cover plate on floor under last seat (fig. 7) on suburban models.

Water modulation valve controls the flow of water through the heater core in accordance with the air pressure delivered to it by the Grad-U-Stat. Valve will start to close when subject to three pounds air pressure, and will be fully closed at 12 pounds pressure.

MAINTENANCE

1. Visually inspect for broken or kinked air line and broken or damaged parts.

2. Apply soapy water to air line connection (7, figs. 6 and 7) and to exposed edges of diaphragm. Unless coach is abnormally cold, leakage will be indicated by bubbles.

3. Use compressed air to blow dust and dirt from area around spring. Cleaning solvents such as trichlorethylene may also be used.

4. Check the valve packing for leakage.

NOTE: The packing nut (4, fig. 24) is self-adjusting; excessive tightening will not stop packing from leaking. The packing nut must however, be threaded completely into bonnet.

5. If leakage cannot be stopped, repack valve as explained later under "Repacking Valve."

REMOVAL OF MODULATION VALVE

1. Remove modulation valve access cover and air duct attached to floor and side with screws on transit models. Remove plate on floor beneath last seat on left side on suburban models.

2. Shut off air supply to valve by turning adjusting knob at pressure regulator valve completely counterclockwise; then disconnect air line from modulation valve.

3. Drain heating water system as previously directed under "Draining."

4. Mark the water pump switch-to-bracket position to assure original switch position when installed later, then remove switch attaching screws. Move switch with attached wiring to one side.

5. Remove four screws which attach valve to water line flanges. Remove valve assembly from between line flanges.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 24.

1. Unscrew valve bonnet (9) with valve mechanism from valve body (13).

2. Using a screwdriver through opening in outer spider (17), pry stem retainer (20) in or out to uncouple valve stem (3) from lock.

3. Place mark on cover (1) and outer spider (17) to assure assembly of parts in correct relationship; then remove cover screws (2) which attach cover to valve outer spider. Remove cover, diaphragm (21), diaphragm cup (23), stem retainer (20), outer spring seat (19), spring (18) and spring inner seat (5) from valve.

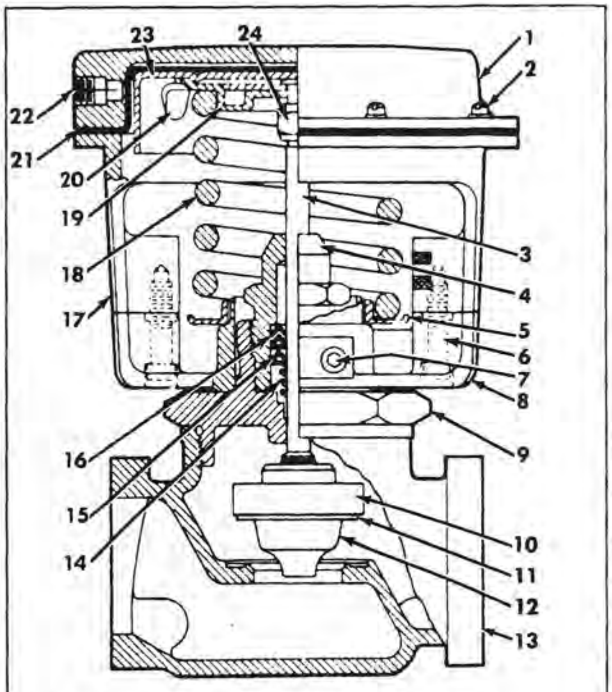
4. Remove two set-screws (7) which secure inner spider (8) to valve bonnet (9).

5. Outer spider (17) can be separated from inner spider (8) after removing two attaching cap screws (6).

6. Measure over-all length of stem assembly including stem button (20) and valve guide (12), to reassure adjustment to same length at time of assembly.

7. Using a nail in small hole of valve stem to hold stem from turning, thread stem button (24) from end of stem.

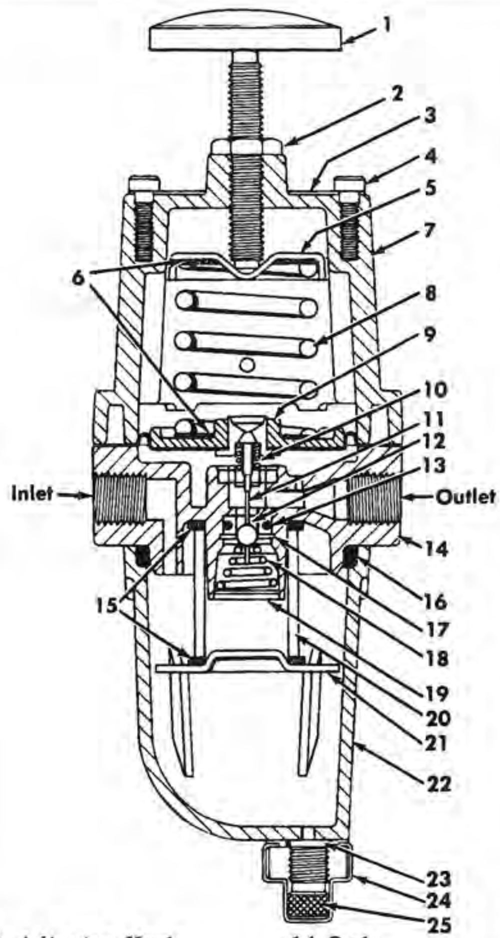
8. Unscrew packing nut (4) from valve bonnet (9); then slide packing nut, with packing ring (16),



1 Cover	13 Valve Body
2 Cover Screw	14 Packing Spring
3 Valve Stem	15 Packing Washer
4 Packing Nut	16 Packing Ring
5 Spring Inner Seat	17 Outer Spider
6 Cap Screw	18 Return Spring
7 Set Screw	19 Spring Outer Seat
8 Inner Spider	20 Stem Retainer
9 Valve Bonnet	21 Diaphragm
10 Valve Disc Holder	22 Air Connection
11 Valve Disc	23 Diaphragm Cup
12 Valve Guide	24 Stem Button

TPM-9422

Figure 24—Water Modulation Valve



1 Adjuster Knob	14 Body
2 Adjuster Lock Nut	15 Filter Gasket
3 Name Plate	16 Body Gasket
4 Panel Mounting Screw	17 Snap Ring
5 Spring Guide Plate	18 Valve Spring
6 Spring Cushion	19 Spring Snap Ring
7 Cap	20 Filter
8 Spring	21 Filter Retainer
9 Diaphragm	22 Bowl
10 Bleed Spring	23 Drain Valve Disc
11 Inner Valve	24 Drain Valve Retainer
12 Seat	
13 Seat Gasket	25 Drain Screw

TPM-9413

Figure 25—Air Pressure Regulator Valve Assembly

from stem (3). Remove packing washer (15) and packing spring (14). Remove packing ring (16) from packing nut (4).

9. Turn valve holder (10) valve disc (11) and valve guide (12) from end of stem (3).

ASSEMBLY

NOTE: Key numbers in text refer to figure 24.

1. Clean and inspect all parts before assembling valve. If any parts are damaged or worn; replace.

2. Assemble valve holder (10), valve disc (11) and valve guide (12) on end of valve stem (3) and tighten firmly.

3. Apply light silicone lubricant to packing rings (16) and to interior of packing nut (4), then insert stem through bonnet (9) and install packing spring (14), packing washer (15), one packing ring (16), another packing washer, remaining two packing rings (16), and packing nut (4) onto valve stem (3) in sequence mentioned. NOTE: Turn packing rings on valve stem threads with the spot of paint on each ring facing outward from valve body. Rings must be positioned as shown in figure 24. Screw packing nut (4) into bonnet (9) and then tighten nut firmly.

4. Thread stem button (24) on end of valve stem to a distance whereby over-all length of stem with stem button and valve guide equals measured length recorded prior to disassembly.

5. Attach outer spider (17) to inner spider (8) with two screws (6); then position spiders over bonnet (9) and secure with two set screws (7).

6. Position valve return spring inner seat (5), return spring (18), and spring outer seat (19) over valve stem in sequence mentioned; then compress spring and engage stem retainer (20) on end of stem (3).

7. Position diaphragm cup (23) over outer spring seat (19); then position diaphragm (21) over cup. While holding valve in closed position (compress stem return spring), install cover (1) over diaphragm and spider. Align marks on cover and spider made prior to disassembly and attach with cover screws (2). Tighten screws firmly.

8. Screw bonnet (9) and valve mechanism into valve body (13); then tighten bonnet firmly.

INSTALLATION OF MODULATION VALVE
(Refer to Figs. 6 and 7)

1. Arrow on valve body indicates direction of water flow through valve. Valve must be installed with arrow on body pointing toward heater core.

2. Position valve assembly with a new gasket at each valve flange, between water line flanges. Install four cap screws through water line flanges and gaskets and thread into valve flanges. Tighten cap screws evenly and firmly.

3. Connect air supply line (7) to cover of valve. Open air supply to valve, by turning adjusting knob on pressure regulator valve, clockwise until pressure gauge at regulator valve indicates 17 pounds pressure.

4. Install water pump switch to water valve to marks made prior to removal.

NOTE: If desired, adjust switch position as directed previously under "Heating System Water

Pump." See "Switch Adjustment At Water Modulation Valve."

REPACKING VALVE

NOTE: Key numbers in text refer to figure 24.

1. Perform steps 1, 2, and 3 under "Removal of Modulation Valve."

2. Force the stem retainer (20) away from locked position with a screwdriver.

3. Loosen two spider set screws (7) then pull actuator unit (diaphragm, spring, and spiders) from valve bonnet (9).

4. Unthread stem button (24), exercising care not to disturb small set screw in end of stem button. Insert pin in small 1/16" hole just below stem button to hold stem while removing button.

IMPORTANT: DO NOT MAR STEM.

5. Thread packing nut (4) from bonnet (9). Remove spring (14) packing washers (15) and packing rings (16) from packing nut (4).

6. Clean and polish valve stem (3) if necessary with trichlorethylene and crocus cloth. Rub the stem lengthwise with cloth.

7. Dip the new packing rings in a light silicone lubricant and allow to drain. Also coat valve stem and inside of packing nut with lubricant.

8. In the following sequence, install packing spring (14) one steel packing washer (15), one packing ring (16), another packing washer (15) and remaining two packing rings (16) on valve stem (3).

NOTE: Turn packing rings over stem threads, with the spot of paint on each ring facing outward from valve body.

9. Replace the stem button (24) on valve stem (3). Tighten button firmly. Do not disturb set screw in stem button.

10. Reinstall the actuator units as directed previously under "Assembly" of valve.

AIR PRESSURE REGULATOR VALVE

Air pressure regulator valve (fig. 25) is mounted on bulkhead at rear of underfloor heating and cooling compartment (fig. 19). Valve is accessible from underneath coach at right side. Valve serves two purposes, to strain the air of dirt and moisture and to regulate air pressure to Grad-U-Stat. As the Grad-U-Stat uses the compressed air, the regulator valve admits additional compressed air, thus maintaining a constant pressure at Grad-U-Stat. Air pressure at Grad-U-Stat should be 17 pounds.

Should there be a constant bleeding of air through vent hole in the regulator cap (7, fig. 25), the inner valve assembly should be checked. Foreign matter may be lodged in valve seat or the valve may be worn.

ADJUSTMENT (Refer to Fig. 19)

When adjusting air pressure regulator valve, always observe air pressure reading on air pressure gauge at regular valve outlet. To adjust valve, loosen lock nut at top of valve unlocking valve adjusting knob. Turn adjusting knob counterclockwise to lower air pressure output. Adjusting knob in complete counterclockwise position will shut off air pressure entirely. To raise air pressure output, turn adjusting knob clockwise until desired air pressure output is indicated on air pressure gauge at valve. Air pressure gauge should be checked occasionally using test gauge to check accuracy of valve gauge.

DRAINING

Drain regulator valve at regular intervals to drain collected moisture by turning out drain screw (fig. 19) at bottom of valve. Tighten screw after draining.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 25.

1. Loosen adjuster lock nut (2) which secures adjusting knob (1) in regulator cap (7). Turn out adjusting knob from cap.

2. Scratch or mark side of regulator cap (7), valve body assembly (14) and bowl (22) to assure original alignment at assembly. Remove four screws attaching these units together.

3. Remove regulator cap (7), spring guide plate (5), cushion (6), spring (8), another cushion (6), diaphragm assembly (9), and small bleed spring (10) from valve body (14).

4. Separate valve body (14) from bowl (22). Remove body gasket (16) from valve body, then remove filter (20), filter gaskets (15) and filter retainer (21) from filter body.

5. Inner valve (11) and valve spring (18) can be removed from valve body (14) after removing spring snap ring (19) from body.

6. Remove snap ring (17), then using a small hooked tool pull inner valve seat (12) with seat gasket (13) from valve body (14).

CLEANING AND INSPECTION

NOTE: Key numbers in text refer to figure 25.

1. Clean all parts except diaphragm (9) and valve body assembly (14) with cleaning solvent. Wipe diaphragm and valve body with clean cloth. Clean filter (20), using compressed air directed from inside of filter.

2. Make visual inspection of valve body (14) and bowl (22) for cracks and breakage. If diaphragm in valve body is cracked, it will be necessary to replace complete valve body and diaphragm assembly.

3. Replace springs indicating evidence of corrosion, fracture, or weakness.

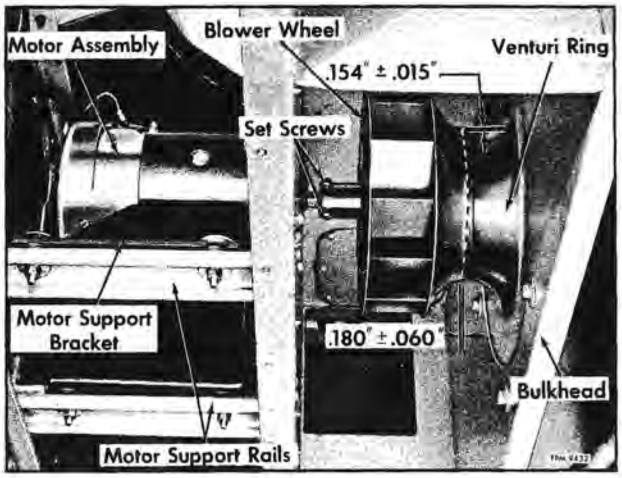


Figure 26—Blower Motor and Wheel Installed

ASSEMBLY

NOTE: Key numbers in text refer to figure 25.

1. Position drain valve disc (23) in bowl, then install drain screw (25). Install drain valve retainer (24) over drain screw to body.

2. Lower filter seat (21) with rubber gasket (15), filter (20), and another gasket (15) into bowl (22).

3. Place seat gasket (13) into groove of valve seat (12). Press seat with gasket into valve body and install retaining snap ring (17). Refer to illustration for position of parts.

4. Position body O-ring gasket (16) over shoulder of valve body (14).

5. Insert inner valve (11) and valve spring (18) in valve body and retain with spring snap ring (19). Refer to illustration for proper positioning of parts.

6. Lower valve body assembly over filter to bowl.

7. At top of valve body, position small bleed spring (10) over protruding needle point.

8. Position diaphragm (9) to valve body making sure center of diaphragm engages valve needle in valve body.

NOTE: Top side of diaphragm has lipped-seat for engaging main spring (8).

9. Install main spring cushion (6) in spring seat of diaphragm, then install main spring (8), another cushion (6) and spring guide plate (5).

10. Lower regulator cap (7) down over spring to valve body. Align marks made prior to disassembly on bowl, valve body, and regulator cap. Make sure screw holes in diaphragm are also aligned. Install four screws attaching units together. Tighten screws firmly and evenly.

11. Thread lock nut on adjusting knob (1), then thread adjusting knob into regulator cap. Adjust regulator as directed previously under "Adjustment."

UNDERFLOOR HEATING AND COOLING COMPARTMENT

Underfloor heating and cooling compartment is located under coach floor near center of coach as shown in figure 1. Compartment includes air filters, (air conditioning evaporator coil - when used), heater core, and blower wheels.

Access to compartment is gained by opening access doors to filters, evaporator (when used), to heater core, and blower wheels. Figure 1 shows underfloor compartment.

The heating compartment is sealed to outside air below coach by seals around blower motor shafts and around access doors.

Rubber water drains in access doors allow moisture collected in compartment to drain, and are so designed to prevent outside air from entering compartment from below coach. If drains fail to function as designed, they should be replaced. To replace drains remove clamps, then pull from panel flange. Install new drains by stretching round end of drain over panel flange. Secure drains with clamps.

UNDERFLOOR HEATER CORE UNIT

The heater core unit located in the heating and cooling compartment, between the evaporator and blower wheels is of fin and tube design, similar to a conventional radiator. The core assembly actually consists of two separate core units flanged-connected with bolts.

Core units can be repaired in same manner as a conventional radiator.

REMOVAL

NOTE: Individual heater core units can be replaced separately or as a complete unit.

1. Remove access doors and center closure panel from below heating and cooling compartment by removing the panel attaching cap screws.

2. Drain heater cores by opening drain cock at right of compartment (fig. 10). After draining, remove necessary connecting pipes and hoses.

3. While supporting core units safely, remove cap screws which attach flanged ends of core units to bulkhead and the core center support bracket. Carefully lower core unit from compartment.

INSTALLATION

1. If heater cores are to be installed as a complete unit, attach cores together and install connecting pipes and hoses. Make sure hose clamp screw heads are positioned to provide access from below coach when unit is installed.

2. Raise core unit into position and secure flanged ends of core to bulkhead and core center support bracket with cap screws and lock washers.

3. Connect heater supply and return pipes to core unit. Tighten hose clamps firmly.

4. Fill heating system as explained previously under "Maintenance." NOTE: Checking for possible leaks at core connections should be made when water in core and lines is warm.

5. Tighten all hose connection clamps firmly, then install closure panel to underside of heating and cooling compartment.

NOTE: Make sure closure panel gasket is in good condition to provide complete seal between panel and coach understructure.

UNDERFLOOR BLOWERS AND MOTORS

Two blower and motor units are used to circulate air through the heating system. Both units are mounted on bulkhead at rear of the heating compartment (fig. 26).

Blower motors are accessible from underneath coach after releasing fasteners and then lowering access doors. Motors can be overhauled, and electrical circuits tested as directed later under "Blower Motor Repair."

On vehicles equipped with air conditioning, blower motors are of two-speed type. On early models the blower motor high speed circuit is controlled by a magnetic switch (relay) which is mounted on bulkhead between blower motors. See figure 6 in ELECTRICAL (SEC. 7) of this manual. Magnetic switch is energized to complete blower circuit when "VENTILATION" switch, on panel at left of driver is placed in "BLOWER," "HI," or "AIR CONDITION" position. The high speed circuit to each motor is protected by a 90 amp. circuit breaker located on bulkhead next to magnetic switch. Low speed circuit in these coaches is energized by the switch at water modulation valve (when Grad-U-Stat calls for heat) or by the "VENTILATION" switch on panel at left of driver when switch is placed in "BLOWER," "LOW" position. Refer to "Air Conditioning Wiring Diagram - Early Models" at rear of this manual.

On late model coaches having air conditioning, two relays are used instead of only one as used on early models. The operation of relays however, is the same as explained previously for early models with the exception that the relay operating circuit is grounded through a thermostatic unit in each blower motor.

NOTE: Blower motors on early models are not equipped with thermostatic units. If either blower motor should draw excessive current through this circuit, the thermostatic unit will open relay operating coil to break the battery circuit to motor to stop motor. Refer to "Air Conditioning Wiring Diagram - Late Models" in back of this manual.

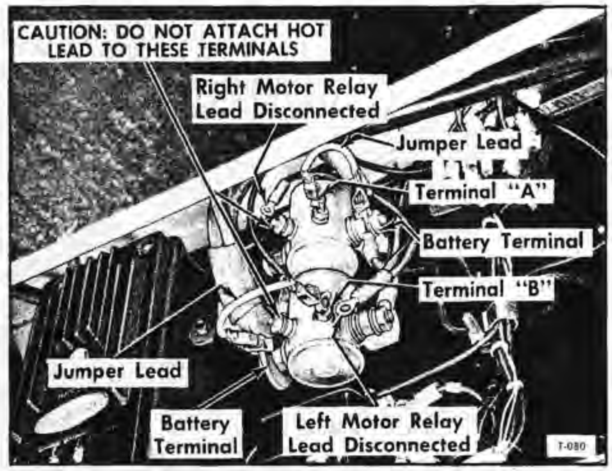


Figure 27—Using Jumper Lead To Operate Blower Motors—Models with Standard Heating and Late Models with Air Conditioning

On vehicles without air conditioning the blower motors operate at one speed (low) only. Circuits to blower motors are completed by blower control relays mounted on bulkhead between the blower motors, as shown in figure 6 in ELECTRICAL (SEC. 7). When relay operating coils are energized, by either the "BLOWER" switch on panel at left of driver or the water modulation valve switch, the relay coil operating (primary) circuit and the battery (secondary) circuit are completed to the blower motors. One field coil winding in motor energized through the relay operating coil (primary circuit) is grounded through the motor. This same winding incorporates a thermostatic unit (circuit breaker). In the event motor should draw excessive current through this circuit the thermostatic unit will open the blower relay operating coil circuit which in turn breaks the battery circuit to blower motor, thus stopping motor.

CAUTION: The thermostat ("T") terminal should not be used for a ground other than for the operating coil circuit of relay.

Refer to "Heating and Ventilation Wiring Diagram" at the rear of this manual.

PROCEDURE FOR OPERATING BLOWER MOTORS FROM BELOW THE COACH

To check blower operation or alignment of blower wheels the blower motors can be operated from below coach using jumper leads as shown in figures 27 and 28.

IMPORTANT

When operating standard blowers using jumper leads, the procedure on following page must be followed as directed, otherwise burning of small thermostatic units within each blower motor could occur.

HEATING AND VENTILATION

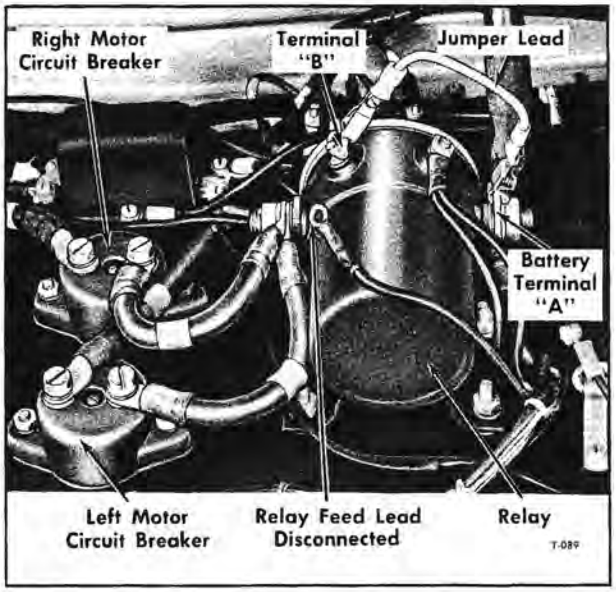


Figure 28—Using Jumper Lead To Operate Blower Motors—Early Models with Air Conditioning

Standard Heating System
(Less Air Conditioning)

NOTE: Refer to figure 27 which shows both right and left motor relay jumper leads installed. If only one motor is to be operated, install jumper lead at respective control relay. The following however, explains procedure for operating both blower motors.

1. Disconnect the blower control relay leads from the small terminals "A," and "B," figure 27. This is to eliminate feed-back of current to coach electrical system.

2. To energize relays, connect jumper leads from battery terminals (see illustration) to terminals "A," and "B," the terminals from which wiring has been disconnected.

CAUTION

DO NOT CONNECT JUMPER LEADS TO SMALL TERMINALS ON OPPOSITE SIDES OF RELAYS. If a hot lead is connected to these terminals, the small thermostatic units within the motors will fail.

Heating System (With Air Conditioning)

NOTE: Refer to figure 28.

1. Disconnect relay feed supply lead at relay terminal "B." This will eliminate feed-back of current to coach electrical system.

2. To energize relay, connect jumper lead from battery terminal "A" at side of relay to the small terminal "B" at opposite side or relay.

CAUTION

DO NOT CONNECT JUMPER LEADS TO SMALL TERMINAL NEXT TO BATTERY TERMINAL. This small terminal is the relay ground terminal and a direct short would occur burning up the jumper leads. NOTE: If only one motor is to be operated at a time, disconnect hot lead at respective motor circuit breaker.

REMOVAL OF BLOWER WHEELS AND MOTORS

1. Lower access door from below the heating and cooling compartment to gain access to blower wheels.

2. Mark position of blower wheel to venturi ring, then loosen two set screws which secure blower wheel to motor shaft.

3. Disconnect wiring from terminals on motor.

4. Remove four bolts attaching motor to motor support bracket. While making sure blower wheel will not drop from motor shaft, carefully move motor unit rearward to pull motor shaft from blower wheel. Remove motor. CAUTION: Do not allow blower wheel to fall from end of shaft.

5. If necessary, motor support bracket and support rails can be removed from underframing.

INSTALLATION OF BLOWER
WHEELS AND MOTORS

1. Referring to figure 1 for arrangement of rubber cushion mounts, install motor support rail and motor support bracket in heating compartment. Each mounting consists of 1 shoulder bolt, 1 large flat washer, two rubber cushions, bolt nut and lock washer. Tighten nuts firmly.

2. Place blower motor into motor compartment through hole provided in bulkhead and insert motor shaft through rubber bulkhead seal to engage blower wheel. Attach motor to support bracket with four 5/16-18 x 5/8" bolts and lock washers.

IMPORTANT: Longer bolts may damage motor.

3. Slide blower wheel fore or aft on motor shaft to a position whereby wheel will overlap edge of venturi ring by 0.180" $\pm$ 0.060" as shown in figure 26. After obtaining this adjustment, tighten wheel set screws firmly. Refer to similar illustration in AIR CONDITIONING (SEC. 26) of this manual, for overlap dimensions with air conditioning.

4. Blower wheel should be concentric over edge of venturi ring at a dimension of 0.154" - 0.015". This adjustment can be made after loosening the cap screws which attach the venturi ring to coach bulkhead, then repositioning ring on bulkhead to obtain specified clearance. NOTE: Holes in ring are large, to permit adjustment.

5. Connect wiring to motor terminals, then check operation of blowers.

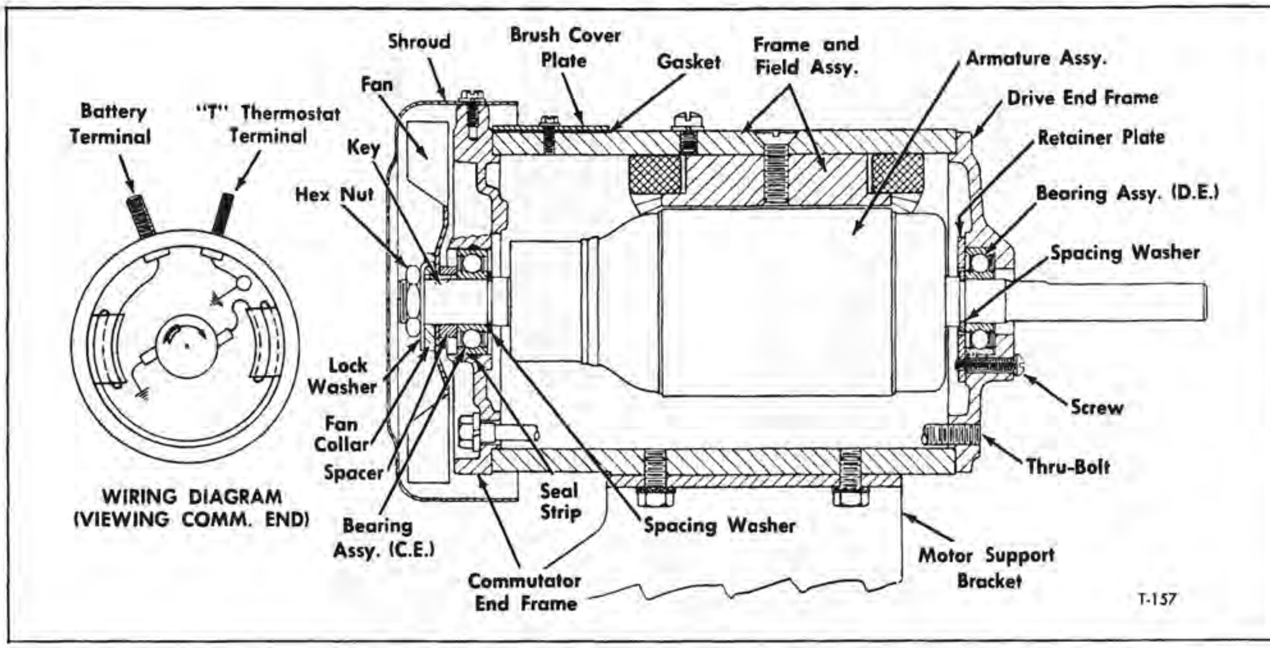


Figure 29—Underfloor Blower Motor (Standard)

CAUTION: If motors are to be operated from below coach refer to procedure explained previously under "Procedure For Operating Blower Motors From Below Coach." If procedure is not performed as directed, the blower motors may be damaged.

NOTE: Operation will be noisy if blower wheel contacts venturi ring. Operate motors for this test only long enough to check clearance, as motor current draw with access door down will be high.

BLOWER MOTOR REPAIR

COMMUTATOR AND BRUSHES

Motor commutator can be cleaned and brushes replaced without disassembling motor.

Motor may be serviced in coach by removing four bolts holding motor to bracket and three screws holding shroud. Motor may then be rotated freely to service brushes.

1. If commutator is dirty, clean with strip of No. 00 sandpaper. Do Not Use Emery Cloth. All dirt must be blown from motor after cleaning.

2. Brushes should be replaced if they measure less than 3/4 inch (standard 3/8 H.p. motor) or 7/8-inch (with air conditioning 3/4 H.p. motor) on the long side. If brushes are of sufficient length but are not seating on commutator properly, seat brushes, using a "bedding" stone. Do Not Use Emery Cloth or Sandpaper. With motor operating, press bedding stone firmly against area on commutator contacted by brushes. Brushes should seat satisfactorily in a short period. Blow motor out with compressed air to remove all particles of abrasive after using stone, then check tightness of pigtail lead connections.

3. To replace standard motor brushes, refer to figure 30, which shows operational brush replacement views.

a. To remove individual brush, push down on spring and back assembly, then forward toward brush to disengage back from retaining lugs. See left view of figure 30. Release back, and remove from motor. Do not attempt to remove brushes prior to removal of spring and back assembly as the spring may be damaged and improper brush tension will result.

b. Center view of figure 30 shows brush separated from spring and back. Remove screw which secures brush cable to bracket. Remove brush.

c. Install new brush in brush holder, insert back and spring assembly inward beyond installed position, then away from brush to engage internal retaining lugs as shown in right view of figure 30.

d. Attach brush cable to bracket with screw.

DISASSEMBLY OF MOTOR

NOTE: Figure 29 shows sectional view of standard motor assembly.

NOTE: Motor on coaches with air conditioning can be disassembled, repaired, and assembled in same general manner as explained below.

1. Remove fan shroud, then nut which retains fan to motor shaft. Remove fan, fan spacer, and key.

2. Remove thru-bolts which attach end frames to motor housing.

3. Remove cover, springs and brushes.

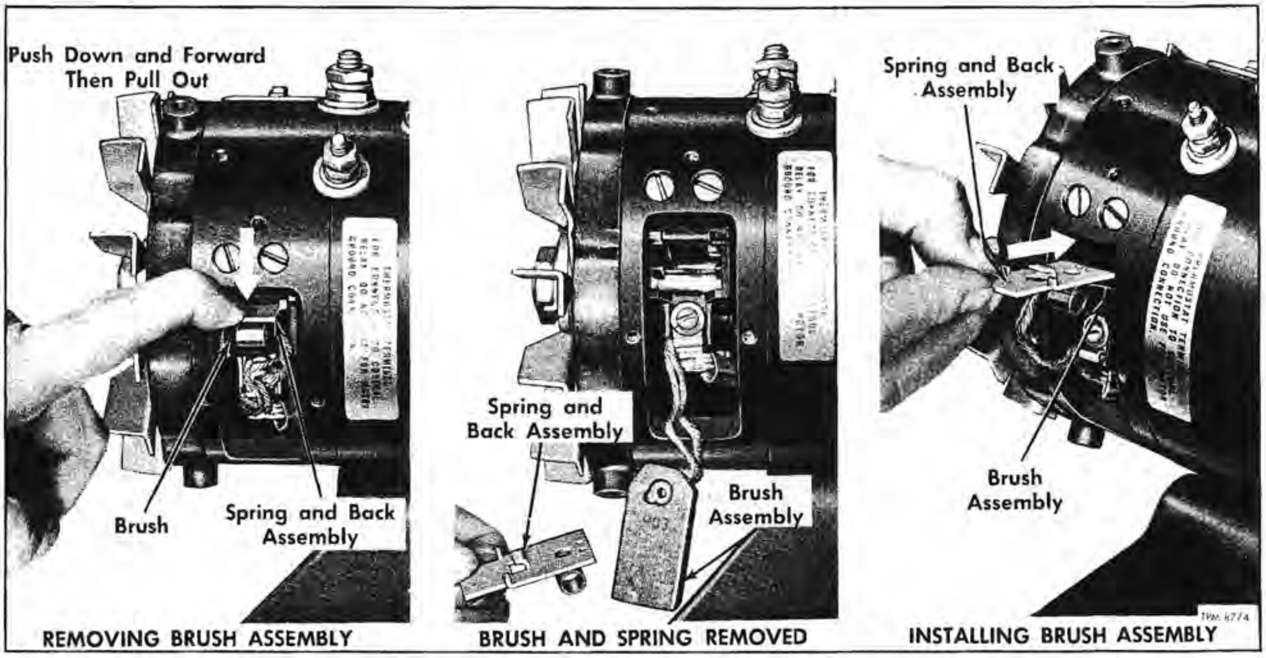


Figure 30—Replacing Standard Underfloor Blower Motor Brushes

4. Tap end frames with soft hammer to loosen, then separate end frames.

5. Remove armature from motor housing and winding assembly.

6. If necessary, shaft bearings can be readily removed from shaft or end frames using a conventional bearing puller.

PARTS INSPECTION AND TEST

Before proceeding with repair operations, the following inspections should be made:

1. Check armature to commutator leads to be sure they are properly soldered. Loose leads should be resoldered.

2. Inspect commutator and if found to be rough, out-of-round, worn, has high mica, or is badly burned, replace armature or repair commutator as instructed later under "Armature Repair."

3. Inspect field coil insulation. If insulation is cracked, charred, or worn so that wire is exposed, it is recommended that field coil and frame assembly be replaced.

4. Check length of brushes and replace if less than 3/4 inches long (on standard heater motor) or 7/8 inches long (on motor used with air conditioning) measured on longest side. Be sure that pigtail leads are secure in the brushes and that terminals are properly fastened to leads.

5. Carefully inspect ball bearing assemblies for evidence of damage or wear. If rough, pitted, or worn; replace bearing assembly.

6. Inspect brush bracket assembly and brush retainer spring assembly for wear or damage. If either assembly is badly worn or broken, replace.

TESTING ARMATURE

1. With a conventional test light and prods, test armature for ground. Place one test prod on armature and other on commutator. If test light lights, armature is grounded and should be replaced.

2. If armature is open circuited, this can easily be detected visually, since an open circuit in the armature usually results in badly burned commutator bars.

3. To test armature for short circuit, place armature on growler connected to alternating current. Hold hack saw blade over armature while armature is rotated slowly. If saw blade vibrates or buzzes, armature is short circuited and should be replaced. However, before replacing an armature that is apparently shorted, inspect commutator slots for copper or brush dust deposits, clean thoroughly, and re-test.

4. Test armature terminal circuits for continuity. Place one test prod on armature terminal and other on terminal of each wire. If test lamp fails to light, wire is open circuited and should be replaced.

ARMATURE REPAIR

1. To turn down commutator, center armature in lathe; then machine until rough or worn spots or out-of-round condition has been removed.

CAUTION: Machine only necessary amount.

2. Mica between commutator segments must be below surface of segments. If this condition does not exist, undercut mica until it is 1/32" below surface of segments. After undercutting, use No.

00 sandpaper to clean and smooth up commutator, then use compressed air to remove all fine particles of cuttings.

3. If armature is open-circuited, burned commutator riser bars may result. When bars are not too badly burned, armature can sometimes be saved by rewelding the leads in the riser bars. After welding, turn down commutator and undercut mica as directed in steps 1 and 2.

ASSEMBLY OF MOTOR

NOTE: The following applies to standard motor but will generally apply to motor used with air conditioning also.

After all parts have been inspected and repaired or replaced, blower motor may be assembled as follows:

1. Insert new seal strip (standard motor) into groove within commutator end frame bearing recess. Coat strip with a clean lubricant, then install new bearing assembly in end frame.

2. Install bearing in drive end frame. Bearing assembly is retained in end frame by a plate which is secured with screws.

3. With small washer located on shaft at each end of armature winding, position armature, case, and end frames, then install retaining thru-bolts.

4. Connect all leads and install brushes.

5. At commutator end of motor, install ventilating fan to motor shaft. Referring to figure 29, install spacer, drive key, fan, fan collar lock washer and hex nut. Tighten nut firmly.

BLOWER MOTOR CONTROL RELAYS AND CIRCUIT BREAKERS

Blower motor relays and circuit breakers are mounted on bulkhead at rear of heating and cooling compartment between blower motors as shown in figure 6 in ELECTRICAL (SEC. 7) of this manual. Relays and circuit breakers are accessible after removing two bolts attaching access door to bulkhead, then lowering hinged door. Refer to ELECTRICAL (SEC. 7) for relay information.

AIR FILTERS

Three air filters, mounted to front of heating compartment (fig. 1) filter all air passing through the compartment. Filters are accessible from underneath coach after opening access door directly below compartment. Door is retained in closed position by four winged fasteners.

Clogged filters restrict air circulation, thus reducing efficiency of system. In addition to the effect on system operation, dirty filters permit dirt to pass into the core clogging coil and fins.

Screens are of all metal construction and should be REMOVED FREQUENTLY and THOROUTHLY WASHED. Screens should then be sprayed sparingly with odorless oil, or dipped and thoroughly drained.

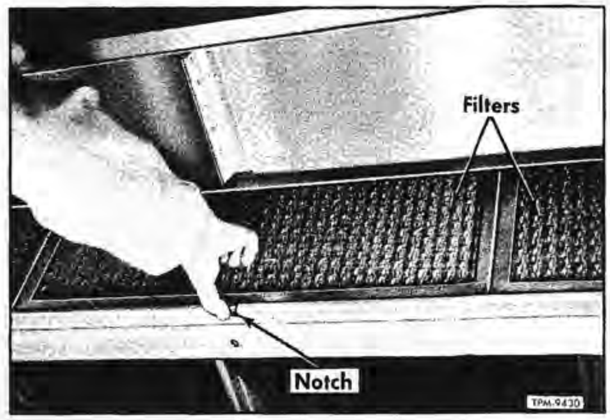


Figure 31—Removing Air Filters

To remove filter sections, open access door, then using thumb pressure or a small screwdriver as shown in figure 31 pry center section upward against tension and pull lower end rearward from channel. Slide end sections toward center of coach, then remove.

After installing filters make sure filter sections are seated firmly in channel and no space exists between sections.

DEFROSTER HEATER

Defroster heater assembly is located in compartment at front center of dash. Assembly consists of fan motor, a fan wheel and shroud assembly, heater core unit and air inlet duct with damper door. Figure 32 shows heater core assembly removed. Access to heater assembly is gained after removing dash center closure panel.

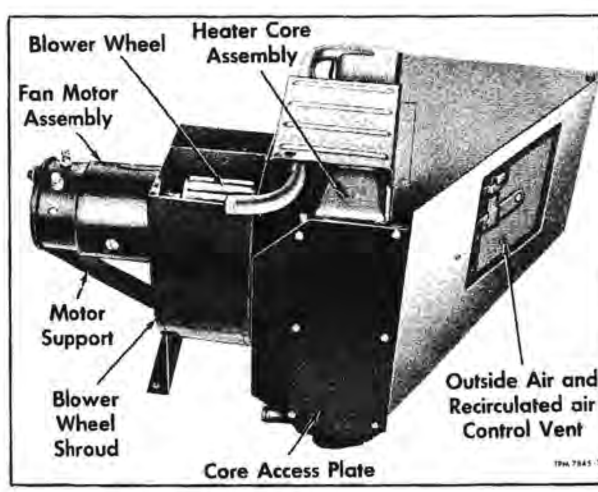


Figure 32—Defroster Heater Unit Removed

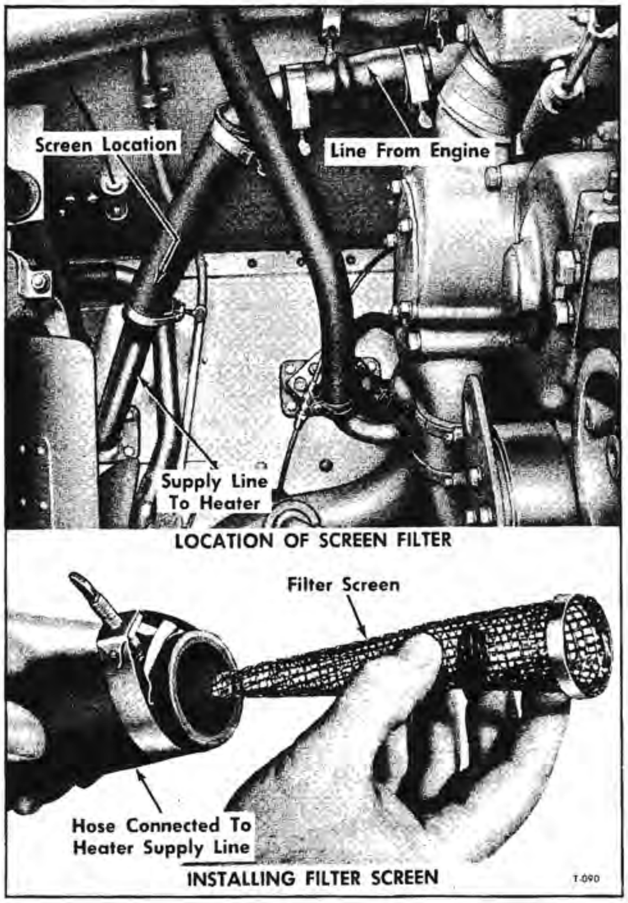


Figure 33—Heater Supply Line Filter Screen

The heater motor can be removed after removing attaching screws and the heater core only can be removed after disconnecting heater lines, removing core access plate, then pulling core from heater unit.

Heater fan motor is of two speed type and is controlled by "DEFROST" switch on control panel at left of driver. Whenever the switch is placed in "HI" or "LO" position the heating system water pump becomes operative, circulating engine coolant through the defroster heating system.

Flow of water through the heater core is controlled by driver by positioning of heater supply shut-off valve control knob. Knob is located behind dash panel at right of operator (fig. 8). Pull knob to increase heat.

IMPORTANT

EXCESSIVE USE OF DEFROSTER HEATER WILL CAUSE HIGH TEMPERATURE AT THE FRONT END OF COACH, THEREBY SATISFYING THE GRAD-U-STAT AND LEAVING THE BALANCE OF COACH COLD.

HEATER LINE WATER FILTER SCREEN

Heater water filter screen, located in heating system water supply line hose at engine water manifold, should be removed and cleaned whenever water system is drained. Filter screen is easily removed from hose after removal of hose clamps and then disconnecting hose. Figure 33 shows screen location and proper positioning of screen when installing.

NOTE: If rubber connection hose is collapsed, or deteriorated, it should be replaced at this time.

NOTE

At regular coach inspection intervals, check operation of all heating and ventilation controls. Properly adjusted controls will provide maximum comfort for passengers and the driver.

TROUBLESHOOTING CHART

TROUBLE	POSSIBLE CAUSES
UNDER-HEATING (Items with an asterisk (*) also apply to under-cooling)	Grad-U-Stat setting too low. Grad-U-Stat temperature sensing bellows ruptured. Grad-U-Stat barometric bellows out of adjustment. *Grad-U-Stat out of calibration. *Grad-U-Stat air valve unit sticking, plugged, or damaged. *Water modulation valve stem bent or sticking. *Foreign material in water modulation valve body. *Blowers inoperative. *Air filters dirty. Heater cores dirty. *Proportion of outside air admitted too high. *Clogged recirculated air inlet screen. Heater line gate valve closed. Air in heater system water lines. Excessive heat at dash heater. UNDER-COOLING ONLY: Grad-U-Stat setting too high. Pressure regulator valve setting too low. Leakage in air lines and fittings.
OVER-HEATING (Items with an asterisk (*) also apply to over-cooling)	Grad-U-Stat setting too high. *Grad-U-Stat out of calibration. *Grad-U-Stat barometric bellows out of adjustment. *Grad-U-Stat barometric bellows ruptured. *Grad-U-Stat air valve unit sticking, plugged, or damaged. Pressure regulator valve setting too low. Leakage in air lines and fittings. Defective diaphragm in water modulation valve. Outside air intake restricted. OVER-COOLING: Grad-U-Stat setting too low.
ALTERNATE UNDER- AND OVER-HEATING	Water modulation valve stem bent or sticking. Grad-U-Stat bellows insulated with dirt or oil. Differential range setting of Grad-U-Stat too low. (Also applies to alternate over- and under-cooling.)

NOTE: Differential range setting of 6°F. is recommended for Grad-U-Stat.

Refer to next page for "Heating and Ventilation Specifications."

SPECIFICATIONS

UNDERFLOOR HEATER BLOWER MOTORS (With Air Conditioning)
GM Part No. 5375834
Make .... Delco Products
H.P. 3/4
Volts 13.5
Rotation (Commutator End) .... Clockwise
RPM .... 1750 (Low Speed)
.... 2250 (High Speed)
Amps (Under Load—High Speed) .... 60 to 65

UNDERFLOOR BLOWER MOTORS (Without A/C)
GM Part Number 1114642
Make .... Delco-Remy
Volts 13.5
Rotation (Shaft End) .... CCW
H.P. 3/8
RPM (Under Load) 2500
Amps (Under Load) .... 35 to 37

DASH HEATER BLOWER MOTOR
GM Part Number 1114615
Make .... Delco-Remy
Volts 12
Rotation .... C.W.

DASH HEATER BLOWER MOTOR—(Continued)
Type .... 2 Spd.
RPM .... 2200 and 1400
H.P. .... 1/5 @ 2200 RPM

WATER PUMP MOTOR
GM Part Number 2397746
Make .... Marine Products Co.
Volts 13.5
Amps .... 8.5 to 9.5
Rotation (Drive End) .... CCW
RPM 3000

GRAD-U-STAT
GM Part Number 2340294
Make .... Minneapolis Honeywell
Model .... TP 900 F1032

WATER MODULATION VALVE
GM Part Number 2389439
Make .... Minneapolis Honeywell
Model VP511A1016
Starts to Close .... 3 ± 3/4 psi
Completely Closed .... 12 ± 3/4 psi

Brakes

This group is divided into five sections as shown in index below:

AIR SYSTEM EQUIPMENT

The coach air system is made up of a group of devices. Some of these devices maintain a supply of compressed air. Others direct and control the flow of this compressed air. Still other devices, directly connected with the braking function, are operated by compressed air. Only those units with functions directly related to vehicle braking system are covered in this group. Information on all units in air system will be found in sections of this manual as shown below in "Index of Air Control Units."

INDEX OF AIR CONTROL UNITS

Air Brakes

BRAKE SYSTEM OPERATION

Compressed air is discharged into the main (wet) air tank and flows from the wet tank into the second main (dry) air tank. There are two tee connections and two single connections at dry air tank. Lines from one tee lead to air compressor governor and to suspension air tank. Lines from second tee lead to rear brake relay valve and to door controls, air gauge, and windshield wipers. Air line at one single connection comes from wet air tank. Line at other single connection leads to air brake application valve.

Moisture ejector valves are used on some vehicles to automatically remove accumulated moisture from wet air tank. Valves are operated by compressed air when brakes are released, or when governor unloads air compressor. Valve opens and allows accumulated moisture at bottom of tank to be blown out through two drain tubes.

Pressure regulating valves are installed in air lines leading to suspension air tank and to windshield wipers. Valves admit air only when main tank pressure is 65 psi or over. Valves prevent pressure in main air system from dropping below a safe limit due to leaks or to use of windshield wipers with engine stopped. Check valve in suspension air tank inlet line prevents loss of suspension air back into main air system.

Low air pressure switch closes an electrical circuit in the tell-tale alarm system when main tank pressure is below switch setting. This causes the tell-tale alarm buzzer to sound and the "LOW AIR" tell-tale to light.

When brakes are applied, air pressure passes through the brake application valve to the front brake chambers and to rear brake relay valve and stop light switch. Air to relay valve actuates the valve, permitting compressed air direct from main tank to pass through the valve to rear brake chambers.

When brakes are released, air in the rear brake chambers is exhausted at the relay valve. Air in front brake chambers and in line leading to relay valve is exhausted at brake application valve.

BRAKE SYSTEM MAINTENANCE

Procedures for testing, adjusting, and overhauling brake system units are described under individual headings later in this section.

Air tanks without moisture ejector valve should be drained daily. Refer to "Air Tanks" later in this section for location of tanks and drain cocks.

The complete air system should be checked for leakage at regular intervals. With engine stopped and brakes released, observe rate of air pressure drop registered by the dash gauge. The rate of drop should not exceed two pounds per minute. With engine stopped and brakes fully applied, observe the rate of air pressure drop registered by the dash gauge. Rate of drop should not exceed three pounds per minute. If leakage is excessive, leakage tests should be made at air line connections and at all air brake control units as directed under individual headings later in this section.

Drain moisture regularly from air system, especially during cold weather. When necessary to protect air system against extreme cold weather operation, install an alcohol evaporator to feed alcohol vapor into the system.

Refer to "AIR COMPRESSOR AND GOVERNOR" section later in this group for information on air compressors and governors.

BRAKE ADJUSTMENTS

BRAKE SHOE ADJUSTMENT

Brake adjustment for normal lining wear is made by turning slack adjuster worm shaft (fig. 28). Brake chambers and slack adjusters installed are shown in figures 29 and 30. Brake chamber push rod travel should be checked after every 2,000 miles of operation to determine whether adjustment is necessary. While maximum travel, listed in "Specifications" at end of this section, is permissible, travel should be maintained as short as possible without brakes dragging for braking efficiency and economy in air consumption. Brake linings should be replaced when worn to a thickness of 5/16" at center of shoe.

1. Always check wheel bearing adjustment and correct if necessary before attempting to adjust brakes. Refer to "HUBS AND BEARINGS" (SEC. 19) of this manual.

2. With wheel jacked up, turn slack adjuster worm shaft until brake drags, then back off until wheel turns freely. NOTE: Lock sleeve must be pushed in before worm shaft can be turned. Make sure sleeve is pushed in far enough to clear hex end of worm shaft before turning shaft.

3. Be sure wheel turns freely with no brake drag when brakes are fully released. After completing adjustment, make sure lock sleeve comes out and engages hex end of worm shaft. Pry sleeve out with screwdriver if necessary. Coat lock sleeve and end of worm shaft with wheel bearing grease after completing adjustment. This keeps out dirt and water, and assures free movement of sleeve at next adjustment. On some coaches install rubber boot over lock sleeve.

BRAKE TREADLE ADJUSTMENT

1. Push brake treadle down to limit of travel.

2. Loosen treadle stop screw lock nut.

3. Turn stop screw to a height of approximately 3.80" from the floor.

4. From full down position, raise brake treadle two full turns of stop screw. This clearance protects brake application valve parts from damage.

5. Adjust adjusting screw (3, fig. 16, 2, fig. 17, or 24, fig. 18) to provide 0.001" to 0.002" clearance between treadle roller and plunger with treadle held tight against adjusting screw. Tighten lock nut firmly.

CHECK VALVE

DISCHARGE LINE CHECK VALVE

One-way check valve (fig. 2) is installed in air compressor discharge line (fig. 1). Check valve may also be installed at dry air tank in air line between wet and dry air tanks. This valve functions in the air system as a safety device. In the event of leakage or breakage in air compressor discharge line, check valve prevents loss of air pressure from the air system. Check valve should be removed, disassembled, and cleaned at regular intervals. Valve disc should be turned over if worn on one side, and a new seal ring should be used when assembling. Install valve to permit air flow in direction of arrow on valve body.

The drain cock in discharge line (fig. 1) is used to check operation of the check valve.

SUSPENSION AIR TANK CHECK VALVE

Suspension air tank check valve (fig. 3) is a ball type check valve installed at suspension air tank inlet. Check valve prevents loss of air pressure from suspension air tank in the event of pressure loss from the main air system. Check valve should be removed, disassembled, and cleaned at regular intervals. Check valve ball should be replaced if any wear or roughness is evident. Use new gasket between valve cap and body when assembling valve. Install valve to permit air flow into suspension air tank as indicated by arrow stamped on valve cap.

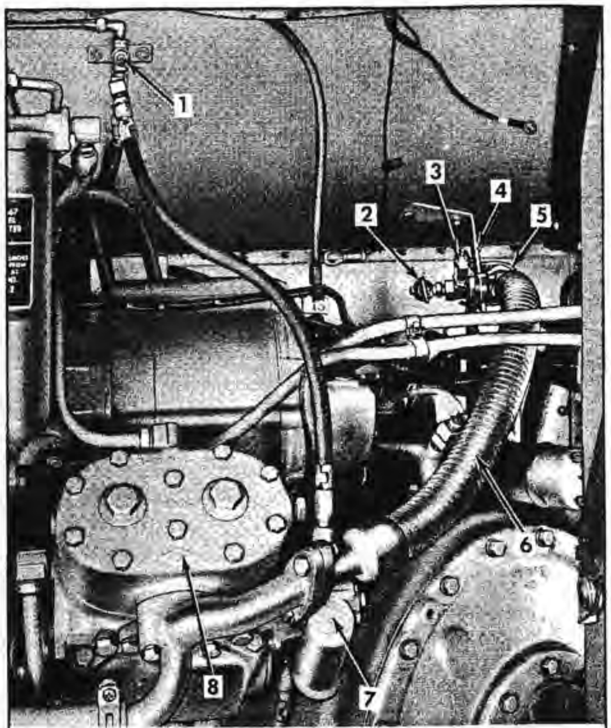
AIR TANKS

Three air tanks are used in the Transit Coach air system, two main tanks and the suspension air tank. On Suburban models, four air tanks are used in vehicle air system, two main air tanks, front brake air tank, and suspension air tank.

These tanks provide an ample supply of compressed air that is available for immediate operation of the brakes, air suspension system, and other air-operated equipment. Tanks store sufficient compressed air for several brake applications with the engine stopped.

Air tanks also serve to cool and condense oil and water vapors in compressed air. Most of this condensation takes place in the main (wet) air tank, the tank connected to the air compressor. The moisture ejector valve (fig. 8 or 10), when used, automatically drains condensation from tank each time air compressor governor operates the compressor unloader, or each time the brakes are applied and released (depending upon the type of ejector system used). The dry air tank, suspension air tank, and front brake air tank on Suburban models, must be drained manually each day. Drain tanks completely by leaving drain cocks open after all air is exhausted and until all drainage stops.

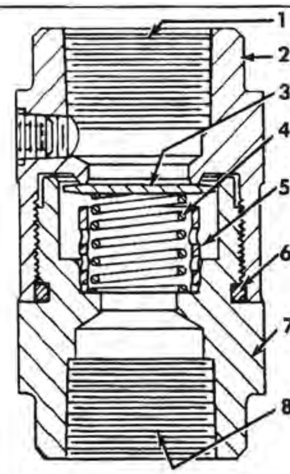
On Transit Coaches, the wet air tank is mounted horizontal on left-hand side of coach behind the batteries. The dry air tank is mounted horizontal at right side of wet air tank. Suspension air tank is mounted horizontal ahead of wet air tank on left side of coach. All air tanks are located below coach floor. On Suburban Coaches, the wet air tank is



1 Filler Valve
2 Drain Cock
3 Safety Valve
4 Mounting Bracket
5 Check Valve
6 Discharge Line
7 Air Compressor Governor
8 Air Compressor

T-123

Figure 1—Bendix-Westinghouse Air Compressor and Discharge Line Installation



1 Air Inlet
2 Valve Cover
3 Valve Disc
4 Valve Spring
5 Spring Cage
6 Seal Ring
7 Valve Body
8 Air Outlet

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Figure 2—Compressor Discharge Line Check Valve

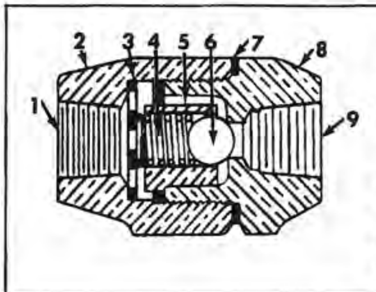


Figure 3—Suspension Air Tank Check Valve

mounted vertical on left side of coach behind the batteries. The dry air tank is mounted vertical beside wet air tank. Suspension air tank is mounted horizontal ahead of the wet and dry air tanks on left side of coach. Front brake air tank is mounted horizontal beneath driver's seat. NOTE: On Suburban coaches with baggage compartment, suspension air tank is mounted in rear bay at right rear of coach. All air tanks are located under coach floor. On some air tanks, drain cocks at bottom of tanks are recessed key type. A special tool must be used to open and close drain cocks. Tool can be made locally to dimensions shown in figure 4.

All air tank mounting bolts should be checked for looseness at regular intervals and tightened if necessary. Air tanks may be cleaned inside and out using steam or hot water. Inspect tanks for corrosion or other damage. If corrosion or other damage has weakened a tank, it must be replaced.

Schematic diagrams of air system showing air tanks, standard air supply and brake system units, and suspension air system are shown in figures 5 and 6. The open lines represent air supply and air brake system air lines. The solid black lines represent air suspension air lines. A more detailed

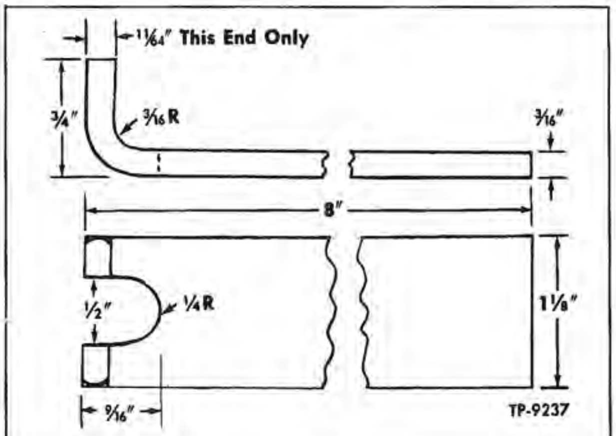


Figure 4—Special Tool For Recessed Type Drain Cock

diagram of the suspension air system is shown in AIR SUSPENSION (SEC. 14) of this manual.

SAFETY VALVE

Key numbers in text refer to figure 7.

Safety valves, shown in figure 7, are installed in the wet air tank and discharge line to prevent air pressure build-up in the air system beyond a set maximum.

OPERATION

When reservoir pressure is built up to exceed 150 pounds, force of air pressure forces ball (3) off seat (2), permitting air pressure in excess of 150 pounds to escape through exhaust port (4) to atmosphere. After pressure bleeds down, spring (5) forces ball (3) back on seat (2).

MAINTENANCE

Check safety valve periodically for leakage, using soap suds at exhaust port. Leakage should not exceed a 1-inch bubble in 5 seconds. Once a year, valve should be dismantled, cleaned with kerosene, and reset to blow off at 150 pounds.

ADJUSTMENT (Fig. 7)

Set safety valve in following manner:

1. Loosen lock nut (8).
2. Adjust set pressure by turning adjusting nut (6). Turn nut clockwise to increase pressure, or counterclockwise to decrease pressure.
3. Tighten lock nut (8) firmly.

MOISTURE EJECTOR VALVE (EXPELLO)

DESCRIPTION

The "Expello" moisture ejector valve used as optional equipment on some coaches (fig. 8) is operated by compressed air and automatically ejects condensation from the wet air tank. The valve is connected to bottom of wet air tank on transit coaches and bracket mounted near wet air tank on Suburban coaches. Condensation drains into valve upper body. An optional heating coil, when used, prevents moisture from freezing. Heating coil is connected to No. 18 circuit breaker behind control panel at left side of driver's seat.

OPERATION

The air line at lower body of ejector valve comes from rear brake relay valve exhaust port. Moisture is ejected each time brakes are released. Exhaust air pressure from relay valve momentarily lifts diaphragm and raises valve off seat in upper body. During this interval air pressure in tank forces moisture out through discharge port.

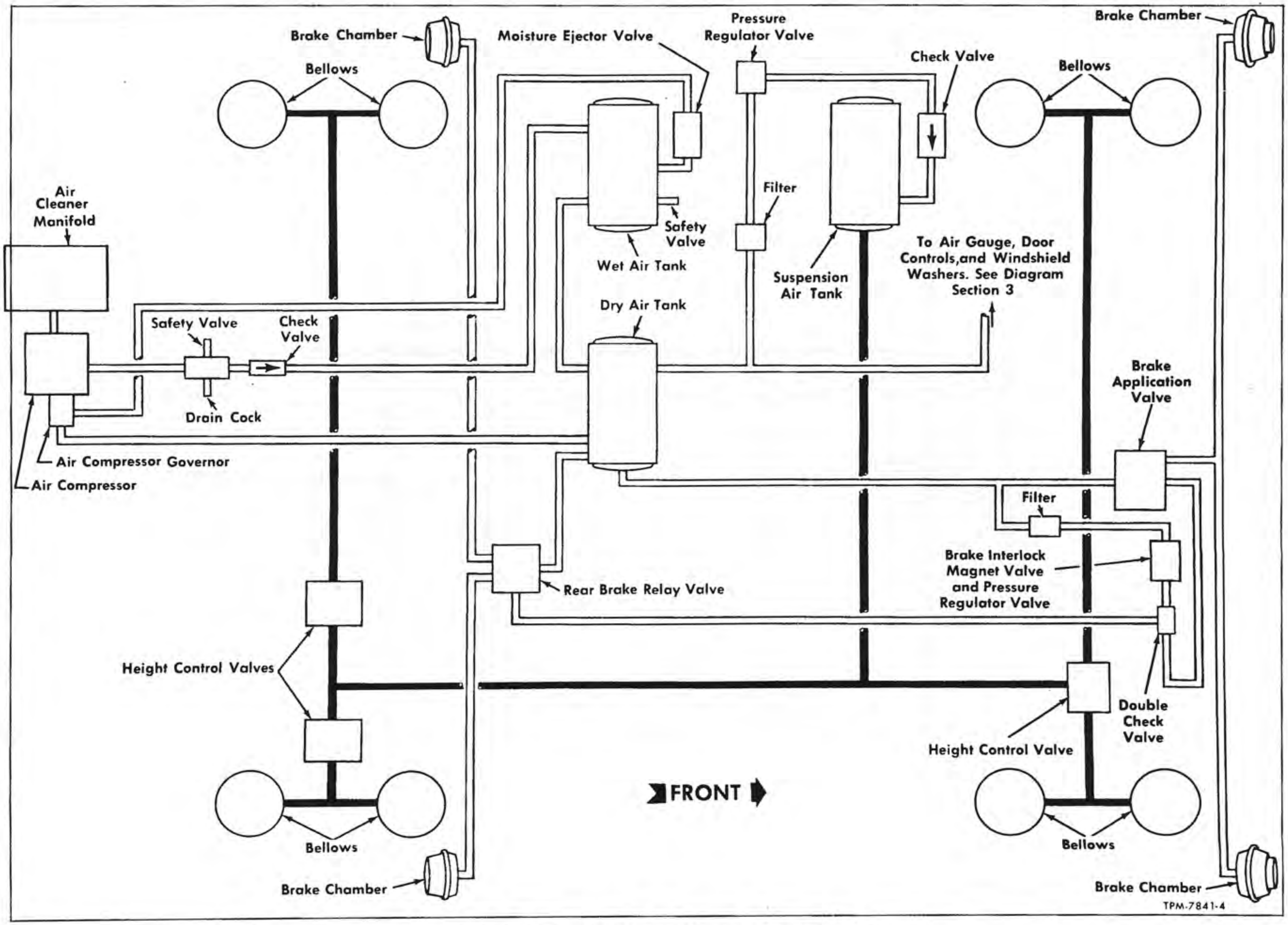
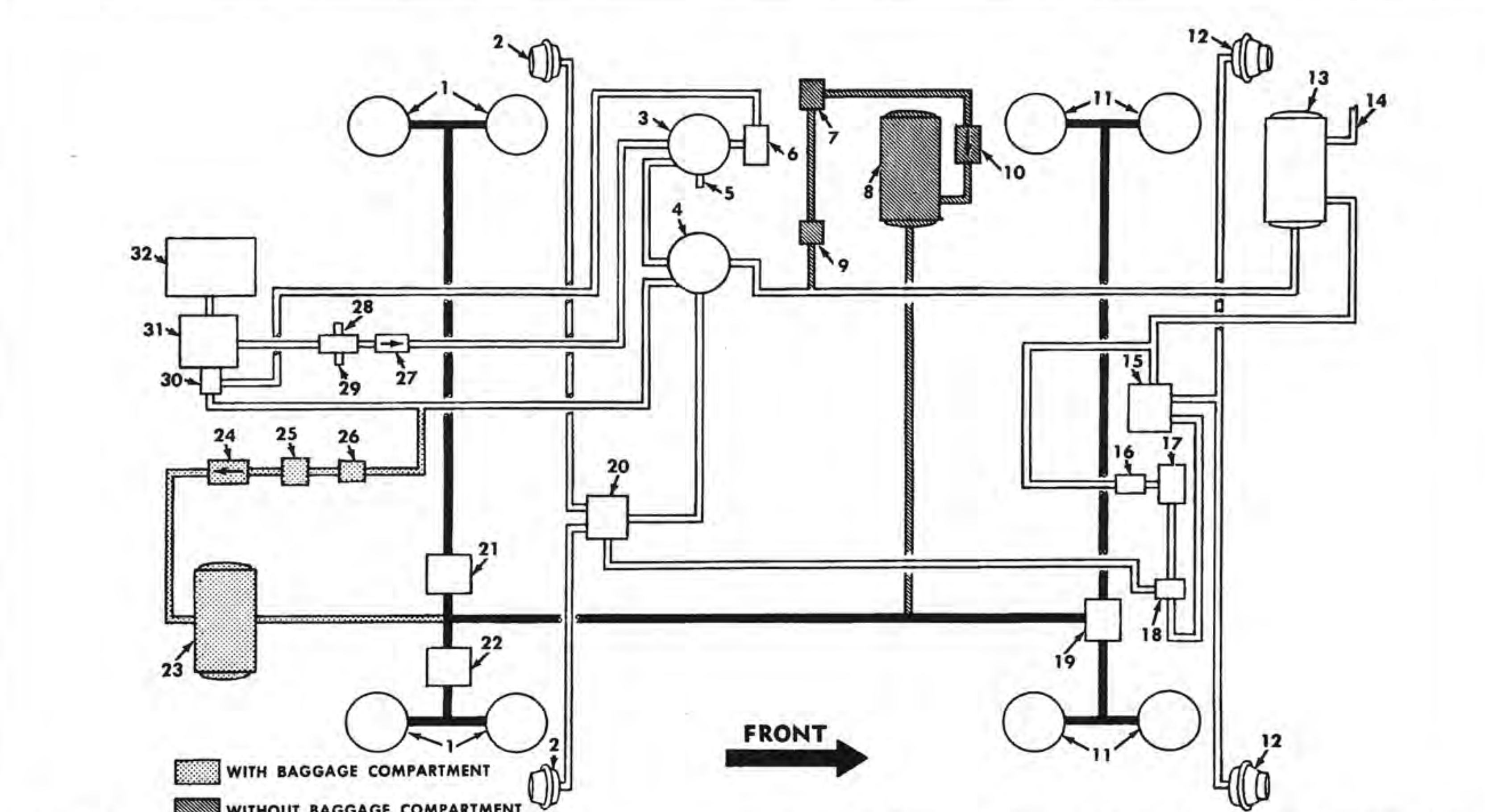


Figure 5—Typical Schematic Air Line Diagram—Transit Coaches



1 Rear Bellows
2 Rear Brake Chambers
3 Wet Air Tank
4 Dry Air Tank
5 Safety Valve
6 Moisture Ejector Valve
7 Pressure Regulator Valve
8 Suspension Air Tank
9 Filter
10 Check Valve
11 Front Bellows
12 Front Brake Chambers
13 Front Brake Air Tank
14 To Air Gauge, Door Controls, and Windshield Washers (See Diagram, Section 3)
15 Brake Application Valve
16 Filter
17 Brake Interlock, Magnet Valve, and Pressure Regulator Valve
18 Double Check Valve
19 Height Control Valve
20 Rear Brake Relay Valve
21 Height Control Valve
22 Height Control Valve
23 Suspension Air Tank
24 Check Valve
25 Pressure Regulator Valve
26 Filter
27 Check Valve
28 Safety Valve
29 Drain Cock
30 Air Compressor Governor
31 Air Compressor
32 Air Cleaner Manifold

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Figure 6—Typical Schematic Air Line Diagram —Suburban Coaches

SERVICEABILITY TESTS

1. Operating Tests

Ejector valve can be operated manually or by applying and releasing brakes.

Manual Operation. Push up projecting end of stem assembly. As valve unseats, moisture is forced from air tank through condensate discharge port.

Brake Operation. Apply and release brakes. As brakes are released, exhaust air from rear brake relay valve operates ejector valve.

2. Leakage Test

With brakes applied, coat bottom of ejector valve with soap suds. If bubbles appear at air exhaust port, leakage in rear brake relay valve is indicated. If bubbles appear at condensate discharge port, leakage is indicated at valve seat in valve upper body. Valve should be disassembled and seat should be cleaned or repaired, or complete valve assembly should be replaced.

EJECTOR VALVE REPLACEMENT

Removal

Exhaust compressed air from system. Disconnect air line from valve lower body. Disconnect wire from valve heating coil lead (if used). Unscrew valve assembly from bottom of air tank on Transit coaches. On Suburban coaches remove valve from mounting bracket.

Installation

Thread ejector valve assembly into bottom of air tank and tighten firmly on Transit coaches. On Suburban coaches install valve on mounting bracket. Tighten bolts firmly. Connect wire to heating coil lead (if used). Connect air line to opening in valve lower body. Build up air pressure in system and test valve as previously directed under "Serviceability Tests."

EJECTOR VALVE OVERHAUL

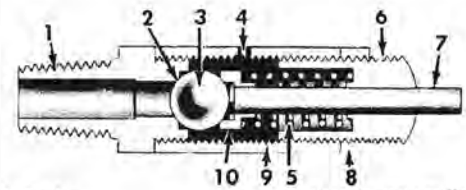
Key numbers in text refer to figure 8.

Disassembly

1. Remove four nuts and lock washers from valve body bolts. Mark valve cover (8) and upper (5) and lower (6) bodies to aid in assembly.

2. Lift off valve cover and heater assembly. See "Inspection and Repair" for method of checking wire assembly and heating element. Carefully remove two brass screws from heating insulator. Remove wire assembly, heating element and insulator, and asbestos gasket. Remove insulating washer from cover.

3. Separate upper and lower bodies and remove four bolts. Remove asbestos gasket from upper body.



1 Body
2 Ball Seat
3 Ball Valve
4 Exhaust Port
5 Spring
6 Adjusting Screw
7 Stem
8 Lock Nut
9 Spring Cage
10 Spring Seat

TPM 8579

Figure 7—Safety Valve

4. Cut off small end of stem at second groove. The sleeve that holds assembly together is swaged as shown in figure 8. Remove sleeve from end of valve stem. Remove brass washer, diaphragm (7), second brass washer, and spring. Remove stem from opposite side of upper body.

Inspection and Repair

1. Check electrical resistance through wire assembly and heating element before removing these parts from cover. Use a 12-volt source. With parts in good condition, resistance will be approximately 7 ohms.

2. Discard stem assembly parts and gaskets.

3. Clean all parts. Use reseating tool CVT-8, if necessary, to clean and restore valve seat. Do not re-use upper body if more than 1/32" has been taken off height of seat.

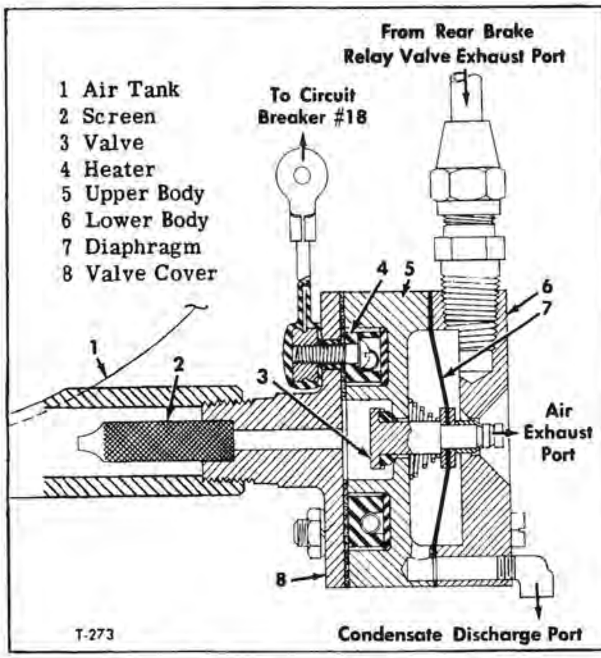


Figure 8—Moisture Ejector Valve (Expello) (Typical)

4. Inspect screen for looseness or signs of damage. If necessary, solder new screen in place.

Assembly

1. Remove any excess rubber from new stem. Install stem in cover side of upper body (5). Place spring over stem, with large diameter against upper body (5). Install brass washer, diaphragm (7), and other brass washer on stem. Install sleeve, large end first, over end of stem and swage as follows:

a. Hold assembly together and carefully position large end of stem on anvil of valve stem service fixture CVT-7 as shown in figure 9.

b. Place swaging tool over small end of stem and sleeve. Lift edge of diaphragm (7) and check position of spring. Edge of spring should not prevent parts from fitting together squarely on stem.

c. Tap shoulder lightly with a hammer until shoulder of tool rests on top of fixture. This will lock diaphragm tightly in place.

Small end of sleeve should be forced tightly enough into stem groove to prevent air leakage at diaphragm (7). To prevent damage to parts, avoid excessive pressure.

2. Place asbestos gasket on cover (8) with screw holes in gasket aligned with screw holes in cover. Insert insulating washer in screw hole in cover.

3. Position insulator, with grooved side exposed, on gasket. Attach insulator loosely with small brass screw. Hold wire assembly opposite screw hole and attach loosely with long brass screw. Insert one end of heating element under head of small screw. Tighten snugly. Overtightening could crack insulator. Stretch element around groove and insert other end under head of large screw. Tighten snugly.

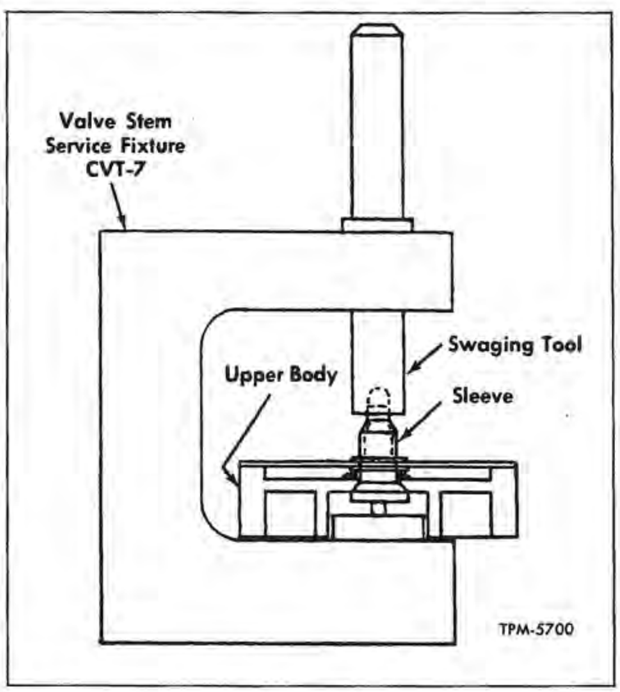


Figure 9—Installing Valve Stem Sleeve

4. Rotate diaphragm (7) until all holes are properly aligned. Diaphragm must not cover condensate discharge port. Place upper body (5) on lower body (6). Place asbestos gasket in upper body.

5. Place cover (8) in position on upper body (5). Use alignment marks made previously. Install four bolts in holes in lower body (6). Place four lock washers and nuts on bolts. Align cover (8), upper body (5) and lower body (6). Stem should be in a central position. Tighten nuts firmly enough to prevent air leaks.

MOISTURE EJECTOR VALVE (GRAHAM-WHITE)

DESCRIPTION (Fig. 10)

The moisture ejector valve, used as optional equipment on some coaches, is bolted to a bracket above wet air tank and beneath coach floor. Valve may also be located above floor and behind access cover in air duct. Most of the condensation takes place in the wet air tank. This condensation is automatically drained through the ejector valve.

OPERATION

Moisture ejector valve operates each time the governor unloads the air compressor or door control is actuated, depending on type of installation. Air pressure from governor or door control works against ejector valve cup. This force moves piston, compresses valve spring, and unseats exhaust valve. Air pressure in wet air tank forces accumulated moisture into valve and out through two drain lines. At end of piston stroke, opposite seat makes contact and closes valve.

SERVICEABILITY TESTS

1. Operating Test

On governor operated system, build up tank pressure in air system; at cut-out point (120 psi), air pressure from governor unloads compressor and also operates ejector valve. On door operated system, operate door control to check operation of ejector valve.

2. Leakage Test

Coat open end of both drain lines with soap solution. The presence of soap bubbles will indicate leakage past valve seat. Disassemble unit and clean or replace exhaust valve.

EJECTOR VALVE REPLACEMENT

Removal

1. Exhaust compressed air from the system.

2. On vehicles with ejector valve mounted in air duct above floor, remove access panel from air duct (ahead of left rear wheelhouse).

3. From under coach or in air duct above floor (depending upon valve location), disconnect air lines from ejector valve.

4. Remove bolts attaching ejector valve to bracket and remove valve assembly.

Installation

1. Position ejector valve at mounting bracket, either from under coach or in air duct above floor (depending upon valve location), and attach with two bolts and lock washers.

2. Connect air lines to ejector valve; tighten connections firmly.

3. Build up air pressure in system and test ejector valve as previously directed under "Serviceability Tests."

4. On vehicles with ejector valve mounted in air duct above floor, install access panel on air duct.

EJECTOR VALVE OVERHAUL

Disassembly

Key numbers in text refer to figure 10.

1. Unscrew spring cap (11) and remove from valve body (4).

2. Remove valve spring (9) and intake valve assembly, consisting of seat (6), seat washer (8), lock nut (12), and valve stem (10) as an assembly, from valve body.

3. Remove lock nut (12); then lift seat washer (8) off valve stem (10). Remove seat (6) from valve stem (10).

4. At opposite end of the assembly, unscrew cylinder cap (1) and remove from valve body (4).

5. Push on piston stem (7) and remove cup (2), piston (3), O-ring (5), seat (6), and piston stem (7) from valve body (4).

6. Unscrew piston stem (7) from piston. Remove seat (6).

7. Remove O-ring (5) from piston and discard.

Inspection

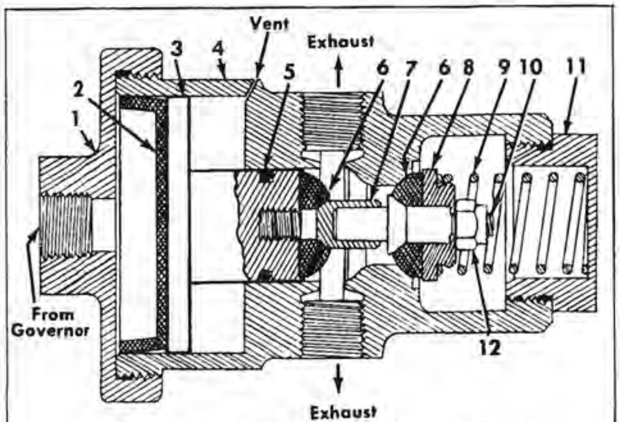
1. Clean all parts thoroughly with cleaning solvent. Wipe or blow parts dry.

2. Examine cylinder cap, valve body, and spring cap for cracks, stripped threads, or other damage.

3. Check vent in valve body for obstruction.

4. Inspect valve cup, piston, seat washer, and seats for wear or damage.

5. Check valve stem and piston stem for distortion, stripped threads, or other damage.



1 Cylinder Cap	7 Piston Stem
2 Cup	8 Seat Washer
3 Piston	9 Valve Spring
4 Body	10 Valve Stem
5 O-ring	11 Spring Cap
6 Seat	12 Lock Nut

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Figure 10—Moisture Ejector Valve (Graham-White)

6. Inspect valve spring for free length, compressed length, distortion, or collapsed coils.

Assembly

Key numbers in text refer to figure 10.

1. Install a new O-ring (5) in groove of piston (3).

2. Position seat (6) to piston (3); then thread piston stem (7) into piston (3).

3. Insert piston assembly in valve body (4).

4. Install cup (2) in body (4); then thread cylinder cap (1) on valve body. Tighten firmly.

5. Position seat (6) on valve stem (10); then place seat washer (8) on stem. Install lock nut (12) and tighten firmly.

6. Install intake valve assembly, consisting of parts assembled in step 5 above, in valve body (4).

7. Position valve spring (9) against seat washer (8) in valve body.

8. Thread spring cap (11) into valve body (4). Tighten cap firmly.

AIR LINES

Metal tubing and flexible hose are used to connect the various units of the air brake system. Service instructions for both types follow:

METAL TUBING

Metal air lines are of annealed copper tubing with three-piece compression type fittings. Flared type fittings should never be used in air brake systems. Connections should be tested for leakage

AIR BRAKES

at least every 5,000 miles and tightened or replaced if necessary. When replacing metal tubing, tubing must be free of burrs, copper cuttings, and dirt. Blow out with compressed air. Any of the above mentioned particles will destroy sealing seats in air control units. New tubing must be of the same size as the old tubing.

FLEXIBLE HOSE

Flexible hose is used at each brake chamber where it is impossible to use metal tubing due to constant flexing during vehicle operation. Hose connections should be tested for leakage at least every 5,000 miles and tightened or replaced if necessary. Any hose which is chafed, worn, or kinked should be replaced.

SERVICEABILITY TESTS

1. Operating Test

If any trouble symptom such as slow brake application or slow brake release indicates restricted or clogged air line, disconnect the suspected tube or hose at both ends and blow through it to make sure the passage is clear. Inspect tubing and hose for partial restriction such as would be caused by dents or kinks. If such a condition is found, tubing or hose should be replaced.

2. Leakage Test

With air system fully charged and brakes applied, coat all tubing and hose connections with soap suds to check for leakage. No leakage is permissible. Leakage can sometimes be corrected by tightening the connection. If this fails to correct leakage, new fittings, metal tubing, or flexible hose must be installed.

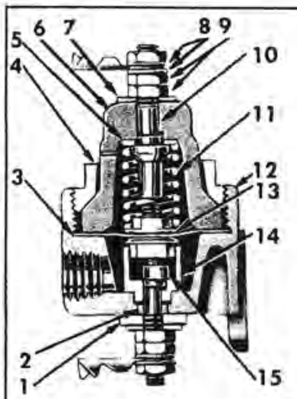
AIR PRESSURE GAUGE

The air pressure gauge in the instrument panel is connected into the air line leading from second main (dry) air tank.

The vehicle should never be put in motion until the air pressure registers at least 60 pounds. If pressure drops below 60 pounds (low pressure buzzer sounds), stop vehicle immediately and determine cause of pressure loss. Check gauge regularly with an accurate test gauge. Replace with a new unit if reading varies four pounds.

LOW AIR PRESSURE SWITCH (BENDIX-WESTINGHOUSE)

Low air pressure switch (fig. 11) is a safety device designed to automatically give a warning when pressure in air system falls below a safe limit for brake operation. The low air pressure switch is actually an air-controlled switch in an electrical circuit, automatically controlling a tell-tale light and buzzer. Operation of tell-tale alarm system is explained in "WIRING AND MISCELLANEOUS ELECTRICAL" in ELECTRICAL (SEC. 7). Low air pressure switch is mounted near door control valve at left of driver, and is connected into the feed line to the door control valve. Refer to "Alarm and Signal Wiring Diagram" in back of this manual for electrical circuits.



1 Terminal Washer
2 Grommet
3 Diaphragm Assembly
4 Cover Retainer
5 Washer
6 Cover
7 Clamping Washer
8 Washers
9 Nuts
10 Terminal Screw
11 Spring
12 Body
13 Shims
14 Terminal Bushing
15 Terminal Screw

TP 5468

Figure 11—Low Air Pressure Switch (Bendix-Westinghouse)

OPERATION (Fig. 11)

When system air pressure under the diaphragm is about 60 pounds, force exerted by air pressure overcomes the force exerted by the diaphragm spring, and the electrical contacts remain open.

When the air pressure drops below 60 pounds, diaphragm spring exerts a force above the diaphragm which is greater than force exerted by the air pressure below the diaphragm. This will cause the diaphragm to move down and close the electrical contacts. This completes electrical circuit to buzzer and tell-tale light, informing driver of his impending loss of air pressure.

The nominal pressure setting of 60 pounds is subject to a tolerance of plus 5 pounds so that actual operating pressure of the low air pressure switch may vary between 65 pounds maximum and 60 pounds minimum.

SERVICEABILITY TESTS

1. Operating Test

Operation of the low air pressure switch may be checked by reducing the system pressure and being sure that the contacts close when reservoir pressure is between 65 pounds maximum and 60 pounds minimum. The contacts will be closed when the tell-tale light and electrical buzzer operate.

2. Leakage Test

A small vent hole is provided in cover of the low air pressure switch to check condition of the diaphragm. Cover vent hole with soap suds. If a leak is indicated it signifies a ruptured diaphragm. The diaphragm should then be replaced.

LOW AIR PRESSURE SWITCH REPLACEMENT

Removal

1. Exhaust air pressure from main air system.

2. Disconnect wires from terminals at top and bottom of switch and disconnect air line from switch.

3. Remove two screws attaching switch and remove switch assembly.

Installation

1. Position switch and attach with two screws.

2. Connect wires to switch terminals.

3. Connect air line to opening in switch body.

4. Build up air pressure in system and test switch as previously directed under "Serviceability Tests."

LOW AIR PRESSURE SWITCH OVERHAUL

Key numbers in text refer to figure 11.

Disassembly

1. Unscrew cover retainer (4) from body (12).

2. Remove cover (6) and lift out spring (11), and diaphragm assembly (3).

Cleaning and Inspection

1. Clean all metal parts in cleaning solvent.

2. Examine diaphragm for signs of cracking, wear, or damage. Replace diaphragm if these conditions are found.

3. Inspect contact points for signs of pitting or wear. If pitting is not too severe, contacts may be reconditioned by filing with a fine distributor point file. If they cannot be reconditioned, they should be replaced.

4. Check spring for free length, compressed length, distortion, and collapsed coils. Replace spring if necessary.

Assembly (Fig. 11)

1. Position diaphragm assembly (3) in body (12).

2. Place spring (11) so it will be on the upper diaphragm follower.

3. Place cover (6) over diaphragm (3). Install cover retainer (4) over cover (6) and thread into body (12). Tighten retainer firmly.

4. Test switch as previously directed under "Serviceability Tests." If pressure setting requires adjustment, add or remove shims (13) under spring.

LOW AIR PRESSURE SWITCH (MIDLAND-ROSS)

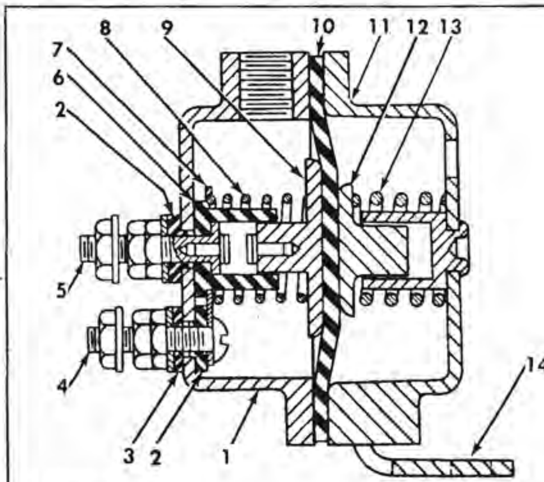
The low air pressure switch used on some coaches is designed to complete an electrical circuit when pressure in air system drops below 54 pounds. Completed circuit illuminates a tell-tale light on instrument panel. The switch shown in figure 12 is in normal (cut-out) position with 54 pounds of air or more in system. Pressure is depressing the diaphragm, keeping the contacts separated. When pressure drops, spring on non-pressure side of diaphragm will overcome spring force on pressure side and close contacts. Closed contacts complete circuit and illuminate tell-tale. Light will stay on until pressure builds up to approximately 54 pounds.

SERVICEABILITY TESTS

Operating Tests

1. With no air pressure in system, turn ignition switch "ON" and start engine. The low pressure tell-tale must remain on until pressure in air system rises above 54 pounds.

2. Continue to build up pressure in system to at least 60 psi; then stop engine. Slowly exhaust air from system. Note reading on air pressure gauge when tell-tale comes on. Tell-tale should light when pressure falls below 54 psi.



1 Body	8 Diaphragm Spring
2 Insulator	9 Contact Plunger Assembly
3 Insulator Washer	10 Diaphragm
4 Terminal Screw	11 Cover
5 Terminal Screw and Contact Assembly	12 Plunger
6 Insulator Base	13 Plunger Spring
7 Terminal Strap	14 Mounting Bracket

TP 5235

Figure 12—Low Air Pressure Switch (Midland-Ross)

LOW AIR PRESSURE SWITCH REPLACEMENT

Removal

1. Exhaust air from system.

2. Disconnect air line and electrical connections.

3. Remove mounting bolts and remove unit from vehicle.

Installation

1. Position switch to bracket and install mounting bolts.

2. Connect air line and electrical connections.

3. Build up air pressure in system and test unit as previously directed under "Serviceability Tests."

LOW AIR PRESSURE SWITCH OVERHAUL

Disassembly (Fig. 12)

1. Remove screws, nuts, and lock washers attaching cover to body. Separate cover and body; then remove diaphragm. Remove plunger and plunger return spring from cover.

2. Remove contact plunger assembly and diaphragm return spring from body.

3. Remove nut, washer, and insulator washer from each terminal screw. Push screws out of body and remove insulators and terminal strap from screws.

Inspection

A repair kit is available, containing all parts that should be replaced during overhaul. Replace old parts with new parts in kit. Inspect body, cover, springs, and plunger for corrosion. Make sure plunger slides freely in and out of guide cover.

Assembly (Fig. 12)

1. Assemble terminal screws, insulator bushing, insulators, and terminal strap in body with parts positioned as shown in figure 12.

2. Place diaphragm return spring over insulator base in body. Insert contact plunger into insulator base.

3. Place plunger return spring over plunger guide in cover, then insert plunger into guide.

4. Assemble cover and body with diaphragm carefully positioned between the two parts. Tighten screws alternately and evenly.

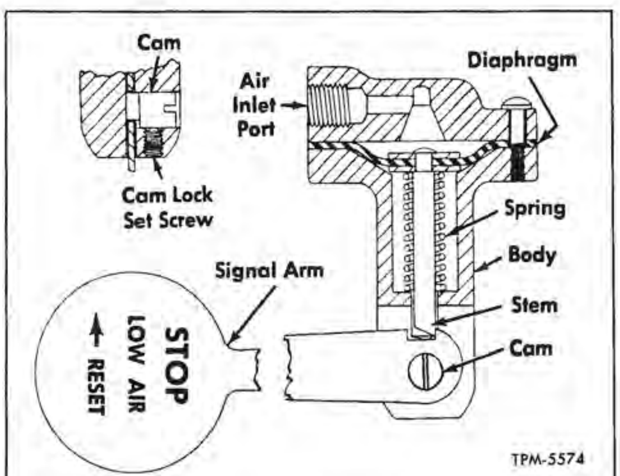


Figure 13—Low Air Pressure Signal

LOW AIR PRESSURE SIGNAL

The low air pressure signal shown in figure 13 is installed as special equipment on some vehicles. Unit is attached by bracket to windshield header directly in front of driver's seat. When air pressure falls below a safe operating level, signal arm swings down into driver's line of sight as a warning.

OPERATION (Fig. 13)

As the pressure above diaphragm decreases, spring raises diaphragm and stem assembly. Stem is lifted out of notch releasing arm, and arm swings down to a vertical position. Vertical signal arm indicates that air pressure is too low to safely operate air brakes.

Signal arm must be reset by hand after pressure builds up to operating range. As pressure increases above diaphragm, stem is forced downward against signal arm. When arm is moved clockwise to a horizontal position, stem will snap into a locking notch. Arm will lock in a horizontal position as long as operating air pressure is maintained.

SERVICEABILITY TESTS

1. Operating Test

Make a series of brake applications to reduce pressure in air system. As pressure reaches approximately 65 psi, signal arm should swing down to a vertical position. Build up pressure above 65 psi and reset signal arm. Arm should lock securely in place.

2. Leakage Test

Coat cover and lower part of signal body with soap suds. Replace diaphragm assembly if leaks at cover cannot be stopped by tightening cover screws. Leakage of air from body near signal arm also indicates leaky diaphragm. Replace diaphragm assembly.

LOW AIR PRESSURE SIGNAL OVERHAUL

Disassembly (Fig. 13)

1. Mark cover and body to aid in proper assembly. Remove six screws attaching cover to

body. Remove cover.

2. Lift diaphragm assembly out of body. Remove spring.

3. Mark position of cam slot on body. Remove set screw locking cam in body. Tap body lightly until cam drops out. Remove signal arm from body.

Inspection

Clean all parts thoroughly. Examine diaphragm for signs of cracks, wear, or damage. Replace diaphragm, if damaged, with a new part.

Assembly (Fig. 13)

1. Position signal body so that cam will be in front. Hold signal arm in a horizontal position with notch at right end and on top of arm. Place arm in body slot and align hole in arm with cam hole in body. Insert cam and align slot with mark on body. Install and tighten set screw.

2. Place spring in body. Rotate stem so that taper at bottom slants downward toward right. Install diaphragm and stem assembly. Align holes in diaphragm with holes in body.

3. Align mark on cover with mark on body and position cover on body. Install six screws and tighten firmly.

NOTE: Connect air line to signal inlet port. Apply air pressure. Reset signal as previously explained under "Operation." Bleed pressure down past 65 psi. If signal does not reset and release properly, loosen set screw and adjust cam as necessary. Tighten set screw.

AIR STRAINERS

Three air strainers are used in air lines (fig. 14). One is located at pressure regulator valve, one at brake interlock valve, and one at air suspension pressure regulator valve.

Strainers should be removed, disassembled, and cleaned yearly. Replace gaskets if necessary. Soak filter material in cleaning solvent. Dry the material and assemble strainers. Tighten bushings firmly.

PRESSURE REGULATING VALVE

Two identical pressure regulating valves (fig. 15) are used, one in the windshield wiper control and door control feed line, the other in the suspension air tank feed line. Windshield wiper pressure regulating valve is mounted at left of driver by the door control valve. Suspension air tank pressure regulating valve is mounted under vehicle between dry air tank and suspension air tank.

Each pressure regulating valve serves two purposes in the air system. One purpose is to prevent air from entering the windshield wiper lines or the suspension air tank until pressure in the main air brake system reaches 65 psi. This provides a rapid build-up of pressure in main air system for operation of brakes. When pressure in main air system reaches 65 psi, pressure regulating valves admit compressed air into the windshield wiper lines and into suspension air tank. The second purpose of pressure regulating valves is to prevent a pressure drop in main air system below 65 psi by operating windshield wipers, or by leakage in wiper lines or air suspension system.

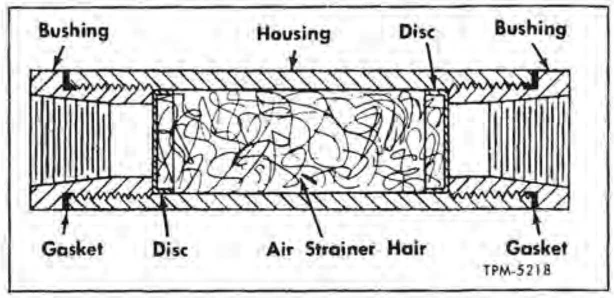


Figure 14—Air Strainer

SERVICEABILITY TESTS

Test each pressure regulating valve as follows:

1. Operating Test

Exhaust air pressure from air system. Connect a test air gauge in main air system, preferably in the supply line to the pressure regulating valve being tested. Disconnect air line from outlet port at bottom of valve. Build up air pressure in system and note reading on test air gauge when valve permits air pressure to exhaust to atmosphere. If pressure varies more than 5 psi from the original setting (65 psi), the valve requires adjustment.

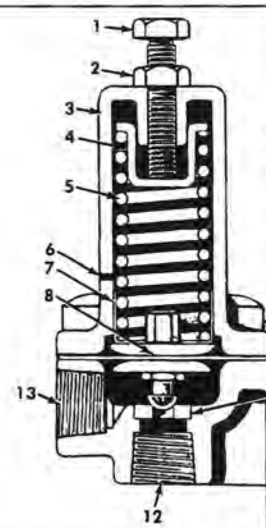


Figure 15—Pressure Regulating Valve

2. Leakage Test

With air line disconnected from outlet port at bottom of valve and with pressure in main air system just below the valve setting (65 psi), coat the outlet port with soap suds to check for leakage. If leakage is evident, it may be caused by dirt on valve seat or by a worn valve.

ADJUSTING SET PRESSURE

Key numbers in text refer to figure 15.

Pressure at which the valve is unseated is controlled by the adjusting screw (1). Setting may be increased or decreased by turning screw.

1. Connect air pressure gauge as in "Operating Test" above.

2. Back off lock nut (2); then turn adjusting screw (1) clockwise to increase pressure, or counterclockwise to decrease pressure.

3. Tighten lock nut (2) when proper adjustment is obtained.

PRESSURE REGULATING VALVE REPLACEMENT

Removal

1. Exhaust air pressure from air system and disconnect air lines from valve.

2. Remove mounting bolts and remove unit from vehicle.

Installation

1. Position valve assembly on vehicle and attach with two mounting bolts.

2. Connect air lines to valve.

3. Build up air pressure in system and test valve as previously directed in "Serviceability Tests."

PRESSURE REGULATING VALVE OVERHAUL

Key numbers in text refer to figure 15.

Disassembly

1. Remove four screws (9) attaching cover (3) to body (11) and remove cover.

2. Remove spring (5), spring seat (4), and dampener (7) from cover.

3. Lift diaphragm and valve assembly (8) off body.

Inspection

1. Clean all parts thoroughly, using a suitable cleaning solvent.

2. Examine diaphragm for cracks or wear. If either the valve or diaphragm are worn or damaged, a new diaphragm and valve assembly should be installed.

3. Inspect valve seat in body. If seat is pitted, scratched, or chipped, it should be replaced.

4. Check valve spring for free length, compressed length, distortion, or collapsed coils.

Assembly

1. Place diaphragm and valve assembly (8) on body, with valve seated in valve seat in body.

2. Install spring seat (4), spring (5), and dampener (7), in cover (3) and position cover on body (11).

3. Install four screws (9) through cover and diaphragm into body and tighten firmly.

4. Connect air supply line, with gauge, to valve inlet port, and adjust valve as previously directed under "Adjusting Set Pressure."

BRAKE APPLICATION VALVE (BENDIX-WESTINGHOUSE TYPE E-1)

Brake application valve (fig. 16) is a treadle type brake valve mounted underneath the toeboard at the left side of coach. Brake treadle and roller assembly is mounted on top of toeboard.

OPERATION

1. Application

Foot pressure on brake treadle compresses graduating spring and forces piston down. This brings exhaust valve seat at lower end of piston to upper face of inlet-exhaust valve, closing exhaust passage. Continued downward movement of piston forces inlet valve off inlet valve seat. Air pressure from air tank then flows through inlet valve and outlet ports to brake chambers, applying service brakes.

2. Holding

The compensating passage in body permits air pressure being delivered to brakes to enter cavity below piston. When air pressure below piston balances treadle pressure, piston lifts far enough to close inlet valve, cutting off further supply of air pressure to brake chambers. The exhaust valve remains closed preventing any escape of air pressure through exhaust port. Increased pressure on brake treadle forces piston down and causes a graduated increase of air pressure at brake chambers.

3. Partial Release

As pressure on brake treadle is reduced, spring and foot pressure above piston becomes less than air and spring pressure below piston, causing piston to move upward. As piston moves up, inlet valve closes and exhaust valve opens permitting air pressure below piston to escape through hollow center of piston and out exhaust port until pressure on each side of piston again balances.

4. Release

As foot pressure on brake treadle is removed, the exhaust valve opens and remains open, exhausting all air pressure from brake chambers

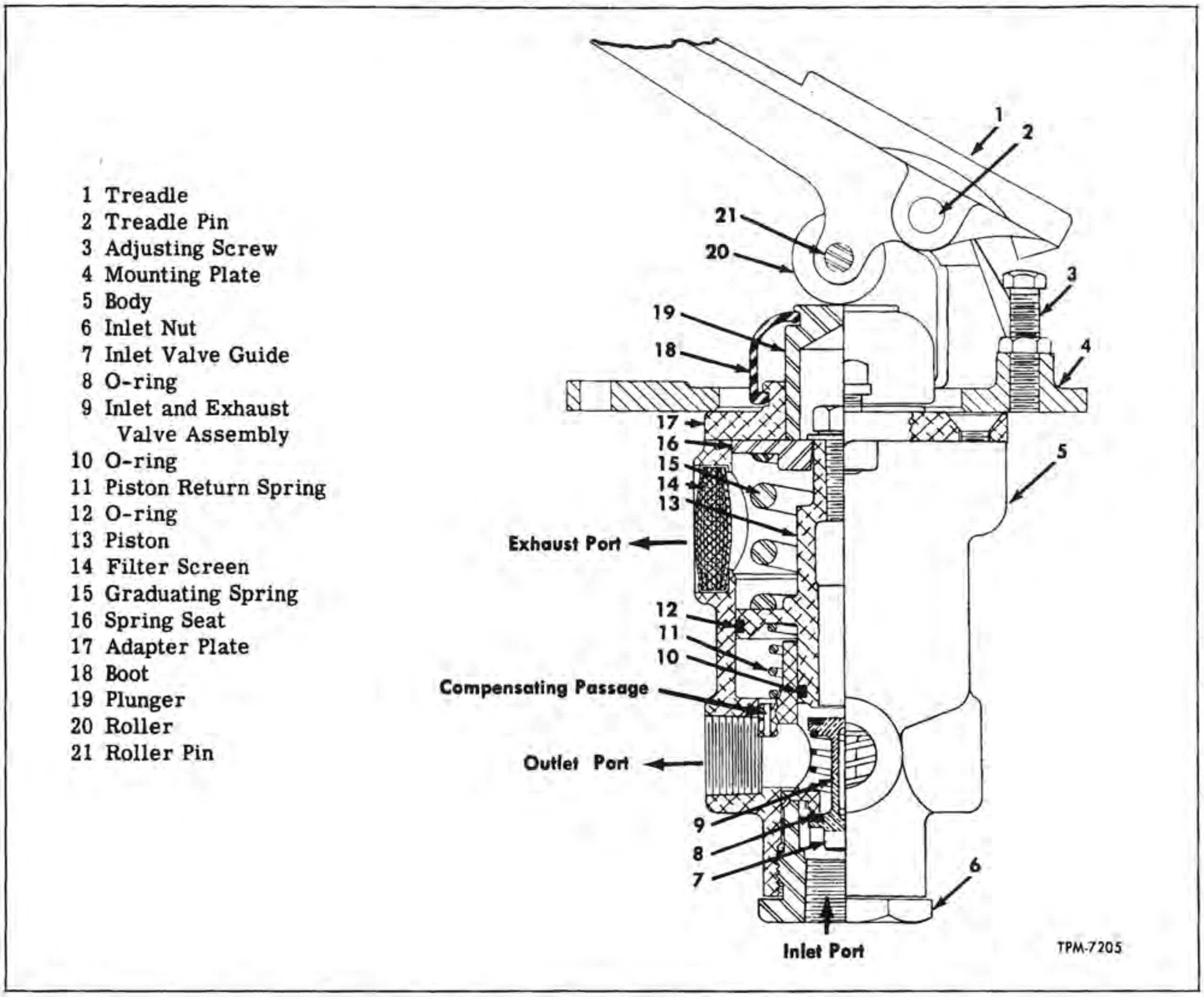


Figure 16—Brake Application Valve (Bendix-Westinghouse—Type E-1)

through exhaust port and fully releasing service brakes.

APPLICATION VALVE SERVICEABILITY TESTS

1. Operating Tests

Check delivery pressure of the valve, using an accurate test gauge connected into one of the air lines leading to the brake chambers. With brake treadle fully depressed, test gauge should show the same pressure as registered on dash air gauge (within 5 pounds).

Depress brake treadle to several positions between fully released and fully applied and note that pressure registered by the test gauge varies in accordance with degree brake treadle is depressed.

2. Leakage Tests

a. With brake treadle fully released, coat exhaust port with soap suds to check for leakage. Leakage in excess of a 1-inch bubble in 1 second is not permissible. Leakage evidenced by this test is probably caused by worn or deteriorated inlet valve seat, preventing the piston from returning to fully released position.

b. With treadle fully depressed, coat exhaust port with soap suds to check for leakage. Leakage in excess of a 1-inch bubble in 1 second is not permissible. Leakage evidenced by this test may be due to a leaking exhaust valve or leaking piston O-ring seals.

APPLICATION VALVE REPLACEMENT

Removal

1. Exhaust air pressure from system.
2. Disconnect air lines at brake valve.
3. Remove three bolts, nuts, and washers attaching brake treadle mounting plate to floor. Remove valve assembly.

Installation

1. Place application valve assembly in position below floor. Attach to mounting plate with three bolts, nuts, and washers. Tighten securely.

2. Connect inlet line at bottom of valve. Connect outlet lines at side ports. Keep first two threads on air line fittings free from sealing compound. Tighten connections firmly. Replace pipe plugs in remaining ports.

3. Build up air pressure in system and test application valve as previously directed under "Serviceability Tests."

APPLICATION VALVE OVERHAUL

Key numbers in text refer to figure 16.

Disassembly

1. Clean all dirt from outside of valve.

2. Remove two cap screws and lock washers attaching mounting plate (4) to adapter plate (17). Separate treadle and valve.

3. Remove cotter pin, tap out treadle pin (2), and remove treadle (1) from mounting plate. Remove roller (20) by removing cotter pin and by tapping out roller pin with pin punch and small hammer. Remove roller. Both treadle pin and roller pin are held in place by cotter pins. Remove adjusting screw (3) and lock nut.

4. Remove boot (18) and plunger (19) from adapter plate (17). Remove three screws attaching adapter plate to body (5). Lift off adapter plate.

5. Lift piston and spring assembly from body. Remove O-rings (10 and 12) from piston and discard. Remove cap screw, lock washer, and flat washer from end of piston (13). Remove spring seat (16) and graduating spring (15) from piston.

6. Remove piston return spring (11) from body.

7. Remove inlet nut (6) and O-ring (8) from body. Discard O-ring. Remove inlet valve guide (7) and inlet and exhaust valve assembly (9) from body.

8. Remove self-tapping screw from body and take out filter screen (14). Remove pipe plugs.

Inspection

Replace the following parts with new parts when overhauling application valve: Boot, O-rings, and inlet and exhaust valve assembly. Wash all other parts in cleaning solvent, dry thoroughly, and inspect as follows:

1. Treadle, Roller, and Pins. Check fit of treadle pin in treadle and mounting plate. Pin must be a neat, free fit. If mounting plate holes are worn excessively, the plate should be replaced. Check fit of roller on roller pin. There should be a free rolling fit between roller and pin. Replace badly worn or damaged parts with new parts.

2. Adapter and Plunger. Inspect adapter plate for cracks or signs of damage. Check fit of plunger in adapter plate. Replace parts if necessary.

3. Piston. Inspect exhaust seat of piston. Remove slightly worn spots by lapping on a piece of crocus cloth on a flat surface. Inspect outside surfaces of piston which contact bores in body of valve for scratches, nicks, or out-of-round condition. Replace piston if badly worn or damaged.

4. Piston Return Spring, Graduating Spring, and Seat. Inspect piston return spring, graduating spring, and spring seat. Damaged or broken spring or seat should be replaced with new part.

5. Inlet and Exhaust Valve Assembly. Inspect seating surface of inlet and exhaust valve for roughness or signs of wear that might cause leakage. Replace assembly if badly worn or damaged.

6. Body. Inspect bores of body for scratches, scores, or excessive wear. Remove any obstruction from compensating passage. Replace body if necessary.

Assembly (Fig. 16)

1. Install cleaned or new filter screen (14) in exhaust port of valve body (5). Install self-tapping screw to lock filter screen in place.

2. Place graduating spring (15) and spring seat (16) over piston. Install flat washer, lock washer, and cap screw at top of piston. Tighten cap screw firmly against spring retainer. Install new O-rings (10 and 12) on piston (13). Coat O-rings, piston, and piston bore with special lubricant (S-17). Refer to LUBRICATION (SEC. 13) of this manual for description of special lubricant (S-17). Install return spring (11) and piston assembly in body.

3. Install adapter plate (17) on body. Secure in place with three screws.

4. Install plunger (19) and boot (18) in adapter plate.

5. Install inlet and exhaust valve assembly (9) after positioning inlet valve guide (7) on the inlet valve seat. Place new O-ring (8) under inlet valve seat and install inlet nut (6).

6. Place roller (20) in position in treadle (1) and tap roller pin (21) in place. Install new cotter pin. Install adjusting screw (3) and lock nut on mounting plate.

7. Place treadle assembly in position on mounting plate and tap treadle pin (2) in place. Install new cotter pin.

8. Place treadle mounting plate on valve adapter plate, and attach with two cap screws and two lock washers.

BRAKE APPLICATION VALVE (BENDIX-WESTINGHOUSE TYPE E-2)

DESCRIPTION

The brake application valve used as optional equipment on some coaches, is mounted below

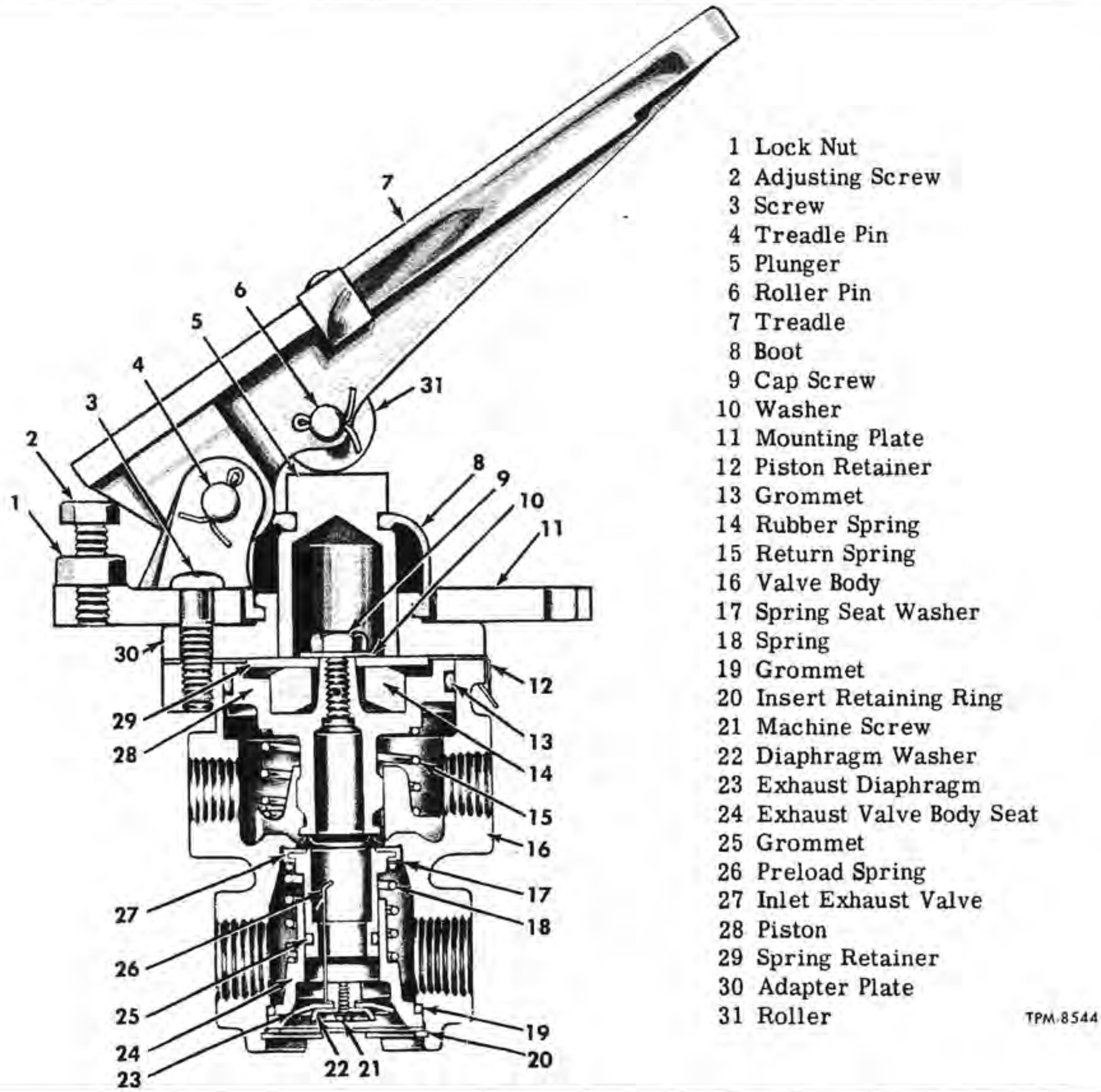


Figure 17—Brake Application Valve (Bendix-Westinghouse—Type E-2)

coach floor in an upright position (fig. 17). Valve is attached to a mounting plate which is bolted to coach floor. The brake treadle is also mounted on the mounting plate and treadle roller contacts valve plunger. Movement of the treadle controls movement of an inlet valve and exhaust valve which in turn control air pressure being delivered to or released from the brake chambers. To fully apply brakes, the treadle must be fully depressed, whereas, when treadle is only partially depressed, correspondingly less braking force is developed. In other words, the farther driver depresses treadle, the greater air pressure delivered to the brake chambers and the more effective brake application. Brake valve is set up to graduate between 5 and 75 psi. First three degrees of brake treadle travel permits valve to deliver 5 psi, and the next 17 degrees of travel is the graduating range (5 to 75 psi). With any treadle movement beyond the first 20 degrees of travel, valve will deliver full reservoir pressure.

OPERATION (Fig. 17)

Application

When the brake treadle is depressed, force is exerted on the plunger, rubber graduating spring, and piston. The piston moves down and its stem, which is the exhaust seat, closes exhaust. As exhaust closes, the inlet valve moves off its seat. Air pressure from the reservoir then flows past the inlet valve and out delivery ports, applying the brakes.

Holding

When air pressure in cavity below the piston and air pressure being delivered to the brakes equals mechanical force on top of the piston, the piston lifts and inlet valve closes, cutting off any further flow of air from supply line through the valve. The exhaust remains closed preventing any escape of air through exhaust port. When the piston is pressed down all the way, the inlet port remains open and full reservoir pressure is delivered to the brakes.

Release

When treadle application is released and mechanical force is removed from top of piston, air pressure beneath the piston is then greater and the piston lifts, opening the exhaust in the valve. Air below piston and in the delivery lines is then exhausted through the exhaust port.

PREVENTIVE MAINTENANCE

After Each 5,000 Miles

1. Lubricate treadle roller and roller pin. Also hinge pin on treadle. Use engine oil for lubrication.

2. Lift boot away from plunger or mounting plate and put a few drops of light engine oil between plunger and mounting plate. Be careful not to get oil on rubber spring when applying to plunger. Oil will cause deterioration of the rubber spring.

After Each 50,000 Miles

It is recommended that inlet and exhaust valve, exhaust diaphragm, grommets, and rubber graduating spring be replaced if they show signs of wear or deterioration.

After 100,000 Miles

Disassemble brake application valve, clean and inspect all parts. Install new parts where parts are found to be worn or damaged.

BRAKE APPLICATION VALVE SERVICEABILITY TESTS

1. Operating Tests

Check delivery pressure of the brake valve using an accurate test gauge connected into one of the air lines leading to brake chambers. Depress brake treadle to several positions between fully released and fully applied positions, and check delivered pressure on test gauge to see that it varies proportionately with movement of the treadle. When treadle is fully applied, reading on test gauge should be approximately that of full reservoir pressure. The reading on the test gauge should fall off to zero when application is released.

2. Leakage Tests

a. With the valve fully released, check exhaust port for leakage. No leakage is permissible.

b. Make and hold a high pressure application. Coat exhaust port and top of valve with soap suds. No leakage is permissible.

c. Leakage evidenced by these tests may be due to a worn or deteriorated exhaust valve or leaking piston seals.

BRAKE APPLICATION VALVE REPLACEMENT

NOTE: The brake application valve can be removed from coach separately or with the brake treadle.

Removal

1. Block or hold vehicle by means other than air brakes.

2. Open drain cocks and exhaust air pressure from the air brake system.

3. Disconnect air lines from the brake application valve.

4. Remove two bolts and lock washers attaching application valve adapter plate to treadle mounting plate. Remove application valve. If valve and treadle are to be removed as an assembly, remove three screws attaching treadle mounting plate to coach floor. Remove valve and treadle.

Installation

1. If application valve was removed from brake treadle mounting plate, attach valve to mounting plate with two bolts and lock washers. If valve and brake treadle were removed from coach as an assembly, position the assembly on coach floor and install three attaching screws.

2. Connect air lines to valve ports. When installing connector fittings in valve, use sealing compound on fitting threads. KEEP SEALING COMPOUND OFF FIRST TWO THREADS OF FITTINGS. Tighten connections firmly. If removed, replace pipe plugs in remaining ports.

3. Build up air pressure in system and test application valve as previously directed under "Serviceability Tests."

APPLICATION VALVE OVERHAUL

NOTE: Inlet and exhaust valve components can be serviced without removing valve assembly from vehicle (steps 6 through 9 following).

Disassembly

Key numbers in text refer to figure 17.

1. If brake valve and treadle were removed from coach as an assembly, remove two bolts and lock washers attaching valve adapter plate to treadle mounting plate. Remove valve assembly.

2. Remove all dirt from outside of valve assembly.

3. Remove three screws attaching adapter plate (30) to valve body (16). Remove adapter plate

(30), boot (8), and plunger (5). Separate these parts.

4. Depress piston assembly and hold down while removing piston retainer (12).

5. Remove piston assembly and return spring (15) from valve body. Remove grommet (13) from piston (28).

NOTE: Piston (28), rubber spring (14), spring retainer (29), and cap screw (9) are serviced only as an assembly.

6. Depress and hold prongs of the inlet and exhaust valve assembly retaining ring with pliers, and remove retaining ring (20). Remove inlet and exhaust valve assembly (27).

7. Remove inlet-exhaust valve body grommet (19). Remove machine screw (21), diaphragm washer (22), and diaphragm (23) from inlet-exhaust valve body seat (24).

8. Depress and hold inlet-exhaust valve (27), and remove preload spring (26).

9. Slide inlet-exhaust valve (27) out of inlet-exhaust valve body seat (24). Remove spring (18), spring seat washer (17), and grommet (25) from inlet-exhaust valve.

10. Remove cotter pin; then using hammer and small punch, tap out brake treadle attaching pin (4). Remove treadle from mounting plate.

11. Remove roller by removing cotter pin and tapping roller pin (6) out with hammer and small punch. Remove roller.

Cleaning and Inspection

Wash all metal parts in cleaning solvent and dry thoroughly. Discard all grommets and exhaust diaphragm. Obtain new parts for reassembly of application valve.

1. Treadle Assembly. Check fit of treadle pin in treadle and mounting plate. Pin must be a neat, free fit. Inspect treadle roller for fit on roller pin, also for flat spots. Roller must be a free rolling fit on pin. If excessive wear or flat spots are found, the pin or roller, or both must be replaced.

2. Plunger and Adapter Plate. Check fit of plunger in adapter plate. Replace plunger if necessary. Check adapter plate for cracks or other damage. Replace if necessary.

3. Piston Assembly. Inspect exhaust seat at bottom of piston stem. Remove slightly worn spots by lapping on a piece of crocus cloth on a flat surface. Inspect outside surfaces of piston which contact bores in valve body for scratches, nicks, or out-of-round condition. Replace piston assembly if badly worn or damaged.

4. Springs. Inspect piston return spring and inlet-exhaust valve spring for evidence of corrosion which would weaken the spring. Check springs for free length, compressed length, distortion or collapsed coils. Replace if necessary.

5. Valve Body. Inspect the body for scores and excessive wear where piston grommets make contact with body. If excessive wear or grooves are found, the body should be replaced. Inspect small bleed hole leading to brake chamber port in body to be sure it is open and not obstructed. Inspect inlet valve seat for roughness or corrosion. If damage is evident, replace body.

6. Inlet-Exhaust Valve Assembly. Inspect rubber seal at top of inlet-exhaust valve. Examine outside diameter of valve and inside diameter of valve body for excessive wear or scoring. Inlet valve must slide freely in valve body. If any damage is evident on either part, replace with new part.

Assembly

Key numbers in text refer to figure 17.

1. Prior to assembly, apply a light coat of special lubricant (S-17) to the piston, valve bores, and grommets. Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17).

2. Mount body (16) in a vise with large opening facing up. Use radius blocks or soft jaws to prevent crushing or marring of body.

3. Install piston grommet (13) on piston. Place piston return spring (15) in valve body. Install piston assembly in valve body. Take precautions not to damage piston grommet during installation.

4. Install piston retainer (12). Be sure prongs snap over groove in valve body.

5. Position inlet valve preload spring (26), exhaust diaphragm (23), and diaphragm washer (22) (lips pointing out) in inlet-exhaust valve body, and attach with machine screw and lock washer assembly (21). Tighten screw to 15-25 inch-pounds.

6. Install grommet (25) and position spring seat washer (17) on inlet-exhaust valve (27).

7. Position valve spring (18) on spring seat of inlet-exhaust valve body (24). Install inlet-exhaust valve into the valve body, by depressing the spring until the preload spring snaps onto the counterbore ledge of the inlet-exhaust valve.

8. Install large grommet (19) on inlet-exhaust valve body seat.

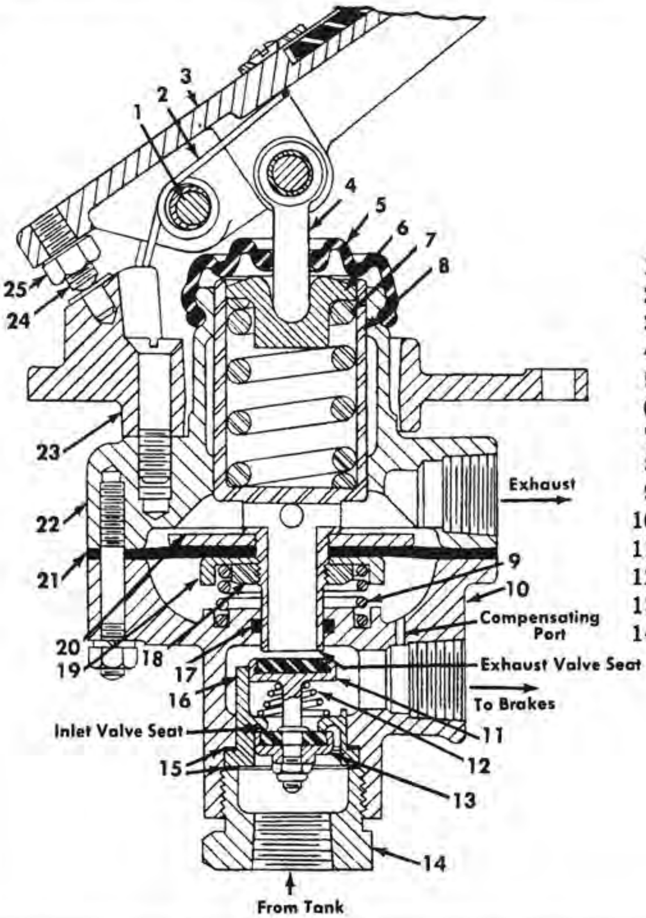
9. Place inlet and exhaust valve assembly into valve body, and press in to install retaining ring (20). Make sure retaining ring snaps into body grooves, locking in the valve assembly.

10. Attach the adapter plate (30) to valve body with three cap screws (3) and lock washers.

11. Replace plunger (5) inside adapter plate, and place rubber boot (8) around plunger.

12. Place roller (31) in position in treadle (7), and tap roller pin (6) in place. Install new cotter pin.

13. Position treadle (7) on mounting plate, install treadle pin (4) and attach with new cotter pin.



1 Treadle Pin	15 Gaskets
2 Treadle Spring	16 Valve Cage
3 Treadle	17 O-ring
4 Push Rod	18 Diaphragm Nut
5 Boot	19 Diaphragm Nut Washer
6 Push Rod Cup	20 Diaphragm Plate
7 Piston Spring	21 Diaphragm
8 Piston	22 Valve Cover
9 Diaphragm Spring	23 Mounting Plate
10 Body	24 Treadle Adjusting Screw
11 Exhaust Valve	25 Screw Lock Nut
12 Valve Cage Spring	
13 Inlet Valve	
14 End Cap	

TPM-7197

Figure 18—Brake Application Valve (Midland-Ross)

BRAKE APPLICATION VALVE (MIDLAND-ROSS)

This brake application valve used as optional equipment on some coaches, is a treadle operated compensating type valve mounted underneath driver's floorboard. Brake treadle is bolted on top of floorboard. The treadle push rod transfers movement of treadle to push rod cup.

OPERATION (Fig. 18)

1. Application

As brake treadle is pushed down, pressure is applied through push rod, push rod cup, and pressure regulating spring to piston and diaphragm. As piston and diaphragm move downward, the exhaust valve seat at bottom of the piston contacts exhaust valve seat. Continued downward movement of the piston and diaphragm pushes inlet valve off its seat. Air pressure from tank flows through the inlet valve and out ports to front and rear brakes.

The treadle stop screw on toeboard stops the treadle just below point at which full air pressure in system is delivered to brakes. Fully depressing the treadle without this stop could damage internal parts of the valve assembly.

2. Holding

The compensating passage in body permits air being delivered to brakes to enter cavity below diaphragm. When air pressure below the diaphragm balances treadle pressure, diaphragm lifts far enough to close inlet valve, but not far enough to open exhaust valve. No more air is admitted to brakes, and no air can exhaust from brakes. When treadle is pressed down further pushing down diaphragm, an equal amount of additional air pressure will be applied to brakes.

3. Partial Release

When brake treadle is partly released, air pressure lifts diaphragm, closing inlet valve and opening exhaust valve. Brake air escapes through hollow piston and through exhaust port. Compressed air from brakes will continue to exhaust until brake pressure balances with treadle pressure.

4. Release

When brake treadle is released, the diaphragm lifts and exhaust valve opens. Brake air escapes, releasing brakes.

APPLICATION VALVE SERVICEABILITY TESTS

1. Operating Tests

a. Check delivery pressure of the valve with an accurate test gauge. Disconnect flexible line from a front brake chamber. Connect test gauge to this flexible line. With the treadle pushed down against treadle stop screw, gauge reading should indicate full air system pressure. The stop screw should be adjusted to stop treadle just below full pressure point.

b. Push brake treadle to several test positions. Check gauge and make sure that brake pressure and treadle pressure follow closely.

2. Leakage Tests

a. With treadle fully released, coat exhaust port with soap suds and check for leakage. Bubbles are probably caused by a worn or deteriorated inlet valve seat. Binding or corrosion between piston and upper body can also prevent piston from returning to fully released position.

b. With treadle pressed down, coat exhaust port with soap suds and check for leakage. Leakage here may be caused by a worn or deteriorated exhaust valve seat or by a leaking diaphragm.

APPLICATION VALVE REPLACEMENT

Removal

Exhaust air from system and disconnect air lines from valve. Remove treadle hinge pin and remove treadle and spring. Remove mounting screws at top side of floorboard. Remove valve from under vehicle.

Installation

Position valve under the toeboard and install mounting screws. Position treadle spring and treadle and install treadle hinge pin. Adjust screws at base of treadle to remove all clearance between treadle push rod and push rod cup (fig. 18). Connect air lines; then start engine and build up air pressure in system. Test valve as previously described under "Serviceability Tests."

APPLICATION VALVE OVERHAUL

Key numbers in text refer to figure 18.

Disassembly

1. Clean all dirt from valve body before disassembling. Mark upper (22) and lower body (10) for proper assembly later.

2. Remove rubber boot (5) from upper body (22). Lift push rod cup (6) and piston spring (7) out of upper body.

3. Remove three nuts and three cap screws holding upper body to lower body. Separate bodies. Remove diaphragm (21) and piston (8) assembly from upper body. Remove diaphragm spring (9) from lower body (10).

4. Unscrew lower body end cap (14). Remove valve cage (16) and inlet (13) and exhaust valve (11) assembly. Remove and discard O-ring (17).

5. Hold exhaust valve (11) with pliers and remove lock nut attaching inlet valve (13) to exhaust valve stem (11). Remove inlet valve (13). Remove exhaust valve (11) and valve spring (12) from valve cage (16).

6. To disassemble the diaphragm (21) and piston (8), mount piston in vise. Use radius blocks or soft jaws to keep from crushing piston or marring piston surface. Remove diaphragm nut (18), diaphragm nut washer (19), diaphragm (21), and diaphragm plate (20) from piston (8).

Inspection

A repair kit is available which contains all parts ordinarily needing replacement at overhaul of the application valve. Install these new parts whenever valve is disassembled. The following parts are contained in the kit: Intake and exhaust valve assembly, diaphragm, boot, gaskets, and O-ring. Discard old parts to be replaced. Inspect remaining parts as follows:

1. Thoroughly wash parts in a suitable cleaning solvent.

2. Inspect small and large radii of piston for nicks or corrosion. Inspect inside bore of upper body for scoring or corrosion. Corrosion or slight scratches may be removed with fine steel wool.

3. Examine inside surface of valve cage contacted by inlet and exhaust valves. Corroded surface could restrict movement of valves.

Assembly

1. Insert new O-ring (17) in piston bore of lower body.

2. Mount piston (8) in vise, small end up. Use radius blocks or soft jaws to prevent crushing or marring of piston. Install diaphragm plate (20) (bevelled edge to diaphragm), and diaphragm (21). Install diaphragm nut washer (19) with cup away from diaphragm (21). Coat piston threads with shellac and install diaphragm nut (18). Tighten nut firmly and stake in three places.

3. Place valve spring (12) over exhaust valve stem, small end next to valve. Insert exhaust valve stem (11) through valve cage (16). Install inlet valve (13) on valve stem with rubber seal next to seat. Hold exhaust valve (11) with pliers and install lock nut. Tighten nut firmly.

4. Install valve assembly in lower body (10). Use new gasket on both sides of valve cage flange (16). Install end cap (14).

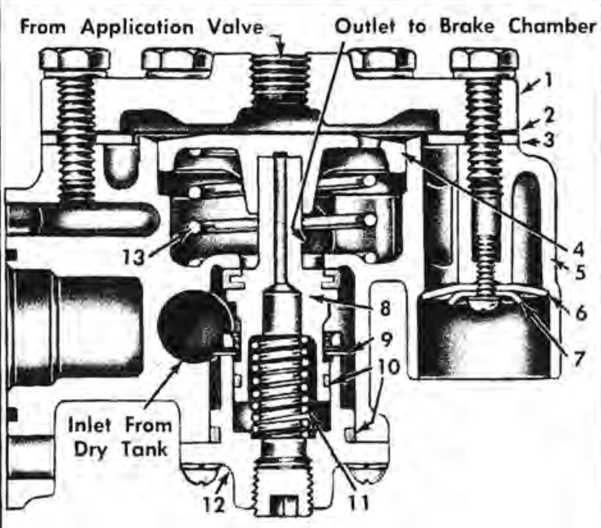
5. Coat piston with special lubricant (S-17), and insert in upper body. Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17). Mount upper body (22) in vise, diaphragm (21) up. Align holes in diaphragm (21) with holes in body (10). Place diaphragm spring (9) in diaphragm nut washer. Install lower body (10), using marks made earlier. Make sure piston enters O-ring seal in body and that diaphragm spring (9) enters recess in body. Install three nuts and lock washers and three cap screws to hold bodies together. Tighten firmly.

6. Insert piston spring (7) in top of upper body (22). Install push rod cup (6) on top of spring; then install rubber boot (5).

REAR BRAKE RELAY VALVE (BENDIX-WESTINGHOUSE)

Key numbers in text refer to figure 19.

Relay valve is mounted on bulkhead above rear axle. Rear brake application and release is made through the relay valve. The supply line from air tank connects to a cavity in lower part of the valve, providing a source of high pressure air close to rear brake chambers at all times. The relay valve and brake application valve are interconnected by a smaller air line which delivers air pressure to top of the relay valve diaphragm to actuate the valve. In addition to providing more rapid application of rear brakes, relay valve also fulfills the function of a quick release valve, permitting rapid release of air pressure from rear brake chambers.



1 Valve Cover
2 Valve Diaphragm
3 Diaphragm Ring
4 Diaphragm Guide
5 Body
6 Exhaust Diaphragm
7 Diaphragm Washer
8 Inlet Valve
9 Retaining Ring
10 O-ring
11 Valve Spring
12 Guide Cap
13 Spring

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Figure 19—Rear Brake Relay Valve (Bendix-Westinghouse)

RELAY VALVE OPERATION (Fig. 19)

Operation of the relay valve is controlled by air pressure delivered to it by the brake application valve. Air pressure from brake application valve enters a cavity above the rubberized diaphragm. Since this cavity is comparatively small and therefore subject to quick changes in air pressure, action of the valve in changing its delivered pressures is very rapid.

1. Applying

As compressed air from the application valve enters cavity at top, air pressure pushes down diaphragm sealing off exhaust cavity. Further movement of diaphragm center forces down diaphragm guide and inlet valve. As inlet valve is forced off seat, air from (dry) air tank flows through valve into cavity below diaphragm and on out to brake chambers.

2. Holding

As soon as air pressure above the diaphragm stops increasing, pressure below the diaphragm balances by means of the by-pass port in valve cover. This balance of pressures on each side of diaphragm removes pressure from diaphragm guide and inlet valve. Valve spring then closes inlet valve. Air pressure above the diaphragm maintains seal between outer edge of diaphragm and rim of exhaust cavity. The valve is now in holding position. Brake chamber pressure is the same as application valve pressure. An increase in pressure at application valve will immediately result in the same pressure increase in brake chambers.

3. Releasing

When the application valve pressure above diaphragm is reduced, brake chamber pressure (below diaphragm) forces diaphragm upward. As diaphragm uncovers rim of exhaust cavity, air is exhausted until pressures again balance. If all pressure is removed from application valve treadle, the relay valve will release all air from brake chambers fully releasing brakes.

RELAY VALVE SERVICEABILITY TESTS

1. Operating Test

With air brake system fully charged, apply brakes and make sure rear wheel brakes apply promptly. Release brakes and make sure air pressure is quickly exhausted from exhaust port of the relay valve.

2. Leakage Tests

a. With brakes released, cover exhaust port with soap suds. Leakage in excess of 1-inch bubble in one second is not permissible. Leakage is caused by inlet valve not seating properly.

b. With brakes applied, cover exhaust port with soap suds. Leakage in excess of a 1-inch bubble in one second is not permissible. Leakage is caused by defective diaphragm or seat.

c. If leakage is caused by diaphragm, both diaphragm and diaphragm seat should be wiped clean with gasoline. If leakage is caused by inlet valve, valve and seat must be cleaned, or replaced with new parts.

RELAY VALVE REPLACEMENT

Removal

1. Exhaust air pressure from system.
2. Disconnect air lines from valve.
3. Remove stop light wires.
4. Remove mounting bolts; then remove valve assembly from vehicle.
5. Remove stop light switch and tee fitting from top of valve.

Installation

1. Install tee fitting and stop light switch on top of valve.
2. Mount valve on frame and tighten mounting bolts firmly.
3. Connect air lines to valve, and wires to stop light switch.
4. Build up air pressure in system; then test valve as previously directed under "Serviceability Tests."

RELAY VALVE OVERHAUL

Disassembly (Fig. 19)

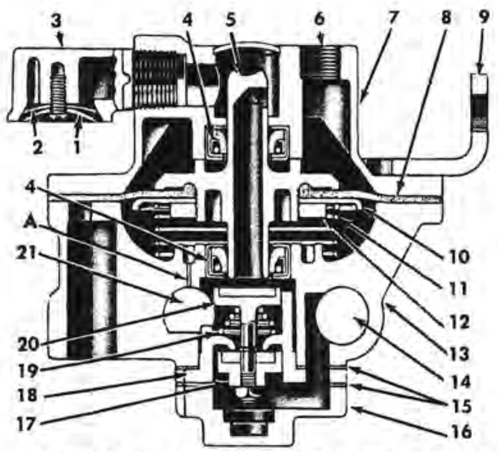
1. Mark valve cover (1), diaphragm ring (3), and valve body (5), so parts can be reassembled in same position.
2. Remove six cap screws and lock washers attaching valve cover (1) to valve body (5).
3. Remove cover (1), diaphragm (2), diaphragm ring (3), diaphragm guide spring (13), and diaphragm guide (4) from valve body (5).
4. Remove four screws and lock washers attaching guide cap (12) to bottom of valve body (5).
5. Remove valve cap (12) and inlet valve assembly (8).
6. Remove retaining ring (9) and separate inlet valve, valve spring (11), and guide cap (12). Remove and discard O-rings (10).
7. Remove screw and lock washer holding exhaust diaphragm (6) in place. Remove diaphragm washer (7) and exhaust diaphragm (6).

Inspection

1. Thoroughly clean all parts in a suitable cleaning solvent.
2. Examine diaphragms for cracking, stretching, or deterioration. Replace if not in good condition.
3. Inspect diaphragm seat at top of valve body. Seat must be smooth and free from scratches or corrosion. If only slightly scratched or corroded, seat may be repaired by lapping on a flat surface covered with fine aluminum oxide abrasive cloth.
4. Examine inlet valve and inlet valve seat. Rubber seating surface on inlet valve is bonded in place. If valve or seat are scratched or worn, replace with new parts.
5. Inspect springs for free length, compressed length, distortion, or collapsed coils.
6. Diaphragm guide bore in valve body, and inlet valve bore in guide cap should be smooth. If damaged, replace parts.

Relay Valve Assembly (Fig. 19)

1. Place new O-ring (10) on guide cap (12) and on inlet valve (8).
2. Apply a thin coat of special lubricant (S-17) inside guide cap, and on body bores in contact with cap and with diaphragm guide (4). Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17).
3. Insert spring (11) and O-ring end of inlet valve (8) in guide cap (12) bore. Force inlet valve down into guide cap.
4. Place retaining ring (9) in cap groove and snap around narrow neck of inlet valve (8).
5. Insert inlet valve and cap assembly through bottom of relay valve body (5).
6. Attach cap to body with four screws and lock washers. Tighten firmly.
7. Position diaphragm guide spring (13) in valve body; then place diaphragm guide (4) over stem of inlet valve (8).
8. Position diaphragm ring (3), on body (5) aligning match marks previously installed.
9. Place diaphragm (2) on ring (3) and align by-pass holes.
10. Install cover (1) aligning match marks. Parts should be aligned now, without obstructing by-pass port.
11. Install six cap screws and lock washers and tighten firmly and evenly.
12. Insert exhaust diaphragm (6) and diaphragm washer (7) (cupped side away from diaphragm) in exhaust port. Install screw and lock washer and tighten firmly.



1 Check Valve Guard
2 Exhaust Check Valve
3 Check Valve Body
4 Plunger Seals
5 Plunger
6 Actuating Air Line Port
7 Upper Body
8 Diaphragm
9 Mounting Bracket
10 Diaphragm Plate
11 Diaphragm Spring
12 Diaphragm Nut
13 Lower Body
14 Air Supply Cavity
15 Gaskets
16 Inlet Valve Cover
17 Inlet Valve
18 Valve Cage
19 Valve Spring
20 Exhaust Valve
21 Service Line Port

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Figure 20—Rear Brake Relay Valve (Midland-Ross)

REAR BRAKE RELAY VALVE (MIDLAND-ROSS)

Key numbers in text refer to figure 20.

Rear brake relay valve, used as optional equipment on some coaches, regulates air supply from a source close to rear brakes. Relay valve is operated by brake application valve. Valve is mounted on bulkhead above rear axle. Air supply line from air tank leads to cavity in lower part of valve. Control pressure line from application valve connects to top of relay valve.

RELAY VALVE OPERATION (Fig. 20)

1. Applying

As air from application valve enters cavity above diaphragm, pressure depresses diaphragm. Downward movement of diaphragm and plunger causes lower end of plunger to contact exhaust valve, closing exhaust port and forcing inlet valve off valve seat. Air will then flow from air supply cavity through valve into brake chambers and apply rear brakes.

2. Holding

The by-pass port (passage A, fig. 20) permits air being delivered to rear brake chambers to enter cavity below diaphragm. When combined forces of air pressure and plunger return spring pressure below diaphragm balances air pressure on top of diaphragm and plunger, plunger is forced upward. This permits inlet valve to close, but not enough to open exhaust valve. Pressure build-up stops, and at the same time air already delivered to rear brakes is prevented from escaping through exhaust port. Relay valve in holding position now maintains same pressure in brake chambers as application valve is delivering.

When brake treadle is depressed still further, admitting more air to top of diaphragm and plunger, there is a corresponding increase in air pressure at rear brakes. Upon partial release of treadle, air pressure below diaphragm overcomes reduced pressure above. Plunger is then forced upward and air from rear brake chambers is exhausted until pressure below diaphragm balances the pressure above.

3. Release

When brake treadle is returned to fully released position, application valve exhausts air from cavity above diaphragm and plunger. Pressure below diaphragm then lifts diaphragm and plunger, permitting inlet valve to close and exhaust valve to open. Air in brake chambers then passes through exhaust valve and hollow plunger into exhaust cavity and out exhaust port to atmosphere.

RELAY VALVE SERVICEABILITY TESTS

1. Operating Test

With air brake system fully charged, apply brakes and see if rear brakes apply promptly. Release brakes and make sure air is quickly exhausted from the exhaust port of the relay valve.

2. Leakage Test

a. With air system fully charged, coat relay valve exhaust port with soap suds to check for leaks. Leakage in excess of a one-inch bubble in three seconds is not permissible. Bubbles are probably caused by dirt on inlet valve, or a damaged inlet valve or seat.

b. With brakes fully applied, coat relay valve exhaust port with soap suds to check for leaks. Leakage in excess of a one-inch bubble in three seconds is not permissible. Bubbles are probably caused by dirt on exhaust valve, by a damaged exhaust valve, or by damaged seat at bottom of plunger.

RELAY VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the system.
2. Disconnect air lines from valve.
3. Remove stop light wires and mounting bolts. Remove relay valve assembly.

Installation

1. Position relay valve on coach bulkhead; then install attaching bolts. Tighten bolts firmly.

2. Reconnect stop light wires and air lines.

3. Build up air pressure in air system as previously directed under "Serviceability Tests."

RELAY VALVE OVERHAUL

Disassembly (Fig. 20)

1. Unscrew check valve body (3) from exhaust port in upper body (7). Remove screw attaching exhaust check valve (2) and guard (1) to valve body. Remove valve and guard.

2. Mark mounting bracket (9), upper body (7), and lower body (13) in some manner to identify their relative positions for reassembly. Remove six bolts attaching upper body to lower body; four of these bolts also attach the mounting bracket. Remove bracket and upper body from lower body.

3. Remove diaphragm and plunger assembly (5 and 8) and diaphragm spring (11) from lower body.

4. Remove nuts from four studs securing inlet valve cover (16) to lower body and remove cover. Remove valve cage (18) and inlet and exhaust valve assembly (17 and 20), and gaskets (15) from lower body.

5. Hold exhaust valve (20) with pliers and remove nut securing inlet valve (17) on exhaust valve stem. Remove inlet valve from exhaust valve stem, then remove exhaust valve from valve cage.

6. To disassemble diaphragm and plunger, hold plunger (5) and remove diaphragm nut (12), diaphragm plate (10), and diaphragm from plunger. Hold plunger in such a manner that surfaces which contact oil seals will not be damaged.

7. Remove plunger seals (4) from upper and lower bodies.

Cleaning (Fig. 20)

Always replace the following parts with new parts when overhauling the relay valve: Exhaust check valve (2), plunger seals (4), diaphragm (8), gaskets (15), inlet valve (17), and exhaust valve (20). All other parts may be reused if no cracks or other damage is evident. Wash parts in cleaning solvent and dry thoroughly. Make sure passage "A" in lower body (13) is not obstructed.

Assembly (Fig. 20)

1. Install new plunger seals (4) in upper and lower bodies (7 and 13), with seal lips in direction shown in figure 20.

2. Install diaphragm (8) on lower end of plunger (5). Be sure bead around hole in diaphragm (8) is seated in groove in plunger (5). Place diaphragm plate (10) on plunger with cupped side away from diaphragm. Coat threads on plunger with shellac, and install diaphragm nut (12). Hold plunger, using care not to damage ends which contact seals, and firmly tighten diaphragm nut.

3. Place valve spring (19) over exhaust valve stem with small end next to exhaust valve (20). Insert valve stem through valve cage (18). Place inlet valve (17) on valve stem with insert facing seat in valve cage. Coat valve stem threads with shellac (do not get shellac on valve inserts), install nut on valve stem, and tighten firmly.

4. Install valve and cage assembly in lower body, using new gasket (15) on both sides of cage flange. Install inlet valve cover and secure with four stud nuts and lock washers. Tighten nuts firmly.

5. Place diaphragm spring (11) in lower body. Coat both ends of plunger with special lubricant (S-17). Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17). Install diaphragm and plunger assembly on lower body with lower end of plunger inserted through seal in body. Align holes in diaphragm with holes in lower body.

6. Place upper body (7) on lower body with upper end of plunger inserted through seal in upper body. Align marks made on upper and lower bodies before disassembling.

7. Place mounting bracket (9) on upper body, with marks aligned. Install six bolts attaching upper and lower bodies and mounting bracket together, using the four longest bolts through the mounting bracket. Install lock washer and nut on each bolt and tighten evenly and firmly.

8. Install exhaust check valve (2) and guard (1) in check valve body (3) and secure with screw. Thread check valve body into exhaust opening in upper body, leaving exhaust opening pointing down When fully tightened.

FRONT BRAKE LIMITING VALVE AND TWO-WAY CONTROL VALVE

A combination limiting and quick-release valve (fig. 22) and a two-way control valve (fig. 23) are used in combination as optional equipment on some coaches, as shown in figure 21. This combination delivers full air pressure to front brakes on dry roads, or at the option of the driver, limits front brake air pressure by half on slippery roads.

The two-way control valve is mounted at right side of seat within easy reach of the driver. The limiting quick-release valve is mounted beneath coach floor near front axle. One air line from brake application valve is connected to the inlet port of the two-way valve and another line connects to the brake valve port at top of limiting quick release valve (fig. 21). Another air line connects side delivery port of the control valve to port opposite the mounting pad of the limiting valve. The two other side ports of the limiting valve are connected to front brake chambers.

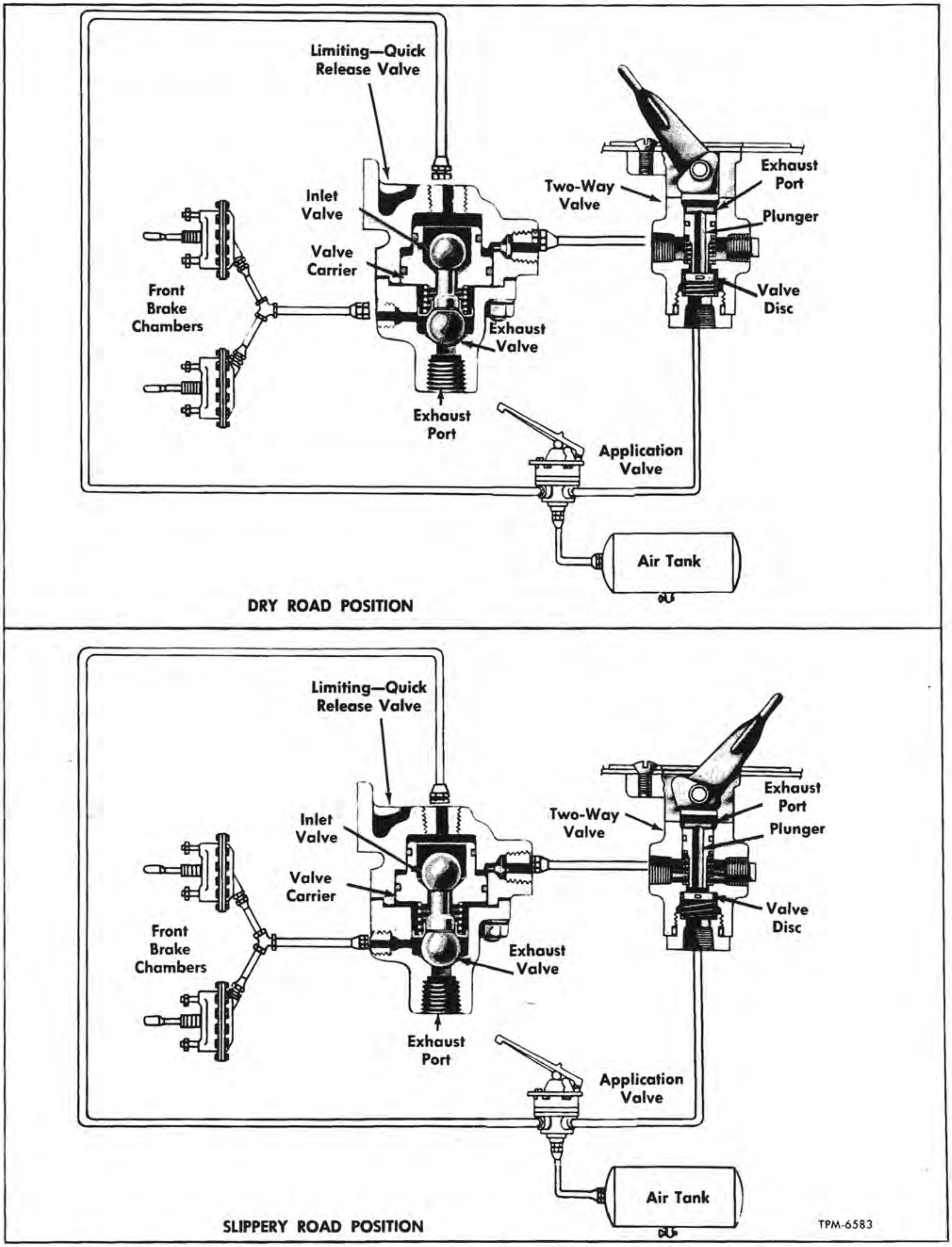


Figure 21—Front Brake Limiting and Two-Way Control Valve Operation

OPERATION

1. Dry Roads (Top View, Fig. 21)

a. When handle of the two-way valve is placed in "DRY ROAD" position, the hollow plunger of the valve is depressed and contacts the valve disc, unseating the valve. In this position, air passage through the hollow plunger is closed and air pressure from application valve has free passage through the two-way valve to front port of the limiting quick release valve.

b. When coach brakes are applied, air pressure from the brake application valve enters limiting quick release valve at the top. This air pressure, acting on upper inner surface of the valve carrier, forces carrier down until the exhaust valve contacts valve seat in the valve cover, closing the exhaust port. The carrier still continues to move downward, partially opening the inlet valve.

c. At the same time, pressure from the application valve passes through the two-way valve as explained in (a) above, and enters limiting quick release valve at the side. With the valve carrier already partially depressed, air pressure coming from the two-way valve acts on larger outer surface of the valve carrier and forces the carrier down still further to limit of travel. This action moves the carrier fully away from the inlet valve, permitting full application valve pressure to be delivered to the front brake chambers.

2. Slippery Roads (Bottom View, Fig. 21)

a. When handle of the two-way valve is placed in "SLIPPERY ROAD" position, the hollow plunger is raised by the plunger spring and valve disc is held closed by the valve spring. Any air pressure in line connecting the limiting quick release valve and the two-way valve will be exhausted through the hollow plunger and exhaust port of the two-way valve.

b. When the brake application valve is applied with the two-way valve in slippery road position, air pressure from brake application valve is stopped at the valve disc of the two-way valve and does not enter the side port of limiting quick release valve. At the same time, however, air pressure from the application valve enters limiting quick release valve at top. This pressure, acting on upper inner surface of the valve carrier, forces carrier down until exhaust valve closes the exhaust port and partically opens the inlet valve. Air pressure passing by the inlet valve and building up in brake chambers is acting on the lower surface of valve carrier. The lower surface of valve carrier is approximately twice as large as the upper inner surface. Therefore, when pressure acting on the lower surface of the carrier is approximately one-half application valve delivery pressure, the valve carrier moves up and closes the inlet valve, and the exhaust valve will remain closed. The limiting quick release valve is then in a position where pressure in the lower portion of the valve and in brake chambers will be approximately one-half pressure being delivered to upper portion of the valve by the application valve.

SERVICEABILITY TESTS

1. Operating Tests

a. Install an air pressure test gauge in application valve delivery line. A convenient method of connecting gauge is to remove stop light switch at front of application valve and connect gauge to stop light switch fitting. Disconnect one front brake chamber line from port at side of limiting quick release valve and connect another test gauge to this port.

b. Place handle of the two-way valve in "DRY ROAD" position and apply brakes. Both test gauges should read the same. Place handle of the two-way valve in "SLIPPERY ROAD" position and apply brakes. The test gauge at the limiting quick release valve should read approximately one-half amount shown on the test gauge connected to the application valve delivery line.

2. Leakage Tests

a. Place handle of the two-way valve in "DRY ROAD" position and with brakes applied, coat exhaust ports of the two-way valve and limiting quick release valve with soap suds. Leakage at either port should not exceed a one-inch soap bubble in one second.

b. Place handle of the two-way valve in "SLIPPERY ROAD" position and with brakes applied, coat exhaust port of the two-way valve with soap suds. Leakage should not exceed a one-inch bubble in one second.

LIMITING AND QUICK RELEASE VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the air system.

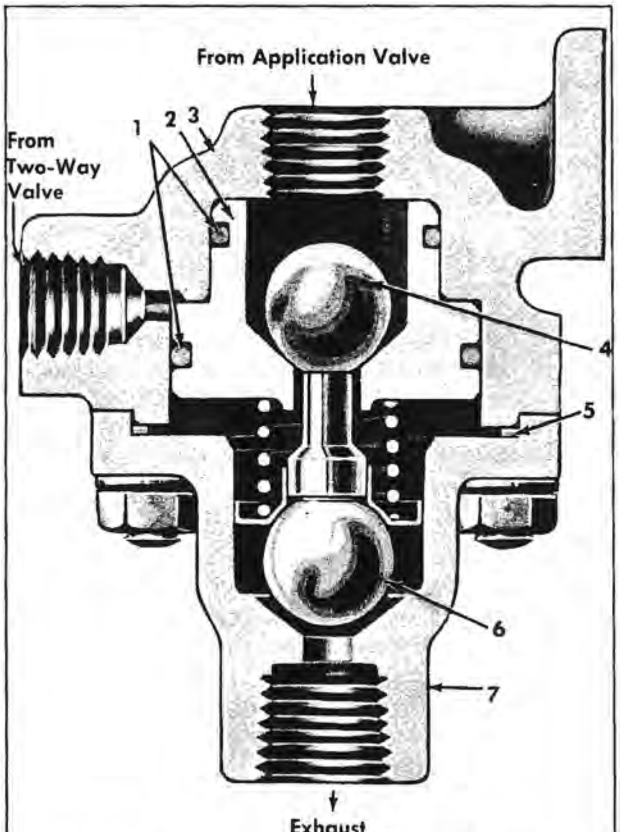
2. Disconnect all air lines from valve. Remove valve attaching screws and remove valve from support.

Installation

1. Position valve on support and install attaching screws. Tighten securely.

2. Connect air lines to valve, making sure all connections are tight.

3. Build up air pressure in system to normal operating pressure; then test valve as previously described under "Serviceability Tests."



1 O-rings
2 Valve Piston
3 Valve Body
4 Inlet Valve
5 O-ring
6 Exhaust Valve
7 Valve Cover

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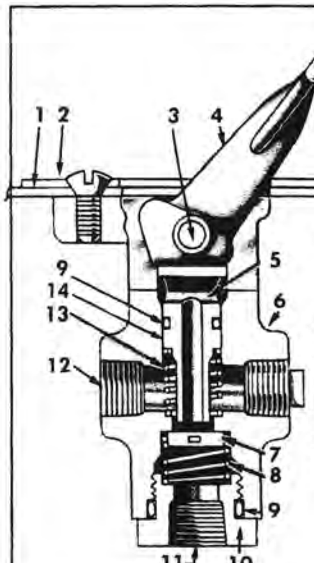
Figure 22—Front Brake Limiting and Quick Release Valve



1 Instrument Panel
2 Dash Plate
3 Fulcrum Pin
4 Control Lever
5 Exhaust Port
6 Body
7 Valve Disc
8 Valve Spring
9 O-ring
10 Cap Nut
11 Inlet from Application Valve
12 Outlet to Limiting Valve
13 Plunger Spring
14 Plunger

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Figure 23—Two-Way Control Valve (Also I.C.C. Valve)

TWO-WAY CONTROL VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the air system.
2. Disconnect all air lines from control valve; then remove control valve from front of dash by removing two screws and valve dial.

Installation

1. Install control valve at front of dash panel attaching with valve dial and two screws.
2. Connect all air lines to valve, making sure all connections are tight.
3. Build up air pressure in system to normal operating pressure; then test valve as previously described under "Serviceability Tests."

LIMITING AND QUICK RELEASE VALVE OVERHAUL (Fig. 22)

Disassembly

1. Remove nuts and lock washers from studs securing valve cover to valve body. Separate cover and body. Remove and discard O-ring seal.
2. Push valve piston with inlet and exhaust valve assembly out of valve body.
3. Remove O-rings from grooves in valve piston. Discard O-ring seals.

Cleaning, Inspection, and Repair

1. Wash all metal parts in cleaning solvent. Wipe or blow parts dry.
2. Examine body and cover for cracks or other damage.
3. Inspect exhaust valve seat in cover; if seat is nicked, chipped, or worn, replace cover. Remove slight scratches or scores from inner surface of body with crocus cloth.
4. If any part of the valve piston or inlet and exhaust valve assembly is scratched, nicked, chipped, worn, or damaged in any way, the complete assembly must be replaced.

Assembly

1. Install new O-ring seals in grooves in valve piston; then place valve assembly in body.
2. Place new O-ring seal in cover, then install cover on body, making sure valve guide enters bore in cover. Install nuts and lock washers on cover-to-body studs and tighten firmly.
3. After installing valve in vehicle, or using a test hook-up, test valve as previously directed under "Serviceability Tests."

TWO-WAY CONTROL VALVE OVERHAUL (Fig. 23)

Disassembly

1. Using a drift, drive out fulcrum pin securing control lever in valve body and remove lever.

2. Remove cap nut, O-ring, valve spring, and valve from bottom of body. Discard O-ring.

3. Push against bottom of valve plunger to remove plunger from top of body. Remove plunger return spring from body. Remove O-ring from plunger and discard.

Cleaning and Inspection

1. Wash all metal parts in cleaning solvent Wipe or blow parts dry.

2. Carefully examine small end of plunger which contacts valve; if any roughness or damage is evident, replace plunger.

3. Inspect valve seat in body; if seat shows signs of wear or damage, replace body.

4. Replace valve disc if any wear or damage is evident. Replace valve spring if weakened by corrosion.

Assembly

1. Install new O-ring seal in groove of plunger and on cap nut.

2. Coat plunger, pin, and cam with special lubricant (S-17). Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17).

3. Place spring on small end of plunger, and install plunger and spring in top of body.

4. Install control lever in body, and secure with fulcrum pin. Stake pin in place.

5. Turn body bottom side up and install valve disc, valve spring, and cap nut, being sure new O-ring is in place on cap nut. Tighten cap nut firmly.

6. After installing valve in vehicle, or using a test hook-up, test valve as previously directed under "Serviceability Tests."

AUXILIARY BRAKE CONTROL (I.C.C.) BRAKE VALVE

OPERATION

I.C.C. (Interstate Commerce Commission) brake valve, along with an air pressure cut-off valve and a double check valve are installed as special equipment on some vehicles (fig. 24). The I.C.C. valve is provided as an emergency method for applying the air brakes on rear axle. Valve is mounted at right side of driver. Valve control lever should remain in "OFF" position at all times during normal operation. When lever is moved to "ON" position, full air pressure in system is applied to brakes on rear axle only.

IMPORTANT: Valve should be tested at regular intervals to make sure it is operating properly.

The I.C.C. valve and the two-way control valve shown in figure 23 are identical except for wording on dials. The following key numbers refer to figure 23. Valve is in "OFF" position, with plunger (14) raised and valve disc (7) against valve seat in body. Air supply line from front air tank is connected to inlet port (11) in cap nut (10). Outlet line to rear brake relay valve is connected to outlet port (12).

When control lever (4) is moved to "ON" position, cam on lever forces plunger down. Lower end of plunger seats against valve disc (7) closing exhaust passage through plunger, and forcing valve disc off seat in body. This permits full air pressure to flow past valve disc into line leading to rear brake relay valve. With full air pressure applied to relay valve, relay valve delivers full pressure to brakes on rear axle. At the same time, air pressure being delivered to relay valve enters top of air pressure cut-off valve, cutting off flow of air pressure to brake application valve and auxiliary air system. Refer to "Air Pressure Cut-off Valve" later.

When valve control lever is returned to "OFF" position, plunger spring raises plunger, permitting valve spring to seat valve disc against seat in body, shutting off flow of air pressure. Air pressure which has been let into line leading to relay valve is exhausted through the hollow plunger, permitting relay valve to exhaust air pressure from rear brakes.

I.C.C. BRAKE VALVE REPLACEMENT

Removal

1. Exhaust air pressure from air brake system.

2. Disconnect air lines from valve ports.

3. Remove two screws attaching valve to support. Remove valve assembly and dial.

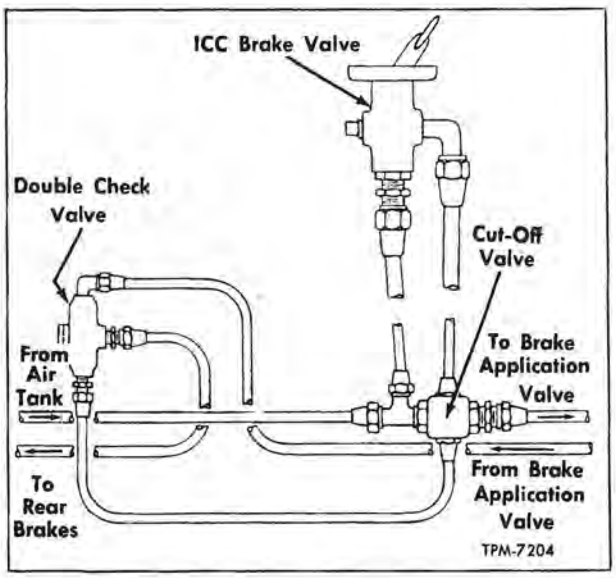


Figure 24—Auxiliary Brake Control Installation

AIR BRAKES

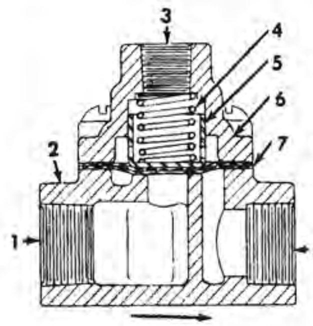


Figure 25—Air Pressure Cut-Off Valve

Installation

1. Position valve assembly on support. Install dial and two screws. Tighten screws firmly.
2. Connect air lines to valve, making sure all connections are tight.
3. Build up air pressure in system to normal operating pressure.

NOTE: Refer to "Two-Way Control Valve Overhaul" earlier in this section for information on disassembly, inspection, and assembly of the I.C.C. valve. Procedures are the same.

AIR PRESSURE CUT-OFF VALVE

Air pressure cut-off valve (fig. 25) is installed in air line from front air tank supplying air pressure to brake application valve and auxiliary air system, and is also connected to the outlet side of the I.C.C. brake valve. Normally, air pressure from air tank lifts diaphragm in cut-off valve and flows through valve to brake application valve and auxiliary air system. When I.C.C. brake valve control lever is moved to "ON" position, air pressure from I.C.C. brake valve, flowing to rear brake relay valve, at the same time enters cut-off valve above the diaphragm. Combined force of air pressure and spring above diaphragm overcomes force of air pressure below diaphragm and forces diaphragm down, cutting off flow of air pressure to application valve and auxiliary air system.

Air cut-off valve is located at right of brake application valve. Arrows on top of valve body indicate normal direction of air flow through valve.

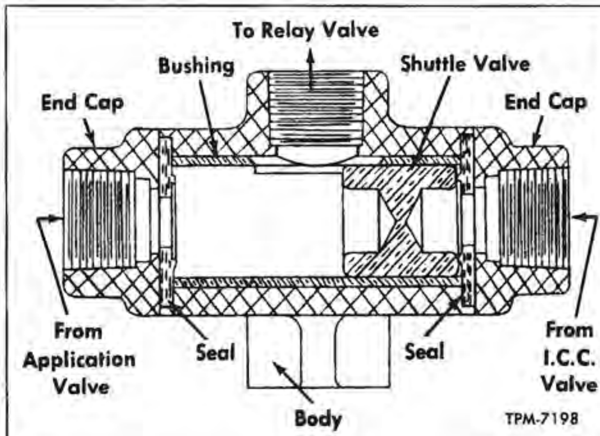


Figure 26—Double Check Valve

AIR PRESSURE CUT-OFF VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the air system.
2. Disconnect all air lines from valve and remove valve.

Installation

1. Connect all air lines to the valve, making sure all connections are tight. Be sure arrows on top of valve cover are pointed toward brake application valve.
2. Build up air pressure in the system to normal operating pressure.

AIR PRESSURE CUT-OFF VALVE OVERHAUL

Disassembly (Fig. 25)

Remove four screws attaching cover to body. Remove cover, spring, spring seat, and diaphragms.

Cleaning and Inspection (Fig. 25)

Clean all parts thoroughly. Examine diaphragms; if any signs of cracking or deterioration are evident, replace with new diaphragms. Make sure diaphragm seat in body is clean and smooth. Bore in cover must be clean and smooth to permit free movement of spring seat. If spring has been weakened by rust or corrosion, replace with new springs.

Assembly (Fig. 25)

Lubricate bore in cover contacted by spring seat with thin coat of special lubricant (S-17). Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17). Place diaphragms on body. Place spring and spring seat in cover and position cover on diaphragms and body. Install four screws and tighten securely.

DOUBLE CHECK VALVE

Double check valve (fig. 26) is installed in air line between I.C.C. valve and brake application valve. Valve is located near auxiliary or air suspension air tank. Lines from check valve lead to application valve, to I.C.C. valve, and to rear brake relay valve.

When I.C.C. brake valve lever is placed in "ON" position, compressed air from dry tank passes through I.C.C. valve and enters double check valve. The air pressure forces shuttle valve against inlet port from application valve. Air passes on through outlet port into rear brake relay valve and applies rear brakes only.

When I.C.C. brake valve lever is in "OFF" position and foot brake is applied, air pressure forces shuttle valve against inlet port. Compressed air then flows through outlet port to rear brake relay valve and applies rear brakes. Air from application valve also applies front brakes.

DOUBLE CHECK VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the air system.
2. Remove nuts and washers attaching check valve to mounting stud.
3. Disconnect all air lines from the valve and remove valve.

Installation

1. Mount check valve assembly on mounting stud and install nuts and washers. Tighten nuts firmly.
2. Connect all air lines to the valve ports, making sure all connections are tight.
3. Build up air pressure in the system to normal operating pressure.

DOUBLE CHECK VALVE OVERHAUL

Disassembly

1. Remove two cap screws, lock washers, and plain washers attaching valve cover to body. Separate cover from body.
2. Remove shuttle valve and valve guide from valve body.
3. Remove grommet from valve cap. Discard grommet.

Cleaning and Inspection

1. Clean parts in cleaning solvent. Wipe or blow parts dry.
2. Inspect parts for corrosion, wear, or other damage. Replace damaged parts.
3. Check shuttle valve. Valve should slide freely in guide.

Assembly

1. Install shuttle valve and guide in valve body.
2. Position a new grommet on valve cover.
3. Place cover on body and install two cap screws, lock washers, and plain washers. Tighten screws firmly.

AIR LINE FILLER VALVE

An air line filler valve installed in air line on engine compartment bulkhead (fig. 1), is used primarily to keep the air suspension system inflated during long periods while coach is standing idle. However, valve can be used to check air system pressure, by using an ordinary tire gauge.

BRAKE CHAMBERS

An air brake chamber (fig. 27) is used at each wheel to convert the energy of compressed air into the mechanical force and motion required to apply the brakes. The yoke on the brake chamber push rod connects to a slack adjuster which is mounted on the brake camshaft. Push rod opening and four equally spaced holes near clamping flange in non-pressure plate provide for breathing and drainage. Front brake chambers are connected to air system through the application valve. Rear brake chambers are connected to air system through rear brake relay valve.

BRAKE CHAMBER OPERATION

As air pressure enters the brake chamber behind the diaphragm, the diaphragm forces push rod outward, thus applying force to the slack adjuster which rotates brake camshaft, applying brakes. When air pressure is released from the brake chamber, the brake shoe return springs and the push rod spring return brake shoes, camshaft, slack adjuster, push rod, and diaphragm to released position.

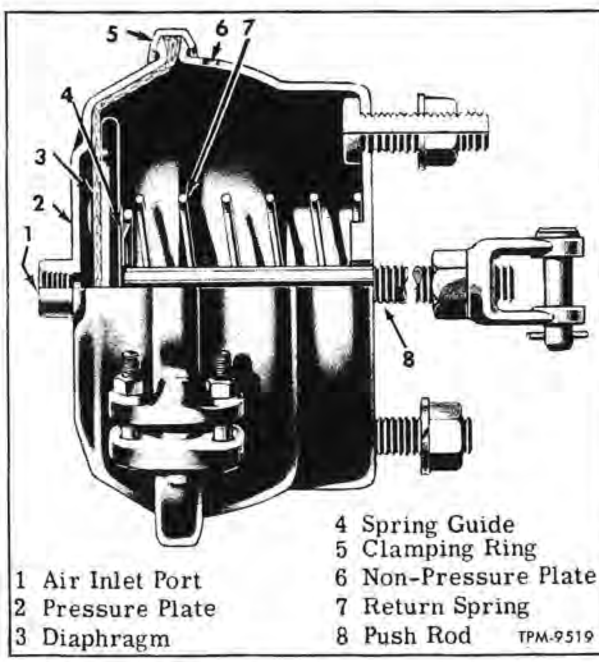


Figure 27—Brake Chamber (Typical)

SERVICEABILITY TESTS

1. Operating Test

Apply brakes. Brake chamber push rods should move out promptly without binding. Release brakes. Rods should return to released position promptly without binding.

2. Leakage Tests

a. Fully apply brakes. Coat edges of the clamping ring with soap suds to check for leakage. No leakage is permissible. If leakage is found, tighten clamp ring bolts.

b. Fully apply brakes. Check for leakage through the diaphragm by applying soap suds to breather holes and to push rod hole. No leakage is permissible. If soap bubbles indicate a leak, replace diaphragm.

BRAKE CHAMBER REPLACEMENT

Removal

1. Disconnect hose from brake chamber as follows: Hold hose union nut with wrench while turning connector out of fitting or elbow in brake chamber. If new brake chamber is to be installed, remove connector fitting or elbow for installation on replacement unit.

2. Disconnect push rod yoke from slack adjuster.

3. Remove nuts and lock washers from mounting studs; then remove brake chamber assembly from bracket.

Installation

1. Position brake chamber at bracket, with mounting studs through holes in bracket. Install lock washer and nut on each stud and tighten firmly.

2. Install elbow or connector fitting in brake chamber.

3. Connect hose as follows: Thread connector into elbow or fitting and tighten firmly while holding hose union nut with wrench.

4. Connect brake chamber push rod yoke to slack adjuster. Adjust brakes as previously directed under "Brake Adjustments." Apply brakes and make sure push rods are correct length. Angle formed by push rod and slack adjuster should form an angle of more than 90 degrees, and should still be slightly greater than 90 degrees with brakes applied. In other words, the slack adjuster should not go "over center" when brakes are applied. If necessary, adjust push rod length by turning yoke on or off push rod. Push rod must not extend through yoke far enough to interfere with slack adjuster. Test brake chamber as previously directed under "Serviceability Tests."

BRAKE CHAMBER OVERHAUL

Disassembly (Fig. 27)

1. Before disassembling brake chamber, mark non-pressure plate, pressure plate, and clamp ring. Parts may then be reassembled in same position as before disassembly.

2. Remove yoke and lock nut from push rod. Remove nuts from two clamp ring bolts and remove bolts. Use caution when separating plates because of tension on return spring. Spread clamp ring and remove from plates; then remove pressure plate and diaphragm.

3. Remove push rod and spring from non-pressure plate.

Cleaning and Inspection

1. Clean all metal parts thoroughly, using a suitable cleaning solvent.

2. Examine diaphragm. Replace with new part if any signs of damage or deterioration are evident. Diaphragms should be replaced every 50,000 miles, or at least once a year.

3. Examine push rod and spring. Replace with new parts if not in first class condition. Replacement spring should have the same tension as spring in opposite brake chamber. Mismatched springs will result in unbalanced braking.

4. Inspect pressure plate and non-pressure plate. Clamping flanges on plates should not be bent or otherwise damaged. Replace damaged parts.

Assembly (Fig. 27)

1. Install spring and non-pressure plate on push-rod.

2. Place clamp ring over flange of non-pressure plate and align marks.

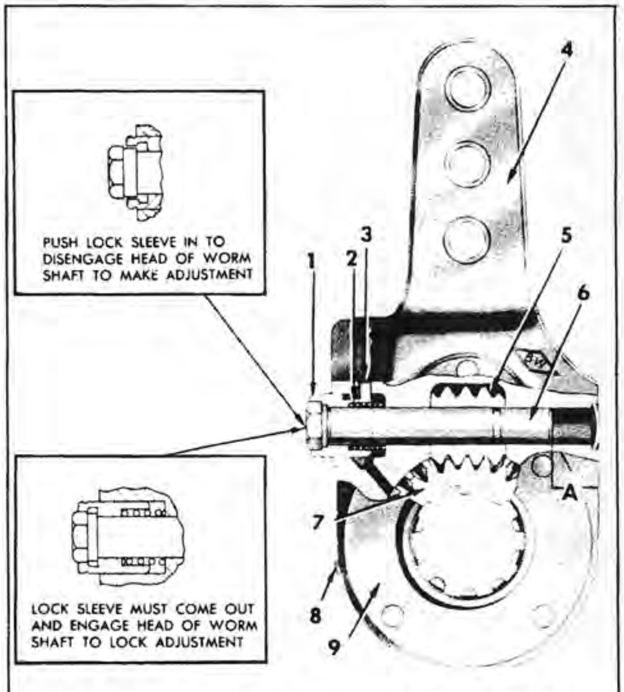
3. Position diaphragm in pressure plate. Position plate and diaphragm against the non-pressure plate; then place brake chamber assembly in a vise. Carefully close vise until clamp ring can be worked over flange of pressure plate. Align marks previously inscribed.

4. Use vise-grip pliers or C-clamp on side of lugs on clamp ring. Draw clamp ring together and install one bolt and nut. Remove tool and install the other bolt and nut. Tighten just enough to form an air-tight seal. Remove brake chamber from vise.

5. Install lock nut and yoke on push rod.

SLACK ADJUSTERS

Slack adjusters function as adjustable levers and provide a quick and easy method of adjusting the brakes to compensate for normal lining wear. Positive locking type slack adjusters are used at front and rear brakes. Construction of both front and rear slack adjusters is shown in figure 28.



1 Lock Sleeve
2 Spring
3 Dowel
4 Lever
5 Worm
6 Worm Shaft
7 Gear
8 Lubrication Fitting
9 Cover Plate

A—See Text

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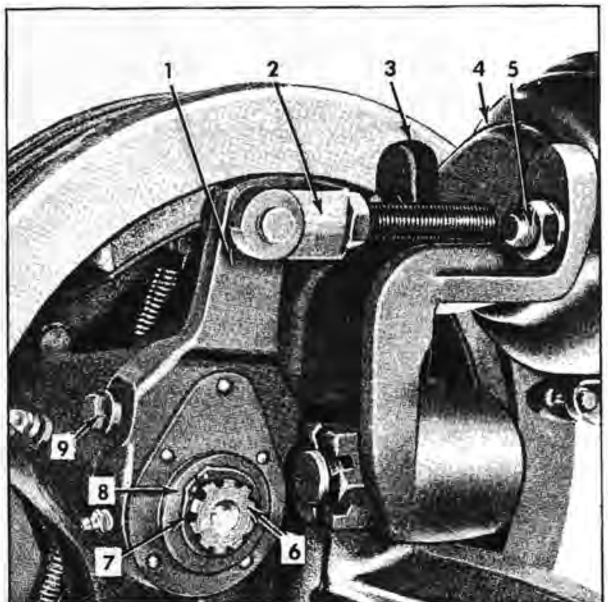
Figure 28—Slack Adjuster (Typical)

Front and rear slack adjuster installations are shown in figures 29 and 30.

Slack adjuster consists basically of a hardened steel gear which is splined to the brake camshaft, a brake lever (body), and a hardened steel worm. Worm is mounted in the lever above the gear and meshes with the teeth in the gear. Turning the worm shaft causes rotation of the camshaft in relation to the brake lever. During brake operation, the entire slack adjuster rotates bodily with the camshaft. As the brake chamber push rod reaches its maximum travel due to normal lining wear, worm shaft can be turned to rotate lever back to original setting.

SLACK ADJUSTER SERVICEABILITY TEST

Adjust brakes as previously directed under "Brake Adjustment" in this section; then carefully measure brake chamber push rod travel as brakes are applied. Make several full brake applications and again measure push rod travel. Push rod travel should be the same as it was immediately after adjustment. If push rod travel increases, or if difficulty is experienced in keeping the brakes adjusted in service, the slack adjuster must be overhauled or replaced.



1 Slack Adjuster
2 Push Rod Yoke
3 Brake Chamber Bracket
4 Brake Chamber
5 Brake Chamber Mounting Stud
6 Camshaft
7 Snap Ring
8 Washer
9 Slack Adjuster Worm Shaft

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Figure 29—Brake Chamber Bracket and Slack Adjuster Mounted On Front Axle

SLACK ADJUSTER REPLACEMENT

Removal (Fig. 29 or 30)

1. Remove clevis pin attaching slack adjuster to brake chamber push rod.
2. Remove snap ring (front) or bolt and washers (rear) securing slack adjuster on camshaft. Slide slack adjuster off end of shaft.

Installation (Fig. 29 or 30)

1. If a new slack adjuster is being installed, make sure it is the same size and type as the one removed. Slide slack adjuster onto camshaft and attach with bolt and washers (rear) or with snap ring (front).
2. Connect brake chamber push rod to slack adjuster, using clevis pin and new cotter pin.
3. Lubricate slack adjuster as directed in LUBRICATION (SEC. 13) of this manual.
4. Adjust brake as previously directed under "Brake Adjustments."

SLACK ADJUSTER OVERHAUL

Disassembly (Fig. 28)

1. Remove dirt and grease from outside of slack adjuster by washing in suitable cleaning solvent.

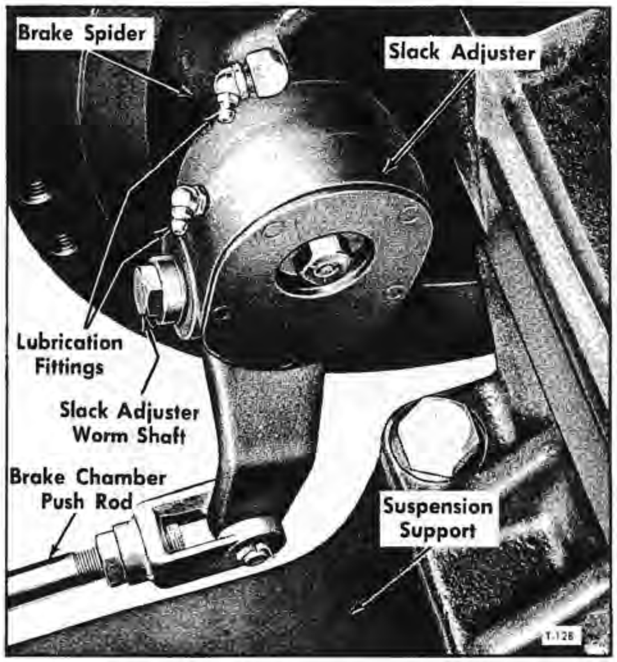


Figure 30—Slack Adjuster and Camshaft Mounted On Rear Axle

2. Cut off riveted ends of rivets attaching cover plates to body. Drive out rivets and remove cover plates.

3. Remove welch plug from end of worm shaft bore. Insert a flat end punch into the worm shaft bore and drive worm shaft out of body and worm.

4. Remove lock sleeve and spring from worm shaft. On some coaches it will be necessary to remove the rubber boot from lock sleeve. Remove gear and worm from slack adjuster body. Remove lubrication fitting.

Cleaning, Inspection, and Repair

1. Wash parts in cleaning solvent and wipe or blow parts dry.

2. Inspect worm and gear and replace with new parts if chipped or broken teeth are evident.

3. Inspect worm shaft for wear. Make sure corners on hex end are not rounded.

4. Inspect bushing in lever arm. If worn, out-of-round, or otherwise damaged, it must be replaced. To replace bushing, press old bushing out and press new bushing into place. Bushing must be reamed after installation to 0.501"-0.503".

5. Examine lock sleeve for cracks or other damage. Replace if necessary.

6. Examine lever (body) for cracks or distortion. If lever is damaged in any way, a new body and bushing assembly must be used.

Assembly (Fig. 28)

1. Place worm and gear assembly in position in body.

2. Place lock sleeve over worm shaft, with socket-like end of sleeve at hex end of shaft. Place lock spring in recess formed by sleeve and shaft.

3. Enter small end of worm shaft through hole in body and worm. Press worm shaft into worm and body, making sure groove in lock sleeve is aligned with pin in body. Press shaft in until distance from small end of shaft to edge of body (A, fig. 28) is as follows: Front - 5/8" - Rear - 9/16". Install welch plug in worm shaft bore.

4. Position cover plates on body and attach with new rivets. Covers must be flat and in good contact with body after riveting.

5. On some coaches install rubber boot over lock sleeve.

6. Install lubrication fitting in body. Connect a grease gun to fitting and force grease into slack adjuster until it is completely filled. Refer to LUBRICATION (SEC. 13) for type lubricant to be used.

FRONT BRAKE SHOES, LININGS, AND CAMSHAFTS

SHOES AND LININGS

Brakes at each front wheel have two shoes which pivot on anchor pins at one end and are expanded at the other end during brake application by constant lift S-type cams (fig. 31). Brake shoe return springs hold shoe rollers firmly against cam. Two-piece block type lining is bolted to each shoe. Holes through lining and upper shoe at cam end are provided to facilitate removal and installation of return springs.

Cam end of each shoe is equipped with a roller which forms the contact between shoe and cam (fig. 31). Anchor pin ends of shoes are equipped with replaceable bushings.

ANCHOR PINS

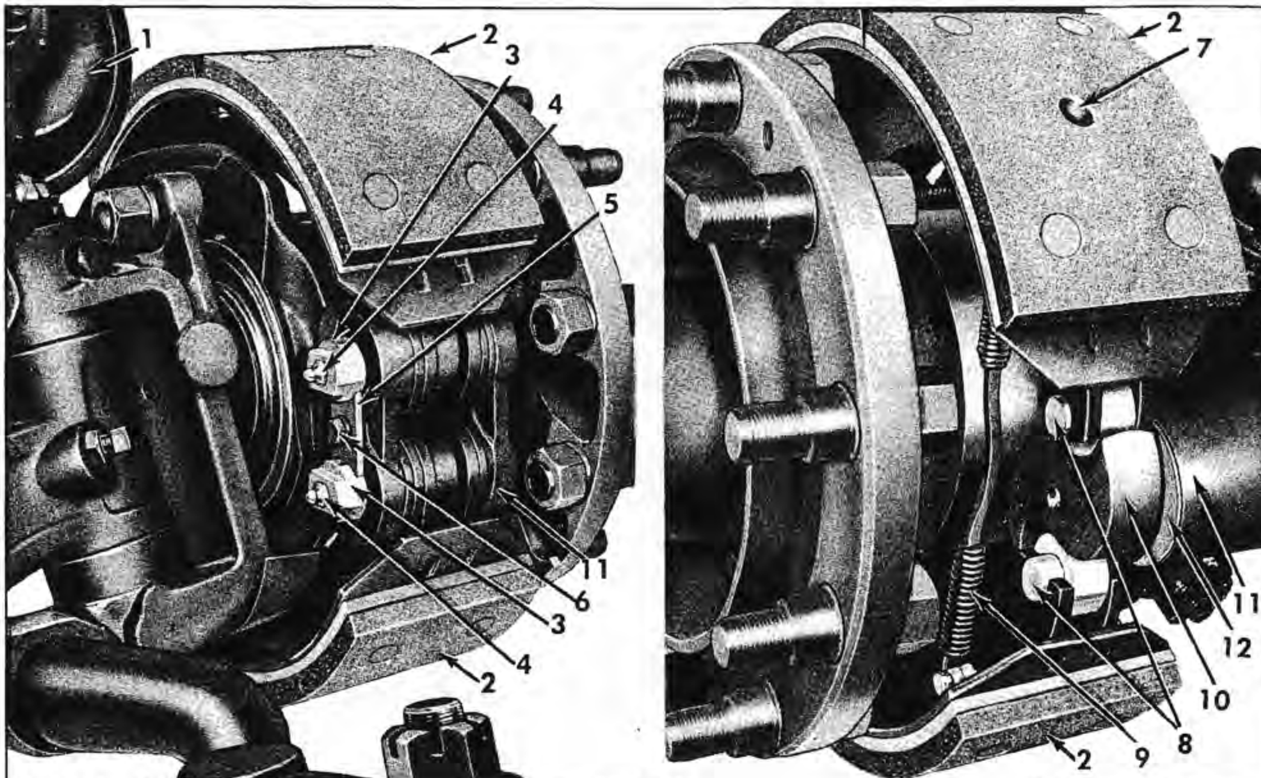
Anchor pin end of each shoe fits between brackets at brake spider, and is retained by straight type anchor pin (fig. 31). Both anchor pins are held in place by a lock plate which engages notches in end of each pin and is attached to brake spider by a lock bolt. Lubrication fittings are provided in each anchor pin so they can be lubricated at regular lubrication intervals. Refer to figure 31.

CAMSHAFTS

Front brake camshafts are mounted in bushings in brake spider (fig. 32). Lubrication fitting in spider provides a method for lubricating bushings. Lubricant is retained by oil seals which are pressed into brake spider.

FRONT BRAKE SHOE AND CAMSHAFT REMOVAL

1. Jack up axle and remove wheel and brake



1 Brake Chamber	5 Lock Plate	9 Return Spring
2 Brake Shoe and Lining Assy.	6 Lock Bolt	10 Camshaft
3 Anchor Pins	7 Return Spring Access Hole	11 Brake Spider
4 Lubrication Fittings	8 Rollers	12 Washers

TPM-8740

Figure 31—Front Brake Shoes Installed

drum. Remove hub as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

2. Drive plugs out of lining at cam end of upper shoes using a punch through holes in shoes. Using a hooked tool through holes in lining and shoes, unhook return springs from pin in upper shoes. Remove springs from pin in lower shoes. Tag or mark brake shoes so that they may be re-installed in original position.

3. Remove lock bolt and washer, then remove anchor pin lock plate. Drive anchor pins out of brake spider and shoes, then remove brake shoes.

4. To remove camshaft (fig. 32), disconnect brake chamber push rod yoke from slack adjuster. Remove snap ring and washer securing slack adjuster on camshaft and pull slack adjuster off end of shaft. Pull camshaft out of brake spider, stripping spacing washers off shaft as shaft is removed.

INSPECTION

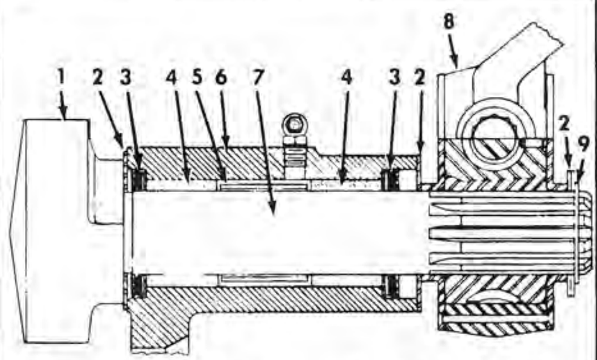
1. Wash all parts except shoe and lining assemblies in cleaning solvent. Check anchor pins and brake shoe bushings for wear in accordance with dimensions listed in "Specifications" at end of this group. Replace with new parts any that are worn or damaged. If brake shoe bushings are replaced, burnish after installation.

2. Examine camshaft bushings, spacer, and seals. If there is any indication of wear or damage, remove old parts and replace with new. Remove bushings and seals by inserting tool through spider and tapping on inside end of each bushing. When installing new bushings, carefully drive into place with a suitable driver. Install spacer between bushings. New seals should be soaked in oil until soft and pliable before installing, and should be installed with tapered edge out to permit installing camshaft without damaging seals.

3. Check fit of roller hubs in shoes. If excessive looseness is evident, remove rollers and check for wear. Replace worn parts. Lubricate roller hubs before installing.

4. Check tension of brake shoe return springs. Replace if weak or broken.

5. Check thickness of brake lining at center of shoe. If worn down to 5/16" thickness, lining



1 Cam (Integral with Shaft)
2 Spacing Washers
3 Oil Seal
4 Bushing
5 Bushing Spacer
6 Brake Spider
7 Camshaft
8 Slack Adjuster
9 Snap Ring TPM-6917

Figure 32—Front Brake Camshaft and Slack Adjuster Mounting

should be replaced. When replacing linings, lining with return spring access holes must be installed at cam end of upper shoe. Linings must be securely bolted to shoes. New lock washers should be used and nuts tightened to 20-25 foot-pounds torque. A 0.006" feeler gauge must not enter between shoe and lining at any point. Drive lining plugs into bolt holes in lining when installation is completed. Make sure roller in shoe is standard size when new linings are installed.

6. Examine camshaft for cracks, distortion, or wear at the bearing surfaces. Replace if worn or damaged.

FRONT CAMSHAFT AND BRAKE SHOE INSTALLATION

1. Work lubricant into camshaft bushings. Refer to LUBRICATION (SEC. 13) for type lubricant to be used.

2. Install large spacing washer on camshaft and insert camshaft through bushings in spider (fig. 32), being careful not to damage seals.

3. Install brake shoes at brake spider in same position from which they were removed. Coat anchor pins with lubricant and insert through brake spider and shoes. Turn anchor pins so notches in inner end face each other. Install anchor pin lock plate and secure with lock bolt and lock washer (fig. 31).

4. Apply a thin coat of special lubricant (S-17) on O.D. of spring coils. Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17). Hook one end of brake shoe return springs on pins in lower brake shoes. Stretch springs and hook onto pins in upper shoes, using hooked tool through holes in lining and shoes. Drive lining plugs into holes after hooking springs.

5. Place spacing washers over inner end of camshaft (fig. 32), install slack adjuster on camshaft, and secure with washers and snap ring. Connect brake chamber push rod yoke to slack adjuster, using clevis pin and cotter pin. Back off slack adjuster worm shaft until shoe rollers rest on lowest points on cam.

6. Install hubs, drums, and wheels, and adjust bearings as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

7. Adjust brakes as previously directed under "Brake Adjustment" in this section.

8. Lubricate slack adjuster and camshaft bushings as directed in LUBRICATION (SEC. 13) of this manual.

REAR BRAKE SHOES, LININGS, AND CAMSHAFTS

SHOES AND LININGS

Brakes at each rear wheel have two shoes (fig. 33). Two-piece block type lining is bolted to each shoe. The hole through lining and shoe table at cam end is used for removing and installing springs. Shoes pivot at one end on anchor pins and ride at other end on rollers (fig. 33). Roller ends of shoes are extended during brake application by constant lift S-type cams. Anchor pin ends of shoes have replaceable bushings.

ANCHOR PINS

The anchor pin acts as a rigid pivot point for fixed end of shoe. Lock bolt in spider extends through hole in bushing and seats in pin groove. The two lock bolts are wired together (fig. 33). Lubrication fittings are provided in each anchor pin so they can be lubricated at regular lubrication intervals. Refer to figure 33.

CAMSHAFTS

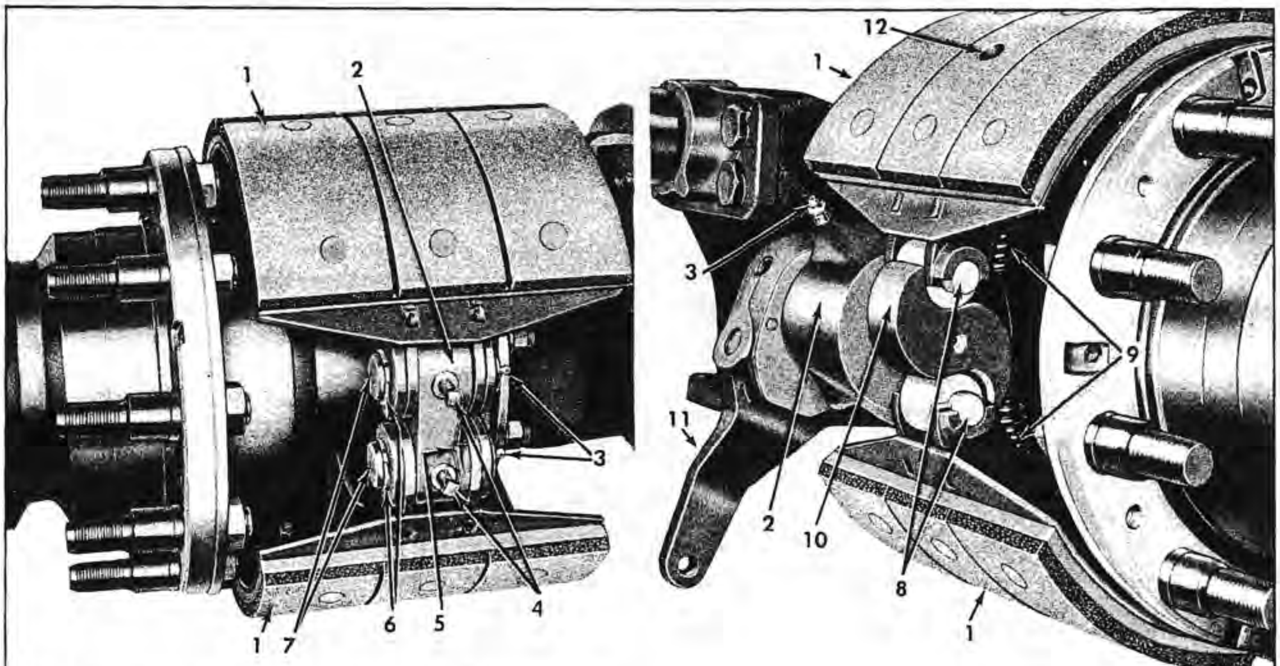
Camshafts are mounted in bushings in brake spider. Mounting is similar to front camshaft mounting shown in figure 32. Lubrication fitting in spider lubricates bushings. Lubricant is retained by seals pressed into spider.

REAR BRAKE SHOE REMOVAL

1. Jack up axle and remove wheels and brake drums. Remove hubs as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

2. Drive plugs out of lining at cam end of upper shoes. Using a hooked tool through holes in linings and shoes, unhook springs from pins in upper shoes. Remove springs from lower shoes.

3. Tag or mark shoes so that they may be reinstalled in original position. Remove lock wire and lock bolts from spider. Remove anchor pins and brake shoes.



1 Brake Shoe and Lining Assy.
2 Brake Spider
3 Lubrication Fittings
4 Lock Bolts
5 Lock Wire
6 Anchor Pin Lock
7 Anchor Pins
8 Rollers
9 Return Spring
10 Camshaft
11 Slack Adjuster
12 Return Spring Access Hole

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Figure 33—Rear Brake Shoes Installed (Typical)

BRAKE SHOE INSPECTION

1. Check anchor pins and brake shoe bushings for wear using "Specifications" at end of this group. Replace badly worn parts with new parts. Burnish brake shoe bushings after installation.

2. Check fit of roller hubs in shoes. Replace worn parts. Lubricate roller hubs before installing rollers.

3. Check tension of brake shoe return springs, Replace weak or broken springs.

4. Check thickness of brake lining at center of shoe. If lining is worn down to 5/16" thickness, lining must be replaced. When replacing linings, lining with return spring access holes must be installed at cam end of upper shoes. Linings must be securely bolted to shoes. New lock washers should be used and nuts should be tightened to 20-25 foot-pounds torque. A 0.006" feeler gauge must not enter between lining and shoe at any point. Drive lining plugs into bolt holes in lining when installation is completed.

REAR BRAKE SHOE INSTALLATION

1. Coat anchor pins, O.D. of shoe return spring coils, and brake shoe roller hubs with a thin coat of special lubricant (S-17). Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17).

2. Position each brake shoe heel at spider. Install anchor pins and pin lock bolts; then tighten bolts firmly. Thread lock wire through bolt heads and twist ends of wire together (fig. 33).

3. Hook one end of brake shoe return springs on pins, on lower shoes. Place roller in toe of each shoe. Stretch springs and hook on spring pins in upper shoes. Use hooked tool through hole in lining and shoes. Drive lining plugs into holes after hooking springs.

4. Back off slack adjuster worm shaft until shoe rollers rest on lowest points on cam. Install hubs, brake drums, and wheels as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

5. Adjust brake shoes as previously directed under "Brake Adjustments" in this section.

REAR CAMSHAFT REMOVAL

1. Unhook brake shoes as directed in "Rear Brake Shoe Removal" steps 1 and 2. Swing brake shoes away from cam. Rear camshaft mounting is similar to front mounting shown in figure 32.

2. Disconnect brake chamber push rod yoke from slack adjuster. Remove bolt, lock washer, and flat washer securing slack adjuster on camshaft.

3. Pull slack adjuster off end of shaft. Pull camshaft out of brake spider, stripping off spacing washers as shaft is removed.

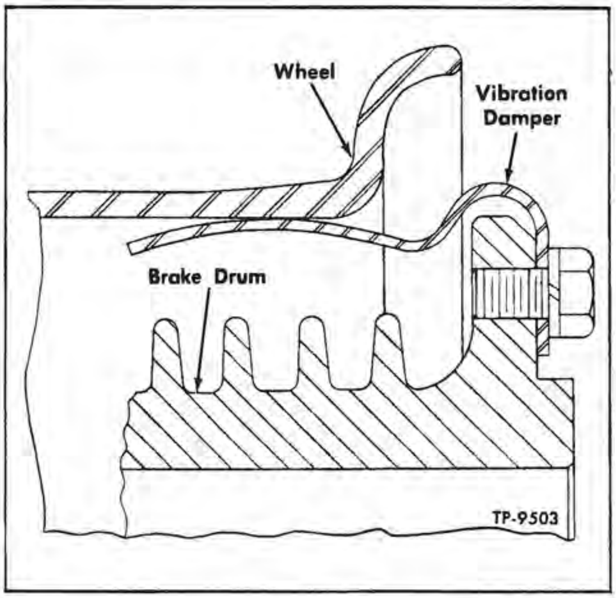


Figure 34—Rear Brake Drum Vibration Damper

CAMSHAFT INSPECTION

1. Wash all parts in cleaning solvent. Wipe or blow parts dry.
2. Examine camshaft for cracks, distortion, or wear at bushing surface. Replace if worn or damaged.
3. Examine bushings in brake spider. Replace with new bushings if wear or damage is evident. Remove bushings and seals by inserting tool through spider and tapping on inside end of each bushing. Soak new oil seals in oil for one hour before installing in spider.

REAR CAMSHAFT INSTALLATION

1. Coat bushings in brake spider with lubricant recommended in LUBRICATION (SEC. 13) of this manual.
2. Place large spacing washer over splined end of camshaft.
3. Insert splined end of shaft through bushings in brake spider.
4. Install spacing washer and slack adjuster on inner end of camshaft. Attach with flat washer, lock washer, and bolt. Connect brake chamber push rod to slack adjuster.
5. Secure brake shoes as directed in "Rear Brake Shoe Installation," steps 3 and 4.
6. Adjust brake shoes as previously directed under "Brake Adjustments." Lubricate spider bushings, anchor pins, and slack adjuster as directed in LUBRICATION (SEC. 13) of this manual.

BRAKE DRUM VIBRATION DAMPERS

Brake drum vibration dampers are installed on each rear brake drum. Each damper is attached with two bolts as shown in figure 34. Dampers are made of spring steel and push against inside of wheel rim. Keep attaching bolts tightened to 40-50 foot-pounds torque. If difficulty is experienced in removing and installing inner wheel, loosen damper attaching bolts.

BRAKE DRUMS

When brake drums become scored, they may be refaced by machining or grinding. To compensate for increased inside diameter of refaced drums, 1/16" and 1/8" oversize brake linings are available from the lining manufacturers. When drums are refaced, they should be machined in increments of 1/16-inch and linings oversize the amount machined from the drum installed.

Satisfactory operation with oversize linings will be obtained until the lining becomes worn sufficiently to permit the brake shoe roller to pass the high point on the cam without effectively applying the brakes.

NOTE: To avoid misunderstanding the term "oversize" as applied to linings and drums, the following example applies:

<u>1/8" Oversize Brake Drum</u>

Inside diameter (I.D.) of the brake drum has been increased 1/8"; that is 1/16" of metal has been removed around the circumference of the drum.

<u>1/8" Oversize Lining</u>

Linings are 1/16" thicker than standard, thus the total increased thickness of linings on both shoes compensates for the 1/8" increased diameter of drum.

Brake drums should never be machined to more than 1/8" beyond original diameter.

SPECIFICATIONS

	TDH/TDM-4518, TDH/TDM-4519, AND SDH/SDM-4502		TDH/TDM-5303, TDH/TDM-5304, AND SDH/SDM-5302	
	Front	**Rear**	**Front**	**Rear**
BRAKE SIZE	14½" x 4"	14½" x 8"	14½" x 5"	14½" x 10"
BRAKE DRUM				
Inside Diameter	14.500"-14.510"	14.500"-14.510"	14.500"-14.510"	14.500"-14.510"
Max. Allowable Out-of-round	0.010"	0.010"	0.010"	0.010"
Width Braking Surface	4"	8"	5"	10"
MAX. ALLOWABLE MACHINE BEYOND ORIGINAL DIA.	0.125"	0.125"	0.125"	0.125"
BRAKE LINING				
Width	4"	8"	5"	10"
Thickness	¾"	¾"	¾"	¾"
Piece Per Shoe	2	2	2	2
Length—Each Piece	7.33"	7.33"	7.33"	7.33"
Effective Brake Area	118 Sq. In.	235 Sq. In.	147 Sq. In.	293 Sq. In.
BRAKE SHOE RETURN SPRING				
Free Length	$8\frac{11}{16}$"	8½"	$8\frac{11}{16}$"	8½"
Length @ Lbs. Pull	$9\frac{13}{32}$" @ 32-38	$9\frac{13}{32}$" @ 113-137	$9\frac{13}{32}$" @ 32-38	$9\frac{13}{32}$" @ 113-137
CAMSHAFT				
Length	$9\frac{11}{16}$"	$8\frac{19}{32}$"	$9\frac{11}{16}$"	$7\frac{23}{32}$"
Width of Cam	1¾"	$2\frac{11}{32}$"	1¾"	$2\frac{11}{32}$"
Outside Diameter of Cam	3⅞"	3⅞"	3⅞"	3⅞"
Outside Diameter of Shaft	1.493"-1.495"	1.493"-1.495"	1.493"-1.495"	1.493"-1.495"
Number of Splines	10	10	10	10
CAM ROLLER IN SHOE				
Outside Diameter	1.488"-1.492"	1.488"-1.492"	1.488"-1.492"	1.488"-1.492"
Outside Diameter of Hub	0.740"-0.745"	0.740"-0.745"	0.740"-0.745"	0.740"-0.745"
Width of Roller	0.790"-0.800"	1.290"-1.300"	0.790"-0.800"	1.450"-1.460"
Width of Hubs	$\frac{15}{32}$"	0.494"-0.504"	$\frac{15}{32}$"	$\frac{19}{32}$"
BRAKE SHOE BUSHING				
Inside Diameter	1.250"-1.254"	1.250"-1.254"	1.250"-1.254"	1.255"-1.257"
Outside Diameter	1.498"-1.500"	1.498"-1.500"	1.498"-1.254"	1.503"-1.505"
Width	1.92"	1.92"	1.92"	⅝"
Bushing To Be Press Fit in Shoe	—	—	—	—
ANCHOR PINS				
Outside Diameter	1.248"-1.250"	1.2485"-1.2465"	1.248"-1.250"	1.2465"-1.2485"
Length	4.375"	6⅞"	4.375"	3.380"
Anchor Pins are Chrome-plated Lubrication Type	—	—	—	—
BRAKE CHAMBERS				
Type (Stamped on Unit)	"20"	"30"	"20"	"30"
Outside Diameter	$6\frac{25}{32}$"	8⅛"	$6\frac{25}{32}$"	8⅛"
Spring Force at 0 Stroke	25¼ lbs.	90 lbs.	25¼ lbs.	90 lbs.
Increase Per In. of Stroke	6¼ lbs.	34½ lbs.	6¼ lbs.	34½ lbs.
Minimum Stroke With Brake Adjusted		Short as possible without brakes dragging.		
Stroke	2¼" + ¼"	2½" + ¼"	2¼" + ¼"	2½" + ¼"
Push Rod Spring	− $\frac{1}{16}$"	− $\frac{1}{16}$"	− $\frac{1}{16}$"	$\frac{1}{16}$"
Outside Diameter of Lg. Coils	3⅛"	3½"	3⅛"	3½"
Free Length Approximate	$7\frac{13}{64}$"	6½"	$7\frac{13}{16}$"	6½"
Compressed Length	$3\frac{3}{16}$" Under 25¼ lbs.	$3\frac{13}{16}$" Under 85 lbs.	$3\frac{3}{16}$" Under 25¼ lbs.	$3\frac{13}{16}$" Under 85 lbs.
Solid Length	$\frac{13}{16}$" (Max.)	$1\frac{3}{16}$" (Max.)	$\frac{13}{16}$" (Max.)	$1\frac{3}{16}$" (Max.)
Number of Coils	6½	7½	6½	7½
SLACK ADJUSTERS				
Type	"15—2"	"20—2"	"15—2"	"20—2"
Bushing I.D.	0.501"-0.504"	0.501"-0.504"	0.501"-0.504"	0.501"-0.504"
No. of Bushings	3	1	3	1
No. of Splines	10	10	10	10
Diameter of Spline	1½"	1.505"-1.515"	1½"	1.505"-1.515"
Offset of Lever	⅝"	1½"	⅝"	1½"

Air Compressor and Governor

(BENDIX-WESTINGHOUSE)

AIR COMPRESSOR

The air compressor is a two-cylinder single-acting, reciprocating type unit. Compressor is flange mounted to the gear train cover at rear end of the engine. Compressor is driven directly from the engine camshaft, and lubricated by the engine lubrication system. The cylinder head and cylinder block are cooled by engine cooling system. Compressor has a rated capacity of 12 cu. ft. per minute based on piston displacement when running at a speed of 1250 rpm.

AIR COMPRESSOR DRIVE AND LUBRICATION

Typical compressor drive is shown in figure 1. A hub with internal fiber teeth is keyed to front end of the compressor crankshaft and secured by a nut and cotter pin. An internal-toothed fiber drive disc is attached to the engine camshaft gear by four cap screws. A drive coupling with external teeth at each end is carried in internal teeth of the hub and drive disc, transmitting power from drive disc to the air compressor crankshaft hub.

Oil, under pressure from the engine lubrication system, enters drilled crankshaft through crankshaft rear end cover and is forced through crankshaft and drilled connecting rods (fig. 8), lubricating bearings, piston pins, and pistons. Oil return is cast integral with compressor crankcase.

Two vent holes through the crankcase above the crankshaft front bearing permit equalization of the compressor crankcase pressure with the engine crankcase pressure.

AIR COMPRESSOR AIR INTAKE

The air compressor air inlet port is connected by a tube to the engine air cleaner manifold. The air drawn into the air compressor is cleaned by the engine air cleaners.

AIR COMPRESSOR OPERATION

Air compressor crankshaft turns continuously while engine is running. Actual compression of air is controlled by the compressor governor, however. Acting with compressor unloading mechanism, governor controls compression of air by loading or unloading compressor when pressure in air system reaches the desired high or low point

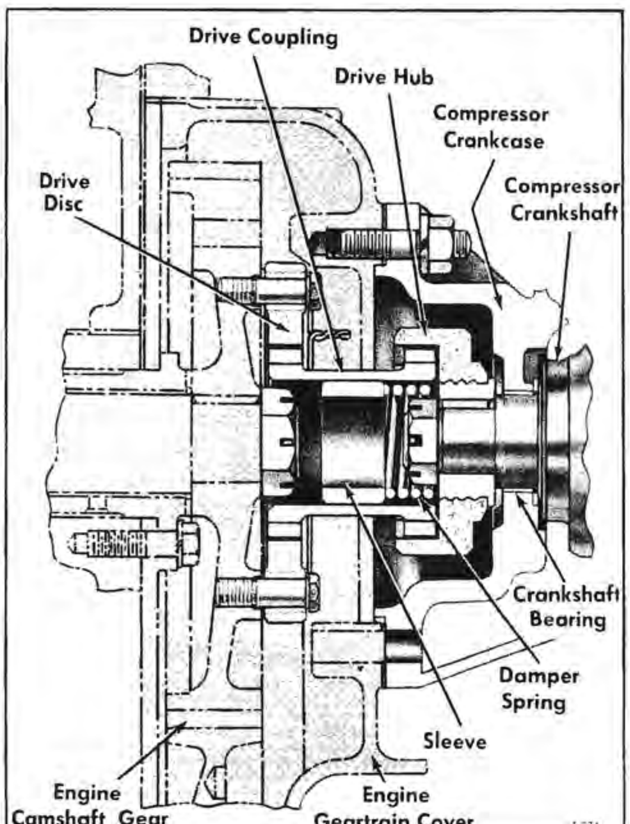


Figure 1—Air Compressor Drive (Typical)

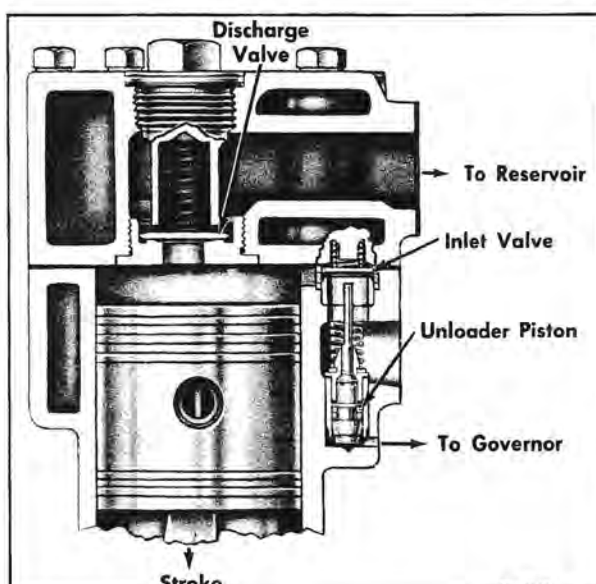


Figure 2—Intake of Air

OPERATION WITH UNLOADER VALVE CLOSED (COMPRESSING) (Figs. 2 and 3)

During the downstroke, a partial vacuum is created above each piston. Intake air forces open the inlet valve and air fills cylinder.

As piston starts upstroke, air pressure on top of inlet valve plus inlet valve return spring force closes the inlet valve. As air above piston is further compressed, pressure lifts discharge valve and compressed air is forced through discharge line into reservoir. At start of downstroke discharge valve returns to seat, blocking return flow of compressed air to cylinder as cycle is repeated.

OPERATION WITH UNLOADER VALVES OPEN (NOT COMPRESSING) (Fig. 4)

When air in system reaches maximum pressure for which governor is set, air passes through governor into unloader cavity below unloader piston cups in compressor cylinder block. Upward movement of unloader pistons caused by air pressure lifts both air inlet valves off inlet valve seats. With both inlet valves unseated, air intake cavity in the cylinder block forms a passage between cylinders above the pistons. Upstroke of one piston exhausts air into cylinder of other piston on downstroke, without compression.

When pressure in air system is reduced to governor cut-in setting, the governor releases pressure from beneath unloader pistons. Pressure of unloader spring on unloader spring saddle, acting against reduced governor pressure, forces pistons away from inlet valves. As inlet valve springs in turn overcome reduced plunger pressure, inlet valves reseat and compression is resumed.

AIR COMPRESSOR MAINTENANCE

It is important that inspection and adjustments listed below be made at intervals determined by severity of service.

1. Remove cylinder head and clean carbon away from discharge valves and inlet valves.
2. Check compressor discharge line. Make sure line is not choked with carbon.
3. Check compressor mounting bolts and tighten if necessary.
4. Make sure oil and air lines and connections are tight and free from leaks.
5. When draining engine cooling system to prevent freezing, be sure and remove drain plug from compressor cylinder block.

UNLOADER ASSEMBLY REPLACEMENT

Parts are available in a kit for replacing unloader assembly components. Unloader parts (fig. 5) may be changed without removing cylinder head. Replace parts as follows:

REMOVAL (Fig. 6)

1. Remove air inlet elbow and gasket.
2. Insert screwdriver blade under unloader spring and raise spring off unloader spring saddle. Remove spring, spring seat, and spring saddle.
3. Lift each plunger guide and remove guide and plunger. Lift pistons out of bores. If piston is not easily removed, build up air pressure in system until governor cuts out raising piston. If compressor has been removed from vehicle, use air pressure as shown in figure 6.

INSTALLATION (Fig. 7)

1. Carefully insert each piston, complete with

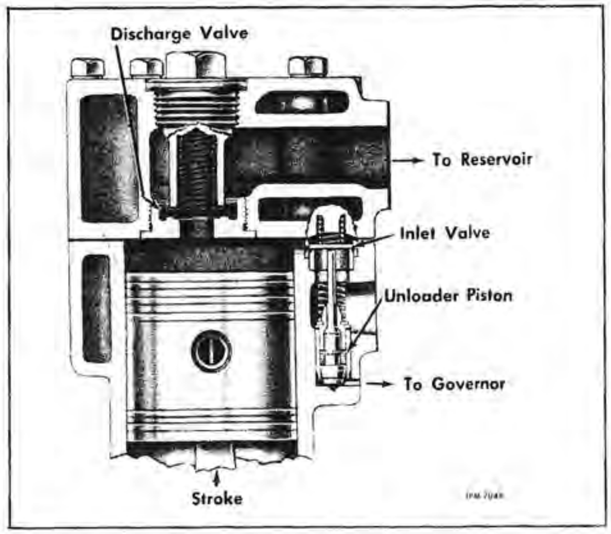


Figure 3—Compression of Air

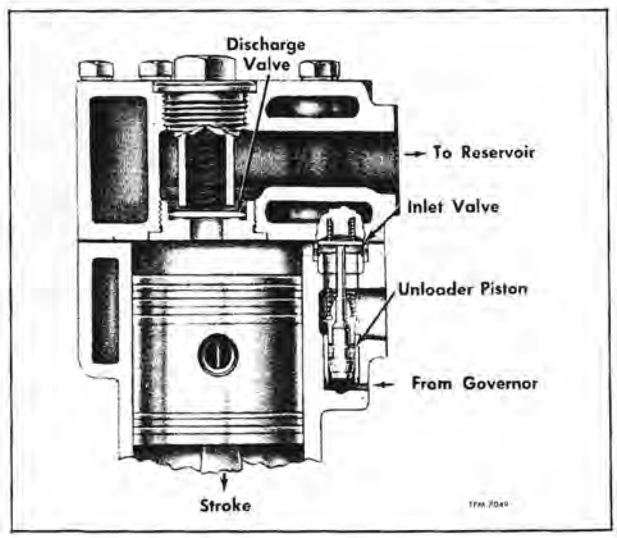


Figure 4—Unloading Compressor

AIR COMP. AND GOVERNOR (B-W)

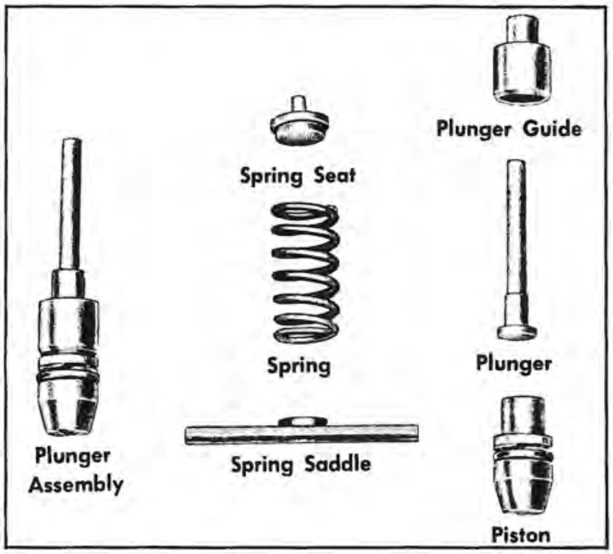


Figure 5—Unloader Assembly Components

new O-ring and back-up ring, in bore.

2. Slide plunger guide down over unloader plunger. Place each guide and plunger in position above unloader piston, then push guide down over top of piston.

3. Install unloader spring seat, spring saddle, and spring.

4. Install new gasket at air inlet and connect air inlet elbow. Tighten bolts firmly.

AIR COMPRESSOR REPLACEMENT

REMOVAL (Fig. 1)

1. Drain engine cooling system.

2. Disconnect water, air, and oil lines from air compressor.

3. Remove nuts and lock washers from four studs attaching air compressor to gear train cover. Pull compressor straight back off studs and remove from vehicle.

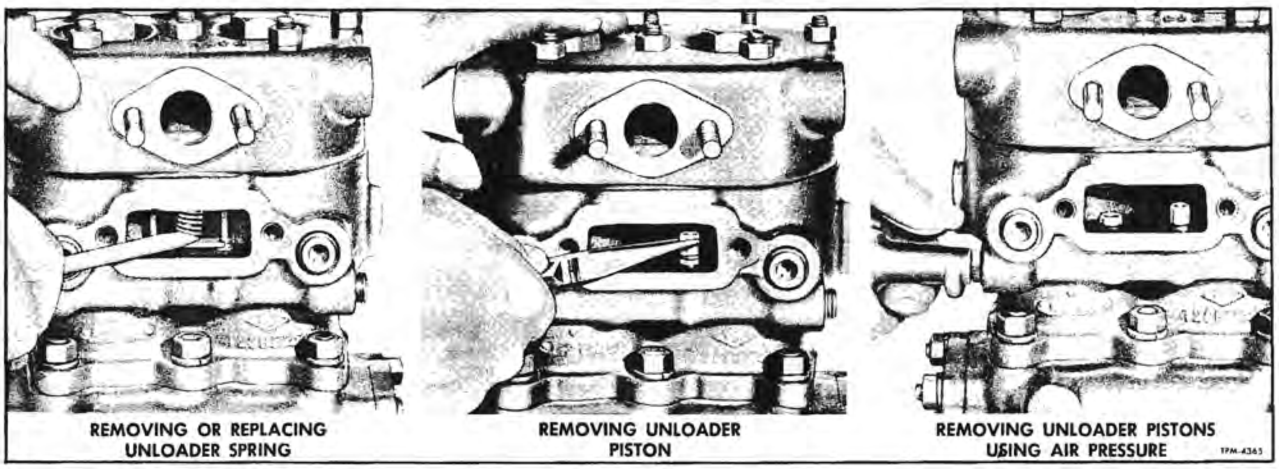


Figure 6—Removing Unloader Components

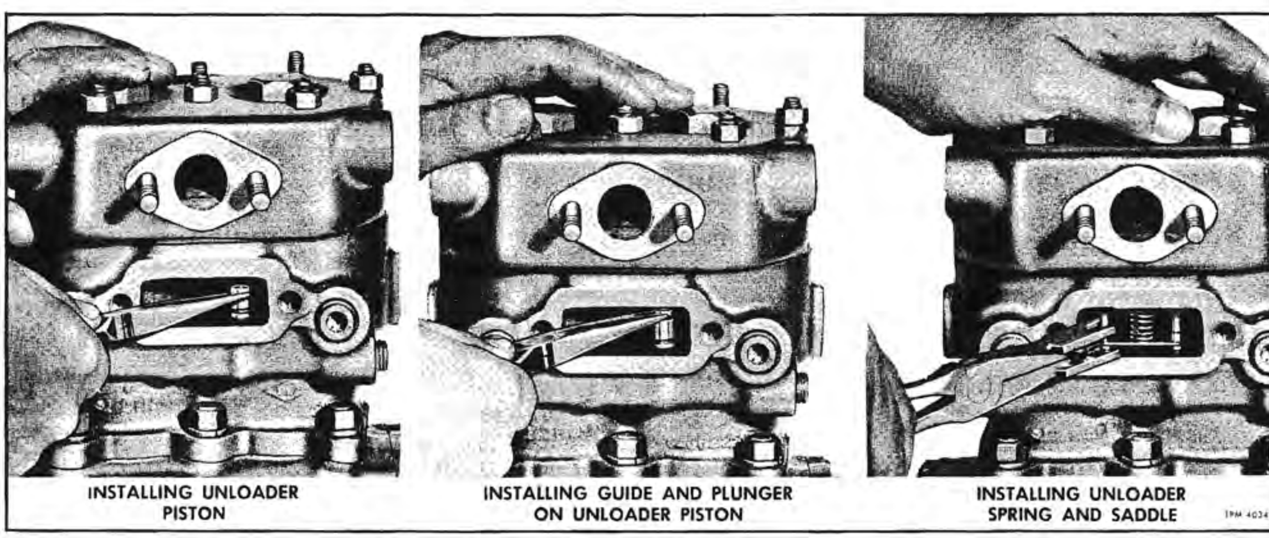


Figure 7—Installing Unloader Components

INSTALLATION (Fig. 1)

1. Clean oil supply line to compressor, and if possible, run engine a few seconds to be sure oil supply to compressor is flowing freely.

2. Clean oil passage in compressor crankcase.

3. Lubricate compressor cylinder walls and bearings with lubricating oil before placing compressor in position.

4. Clean or replace any damaged or dirty air lines or water lines which may be corroded before connecting them to the compressor.

5. Before installing compressor, examine hub on compressor crankshaft and drive disc on camshaft gear for worn or broken teeth. Check backlash between teeth in hub and teeth on drive coupling, also between teeth in drive disc and teeth on coupling. New limits are 0.000" to 0.001" backlash. If backlash is appreciably greater than this, drive disc or hub (or both) must be replaced.

6. Make sure mating surfaces of air compressor flange and gear train cover are clean. Place new compressor to cover gasket on studs.

7. Insert damper spring in drive coupling and place spring end of drive coupling into hub on compressor crankshaft. Place compressor in position on gear train cover, guiding teeth on coupling in to mesh with teeth in drive disc. Install nuts and lock washers on studs and tighten firmly.

8. Connect all water, air, and oil lines, making sure connections are tight.

9. Make sure drain plug is installed in compressor cylinder block, then fill cooling system.

AIR COMPRESSOR OVERHAUL

COMPRESSOR DISASSEMBLY

The crankcase, crankcase bottom cover, cylinder block, and cylinder head are so designed that method of assembly may be varied to meet different installation requirements. These parts should be marked before disassembling, so they can be reassembled in same position.

NOTE: Key numbers in text refer to figure 8.

CYLINDER HEAD REMOVAL
AND DISASSEMBLY

1. Remove all cylinder head cap screws, then lift off cylinder head assembly (9). Tap head with soft hammer, if necessary, to break gasket joint.

2. Scrape cylinder head and block, if necessary, to remove any part of gasket (15) sticking to gasket surface.

3. Remove discharge valve cap nuts (4) and lift out discharge valve springs (3) and discharge valves (2). Remove discharge valve seats (57). Remove inlet valve springs (6) and inlet valves (5) from top of cylinder block.

PISTON AND CONNECTING ROD
REMOVAL AND DISASSEMBLY

1. Remove screws and lock washers attaching crankcase bottom cover (31) to crankcase, and remove cover and gasket (30).

2. Before removing, mark each piston. Marks will be used to reassemble parts in original position. Connecting rods and caps have center punch marks showing proper position of cap on rod.

3. Remove cotter pins and nuts from connecting rod bolts. Remove connecting rod bearing caps (36) and bearing inserts (37). Do not remove bolts from rods. Push pistons (48) with connecting rods (44) attached out top of cylinder block. Replace caps on rods with inserts in place to prevent damage to bearing inserts.

4. Remove piston rings (47 and 54) from pistons. If connecting rods are to be removed from pistons, remove piston pin lock wires (51), then press piston pins (50) out of pistons and connecting rods.

CRANKSHAFT REMOVAL

1. Remove cotter pin and nut (41) from front end of crankshaft (42) and pull drive hub off shaft. Remove drive hub key (40) from keyway in shaft.

2. Remove cap screws (24) attaching rear end cover (26) to crankcase and remove cover and oil seal (29). Remove oil seal from boss on cover.

NOTE

Crankshaft rear bearing (27) will come off with end cover.

3. Remove crankshaft through rear end cover opening.

4. Remove crankcase front and rear thrust washers. Do not remove crankshaft bearings from crankcase and end cover unless inspection shows necessity for removal.

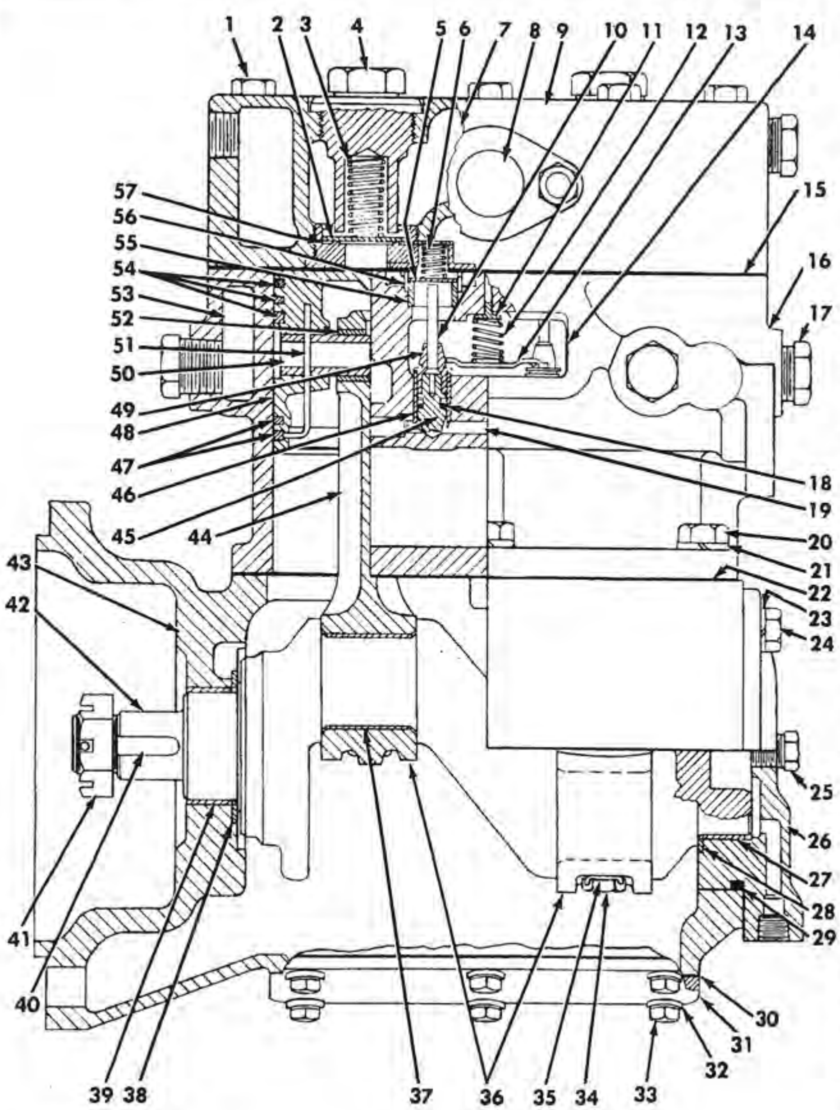
CYLINDER BLOCK REMOVAL
AND DISASSEMBLY

1. Remove bolts and lock washers securing air compressor governor to cylinder block, then remove governor and governor gasket. Discard gasket.

2. Remove cap screws securing cylinder block (16) to crankcase (43), then remove cylinder block and cylinder block gasket (22). Discard gasket.

3. Remove unloader spring (12) and unloader spring saddle (13).

4. Remove unloader plungers (10), plunger guides (49), and unloader pistons (45). Remove inlet valve guides (56). NOTE: It may be necessary to use air pressure (with caution) at the governor



1 Cap Screw
2 Discharge Valve
3 Discharge Valve Spring
4 Discharge Valve Cap Nut
5 Inlet Valve
6 Inlet Valve Spring
7 Water Passage
8 Discharge Port
9 Cylinder Head
10 Unloader Plunger
11 Unloader Spring Seat
12 Unloader Spring
13 Unloader Spring Saddle
14 Air Intake Cavity
15 Gasket
16 Cylinder Block
17 Pipe Plug
18 Grommet
19 Unloader Cavity
20 Cap Screw
21 Lock Washer
22 Gasket
23 Lock Washer
24 Cap Screw
25 Pipe Plug
26 Rear End Cover
27 Crankshaft Rear Bearing
28 Crankshaft Rear Thrust Washer
29 End Cover Oil Seal
30 Gasket
31 Crankcase Cover
32 Lock Washer
33 Cap Screw
34 Nut
35 Lock Washer
36 Connecting Rod Bearing Cap
37 Connecting Rod Bearing
38 Crankshaft Front Thrust Washer
39 Crankshaft Front Bearing
40 Crankshaft Key
41 Crankshaft Nut
42 Crankshaft
43 Crankcase
44 Connecting Rod
45 Unloader Piston
46 Bushing
47 Oil Control Rings
48 Piston
49 Unloader Plunger Guide
50 Piston Pin
51 Piston Pin Lock Wire
52 Connecting Rod Bushing
53 Water Passage
54 Compression Rings
55 Inlet Valve Seat
56 Inlet Valve Guide
57 Discharge Valve Seat

TPM-9348-3

Figure 8—Air Compressor Assembly

port of the cylinder block to remove the unloader pistons, after removing the unloader plunger and associated parts.

CLEANING AND INSPECTION OF COMPRESSOR PARTS

CLEANING

1. General. Thoroughly wash all parts in a suitable cleaning solvent to remove all traces of dirt, oil, or grease.

2. Cylinder Head. Soak cylinder head in cleaning solvent to loosen carbon from discharge valve cavities and unloading cavity, and to loosen rust and scale. Blow dirt out of all cavities with compressed air. Scrape carbon and dirt from all surfaces. Scrape gasket particles from gasket surfaces.

3. Discharge Valves. Clean discharge valves, if not worn excessively or damaged, by lapping with crocus cloth held on a flat surface.

4. Oil Passages. Thoroughly clean oil passages through crankshaft, connecting rods, and crankcase rear end cover. If necessary, prod oil passages with a piece of wire; then flush passages with cleaning solvent and blow out with compressed air.

5. Cylinder Block. Soak cylinder block in cleaning solvent to loosen carbon and dirt from air intake cavity. Clean rust and scale from water passages. Blow out all passages with compressed air.

6. Pistons. Scrape all carbon and dirt out of ring grooves in pistons. Clean drain holes in oil ring grooves.

7. Crankcase Bottom Cover. Wash crankcase bottom cover in cleaning solvent.

INSPECTION

1. Cylinder Head. Inspect cylinder head for cracks or breaks. Replace with new head if cracked or damaged.

2. Inlet and Discharge Valve Springs. Discard used inlet and discharge valve springs and replace with new springs.

3. Inlet and Discharge Valves and Seats. Inspect inlet and discharge valves and seats for signs of excessive wear. Replace valves if grooved deeper than 0.003" at point of seat contact. Replace valve seats if condition is such that seats can no longer be refaced.

4. Unloading Pistons and Plungers. Inspect pistons, plungers, and plunger guides for signs of damage or excessive wear. New unloading pistons should slide easily in bores. Check bores for scratches or damage that might increase O-ring wear. Check unloading piston return spring dimension and compare with "Specifications" listed at end of this section. Replace spring if necessary.

5. Crankcase and End Cover. Check crankcase and end cover for cracks or other damage. Replace with new parts if damaged. Check fit of oil seal ring in groove of rear end cover. Ring must be snug fit in groove, and must have 0.008" to 0.015" clearance at gap when placed in end of crankcase.

6. Cylinder Block (Fig. 9). Use telescoping gauge to check bores for out-of-round and taper. Bores which are scored or out-of-round more than 0.002" or tapered more than 0.003" must be rebored, honed, or ground oversize. Pistons and rings 0.010", 0.020", and 0.030" oversize are available.

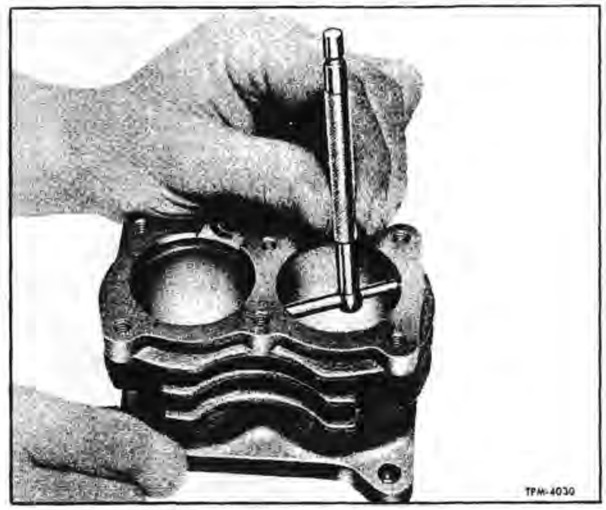


Figure 9—Measuring Cylinder Bore Diameter

Cylinder bores must be smooth, straight, and round and must be finished with a 500 (or finer) grit hone. The clearance between piston and cylinder wall must not be less than 0.002" or more than 0.004". Replace cylinder block if cracked or damaged.

7. Pistons (Fig. 10). Examine pistons for scoring, cracks, or damage of any kind. Measure outside diameter of piston with a micrometer and compare this measurement with the inside diameter of cylinder bore. Clearance should not be less than 0.002" or more than 0.004". Piston over 0.004" smaller than cylinder bore must be replaced with an oversize piston.

8. Piston Pins and Bushings. Check fit of piston pins in pistons and connecting rods. Pins must be light press fit in pistons. If piston pin is loose in piston, the pin, piston, or both must be replaced. Check fit of piston pins in connecting rod bushings by rocking pins in bushings. If looseness is evident, replace connecting rod bushings as directed under "Compressor Repair." Discard all piston pin lock wires.

9. Piston Rings (Fig. 11). Check fit of piston rings in ring grooves, and check ring gap with ring in cylinder bore. Clearance between rings and

Figure 10—Measuring Piston Diameter

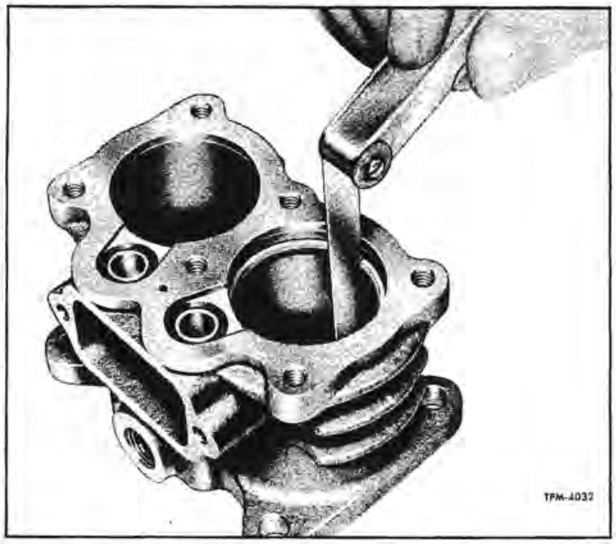


Figure 11—Measuring Piston Ring Gap

sides of ring grooves should be from 0.0035" to 0.0055" for two wide rings and from 0.002" to 0.004" for three narrow rings as shown in figure 12. Ring gap should be from 0.005" to 0.015".

10. Connecting Rods and Bearings. Check fit of connecting rod bearing inserts on crankshaft journals. Clearance between bearings and crankshaft journals must not be less than 0.002" or more than 0.004". Replace bearing inserts if clearance is excessive or if bearings are cracked or flaked. Connecting rod caps are not interchangeable. Position caps so that locking slots are both located adjacent to same cap screw.

11. Crankshaft. Crankshaft journals should not be out-of-round more than 0.001", ridged, or scored. If grinding is necessary, do not grind fillets at ends of journals. Connecting rod bearing inserts are available in 0.010", 0.020", and 0.030" undersize for reground crankshafts. Check main bearing

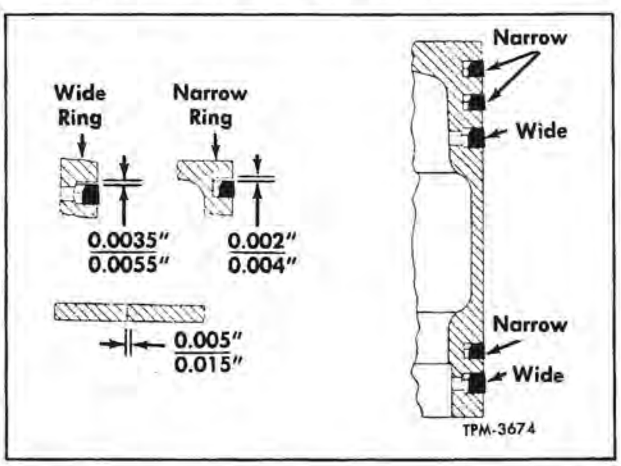


Figure 12—Piston Ring Arrangement and Clearances

journals for excessive wear.

12. Crankshaft Bearings. Inspect crankshaft bearings in end cover and crankcase for wear or damage. If necessary replace bearings as described later under "Compressor Repair."

COMPRESSOR REPAIR

DISCHARGE VALVE AND SEATS

1. Remove slight scratches and pits from discharge valve seats. Use lapping stone, grinding compound, lapping disc, and valve grinding tool.

2. Place discharge valve on valve seats, install discharge valve springs in cap nuts, and thread cap nuts firmly into cylinder head. To test discharge valves for leakage, connect air line to discharge port in cylinder head. Apply 100 pounds air pressure to valves and apply soap suds to discharge valve openings in bottom of cylinder head. Leakage in excess of a one-inch bubble in one second is not permissible. If leakage is excessive, leave air pressure applied. Using a fiber or hardwood dowel and a light hammer, tap valves off seats several times. This should improve fit of valve on seat. Check leakage around top of discharge valve cap nuts by applying soap suds to this area. Leakage must not exceed a one-inch bubble in five seconds. Shut off air pressure and disconnect air line from cylinder head.

3. Remove discharge valve seats too badly worn for refacing. Thread new seats into head and tighten firmly. With new valves, discharge valve travel should be from 0.056" to 0.070".

INLET VALVES AND SEATS

1. Remove slight scratches or pits from inlet valve seats. Use lapping stone, grinding compound, lapping disc, and valve grinding tool. Replace seats that cannot be repaired. Dimension from the top of cylinder block to the inlet valve seat should not exceed 0.145". After installing new seats, the dimension should be 0.101" to 0.113".

2. Inlet valves not badly worn or damaged can be repaired by lapping valves on a piece of crocus cloth held on a flat surface.

CONNECTING ROD BUSHINGS

If piston pin bushings in connecting rods require replacement as previously indicated in step 9 under "Inspection," press old bushings out of connecting rods. Press new bushings in, making sure the oil holes in the bushings line up with the oil passages in the connecting rods. Bushings must then be reamed, honed, or bored to provide 0.0003" -0.0015" clearance on piston pin.

CRANKSHAFT BEARINGS

1. If crankshaft bearings are worn or damaged,

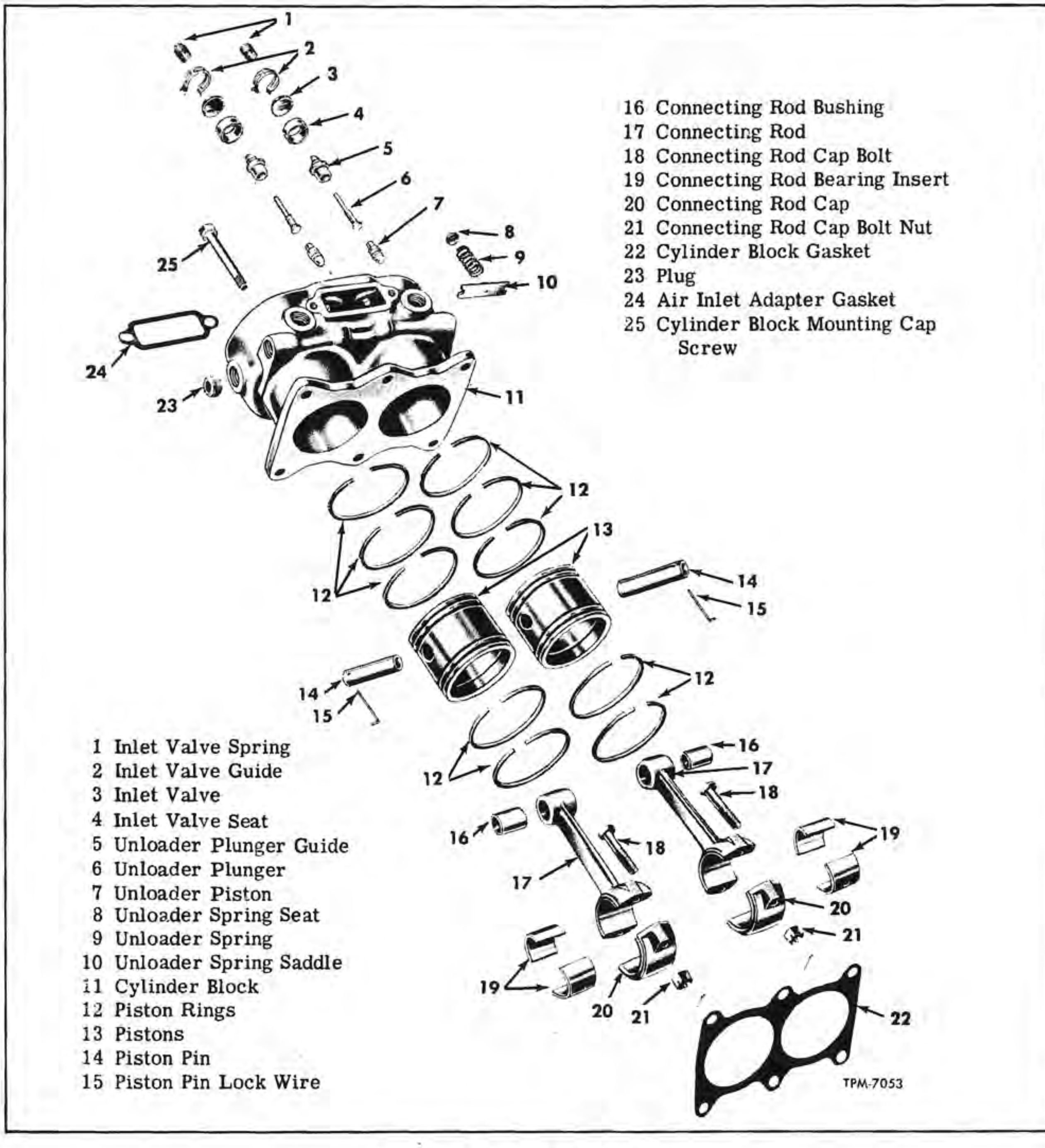


Figure 13—Cylinder Block Components

use a suitable puller and remove rear bearing from end cover.

2. Use a suitable sleeve and press or drive front bearing out of crankcase.

3. Using a suitable sleeve, press or drive new bearing into rear end cover. Press or drive bearing in flush. Use a suitable sleeve and press or drive new front bearing in crankcase. Press or drive bearing in flush.

COMPRESSOR ASSEMBLY

CRANKSHAFT INSTALLATION

Key numbers in text refer to figure 8.

1. Place front thrust washer (38) on crankshaft (42) with oil groove toward shoulder on shaft.

2. Insert crankshaft through end cover opening in crankcase (43).

AIR COMP. AND GOVERNOR (B-W)

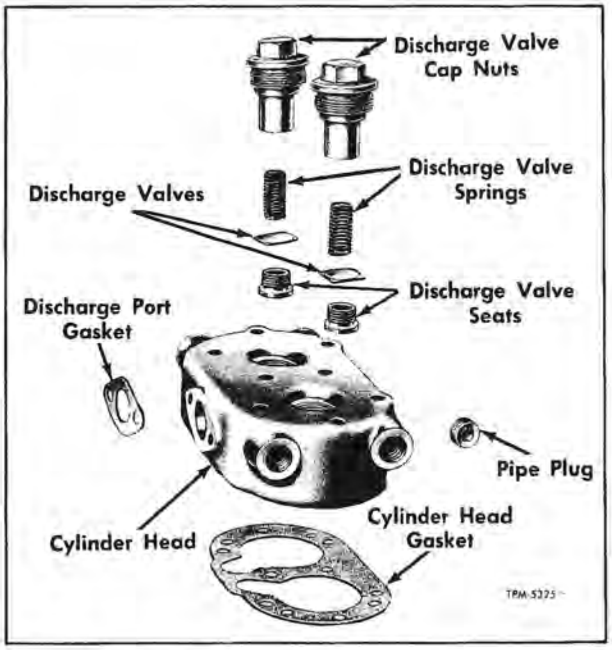


Figure 14—Cylinder Head Components

3. Position rear thrust washer (28) on crankshaft with oil groove toward shoulder on shaft.

4. Install end cover oil seal (29) in groove of end cover (26).

5. Press end cover and bearing assembly on crankshaft until end cover is against the crankcase.

6. Install cap screws (24) and lock washers (23) attaching end cover to crankcase. Tighten cap screws firmly.

7. Install key in keyway in front end of crankshaft, install drive hub on shaft, and secure with nut and cotter pin.

CYLINDER BLOCK INSTALLATION

Place new cylinder block gasket on crankcase. Position cylinder block on crankcase, aligning marks made before disassembly. Install cap screws and lock washers. Tighten cap screws firmly.

PISTON AND CONNECTING ROD ASSEMBLY AND INSTALLATION

Key numbers in text refer to figure 13.

1. Position connecting rod (17) in piston (13) and press piston pin (14) into piston (13) with lock wire holes in pin (14) aligned with lock wire holes in piston (13).

2. Install new piston pin lock wire (15) in piston pin (14) so that long end extends through piston and pin. Snap short end into lock wire hole at bottom of piston skirt.

3. Install piston rings (12) in grooves of pistons. Rings must be installed in proper location and with pip marks upward. Refer to figure 12 for proper clearance dimensions and location of rings. Stagger position of ring gaps outside of inlet throat area.

4. Press bearing inserts (19) into rod and cap (20) by hand, with locking slots in proper alignment (all slots on side of same cap bolt).

5. Lubricate pistons, rings, piston pin bushings, and bearing inserts with clean engine oil.

6. Turn crankshaft to position bearing journal nearest pulley end of crankshaft (No. 1) downward. Remove bearing cap from No. 1 connecting rod leaving connecting rod bolts in rod.

7. Insert No. 1 connecting rod and piston through top of No. 1 cylinder aligning match marks previously installed, and seat squarely on connecting rod bearing journal. Install bearing cap. For proper assembly, two slots in bearing inserts and in rod and cap should be on side of same cap bolt. Install nuts and tighten firmly; then install two new cotter pins.

8. Install No. 2 piston and connecting rod in same manner as described above.

9. Install crankcase bottom cover, using a new gasket, with marks made prior to disassembly aligned. Attach cover to crankcase with screws and lock washers.

UNLOADER PISTON AND PLUNGER ASSEMBLY AND INSTALLATION (Figs. 7 and 8)

1. Coat each unloader piston, O-ring, and piston bore with a silicone type lubricant. Insert piston in bore.

2. Insert plunger in plunger guide. Hold guide and plunger with large-nose pliers and install over unloader piston.

3. Install unloader spring saddle and unloader spring. Make certain that saddle rests squarely on top of plunger guides and make sure top of spring engages spring seat pressed into block.

CYLINDER HEAD ASSEMBLY AND INSTALLATION (Fig. 14)

1. Install discharge valve seats in cylinder head. Place discharge valves on seats through opening in top of cylinder head. Place discharge valve springs in discharge valve cap nuts. Thread cap nuts into cylinder head. Tighten nuts firmly.

2. Place inlet valves (3, fig. 13), inlet valve guides (2, fig. 13), and inlet valve springs (1, fig. 13) in bores in top of cylinder block.

3. Install new cylinder head gasket on cylinder block. Carefully align inlet valve springs with inlet valve guides in cylinder head. Align marks made before disassembly and install cylinder head on cylinder block. Install cylinder head cap screws and tighten evenly and firmly. Replace all pipe plugs.

4. Install new gasket and replace air inlet elbow.

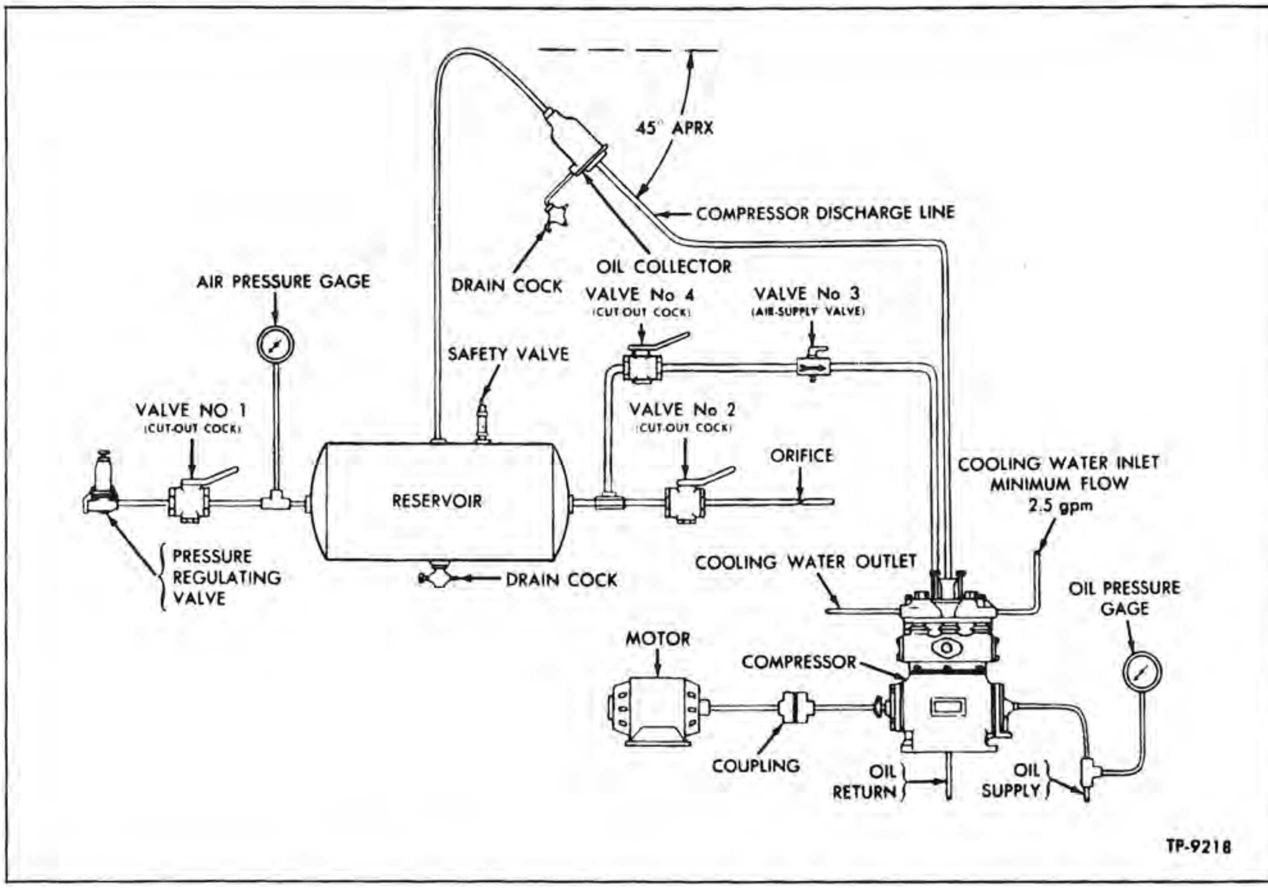


Figure 15—Typical Air Compressor Test Hook-Up

AIR COMPRESSOR TESTS AFTER OVERHAUL

After overhauling the air compressor, following tests are recommended to determine if compressor is operating properly. Connect an oil supply line, having at least 15 pounds pressure to compressor rear end cover opening. Plug other opening in end cover and in crankcase. Provisions must be made for drainage of oil from crankcase during test. Water must be circulated through compressor water passages while compressor is operating. Figure 15 shows a typical test hook-up which can be used to make the following tests.

RUN-IN TEST

Run compressor for one-half hour at 1750 rpm with compressor discharge port open to atmosphere. Check for oil leaks, overheated bearings, and excessive noise.

OIL PASSING TEST

Run compressor for one-half hour at 1750 rpm, pumping against 50 psi air pressure with an oil trap connected in the discharge line (fig. 15). Close valves 2 and 4, open valve 1, and adjust pressure regulating valve to maintain 50 psi air pressure in the reservoir. Cover air inlet opening in compressor intake cavity with a plate drilled at center to a 3/8" orifice. Drain the oil collector completely before starting test. At end of half hour test, stop motor and open reservoir drain cock to drain air pressure completely. Open oil collector drain cock to collect and measure oil passed. The oil passed during this test must not exceed 2 cubic centimeters.

EFFICIENCY TEST

This test is made by running compressor one-half hour at 1750 rpm connected to a reservoir fitted with an orifice type exhaust fitting. Close valves 1 and 4 (fig. 15), open valve 2, and mount orifice in line beyond valve 2. Orifice should be 0.089". With air exhausting continuously through orifice, compressor should maintain 75 psi pressure in reservoir.

This test can also be used on a compressor before it is overhauled to determine the necessity of an overhaul. A compressor which does not maintain 60 pounds pressure in reservoir at 1750 rpm should be overhauled.

COMPRESSOR UNLOADER MECHANISM TEST

The compressor unloader can be tested by closing valves 1 and 2 and opening valves 3 and 4 (fig. 15). Run compressor until unloader operates. Watch air pressure. Unloader should operate at 115 to 120 psi, stopping further compression.

UNLOADER PISTON TEST

Unloader piston should be tested by application of 115 psi air pressure through governor line port. When coating unloader pistons with soap suds, leakage should not exceed a 1/2" soap bubble in less than five seconds.

AIR COMPRESSOR GOVERNOR—TYPE "D-2"

DESCRIPTION

The governor, operating in conjunction with air compressor unloading mechanism, automatically controls air pressure in the air brake or air supply system between the desired, predetermined maximum, and minimum pressures. The air compressor runs continually while the engine runs, but actual compression of air is controlled by the governor which stops or starts compression when the maximum or minimum reservoir pressures are reached. The "D-2" governor has a piston upon which air pressure acts to overcome the pressure setting spring and control the inlet and exhaust valve to either admit or exhaust air to or from air compressor unloading mechanism.

Type "D-2" governors can be attached to the air compressor or mounted remotely. They are adaptable to either mounting. Connections in this system are to the reservoir and compressor unloading ports. They also have an exhaust port (fig. 16).

OPERATION

(Refer to Figure 17)

Reservoir air pressure enters the D-2 governor at one of its reservoir ports and acts on the area of the piston and beneath the inlet and exhaust valve. As air pressure builds up the piston moves against resistance of the pressure setting spring. The piston and inlet exhaust valve move up when reservoir air pressure reaches cut-out setting of the governor. The exhaust stem seats on the inlet and exhaust valve and then the inlet passage opens. Reservoir air pressure then flows by the open inlet valve, through the passage to piston and out unloader port to the compressor unloading mechanism. The air, besides flowing to compressor unloading mechanism, also flows around the piston and acts on additional area of the piston. This additive force which results from a larger area on the piston assures a positive action and fully opens the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and exhaust will open. With exhaust open, air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

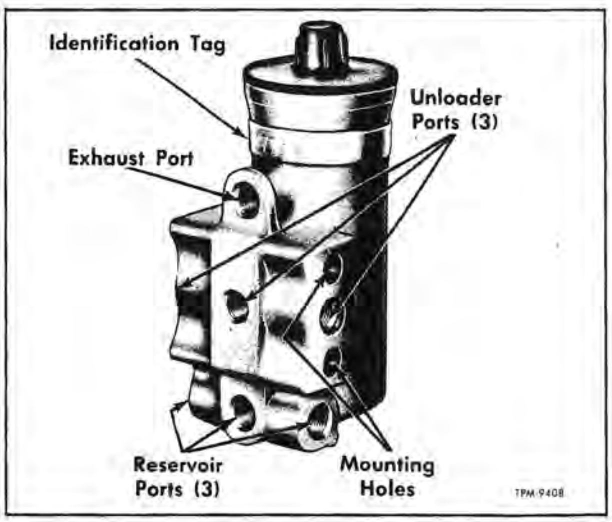


Figure 16—Type "D-2" Governor Ports

MAINTENANCE

Every 500 operating hours or after every 15,000 miles, clean or replace governor filters (fig. 17). Clean or replace filters as described later in this section under "Type D-2" Governor Overhaul."

Every 3,000 operating hours or after every 100,000 miles, disassemble the "D-2" governor and clean and inspect all parts. Repair governor as described later in this section under "Type "D-2" Governor Overhaul."

GOVERNOR TESTS

OPERATING TEST (Fig. 17)

Start the engine and build up air pressure in system. Observe reading on air pressure gauge in gauge panel when governor cuts-out, stopping compression of air by the compressor. Reading on gauge when governor cuts-out should be between 115 and 120 psi.

With the engine still running, slowly reduce air pressure in the system by applying and releasing brakes. Observe pressure registered by gauge when governor cuts-in and compression is resumed. Gauge reading when governor cuts-in should be between 100 and 105 psi.

Before condemning or adjusting the governor, be sure the dash air gauge is registering accurately. Use an accurate test gauge to check pressure registered by the dash gauge. If the pressure settings of the Type "D-2" governor are inaccurate or it is necessary that they be changed, adjust governor as described in the following:

ADJUSTMENT

1. Unscrew cover at top of the governor.
2. Loosen adjusting screw lock nut.
3. Using a screwdriver, turn adjusting screw counterclockwise to raise pressure settings. Turn adjusting screw clockwise to lower the pressure settings.
4. When adjustment is completed, tighten adjusting screw lock nut.
5. Install cover on the governor.

LEAKAGE TEST

Leakage checks on the "D-2" governor are made at its exhaust port in both cut-in and cut-out positions. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston grommet. In the cut-out position check the exhaust port to determine if leakage is present at the exhaust valve seat or stem grommet. In this position leakage could also be past the upper piston grommet.

Leakage in excess of a 1-inch soap bubble in three seconds is not permissible in either of the above tests. Overhaul governor as described below under "Type "D-2" Governor Overhaul."

TYPE "D-2" GOVERNOR OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 18.

1. Using cleaning solvent and a brush, clean dirt and grease from exterior of governor.
2. Using fingers, remove rubber cover (1) from governor assembly. Remove two pipe plugs from governor body.
3. Using Tru-Arc pliers, remove cover retaining ring (2) from groove in governor body (19).
4. Remove adjusting screw and spring assembly from governor body (19).
5. Remove the piston assembly from governor body. It may be necessary to tap governor body flat against work bench to dislodge piston.
6. Remove two piston grommets (10 and 18) from grooves in piston (15). Discard grommets.
7. Remove valve spring (17), valve (16), exhaust stem (11), and exhaust stem spring (12) from piston (15).
8. Remove exhaust stem grommet (14) and washer (13) from bore. Discard grommet.
9. Mount adjusting screw and spring assembly in a vise with soft jaws.
10. Carefully measure distance lock nut (3) is threaded on adjuster screw (9) before removing it in step 11 following:
11. Remove lock nut (3) from adjuster screw; then thread adjuster screw (9) out of upper spring seat (4).
12. Remove spring (5), lower spring seat (6), spring guide (7), and second lower spring seat (8) from adjuster screw.

CLEANING AND INSPECTION

1. Wash all metal parts in cleaning solvent. Blow parts dry. Wipe rubber parts dry.
2. Check valve spring (17), exhaust stem spring (12), and adjuster screw spring (5) for free length, compressed length, distortion, or collapsed coils.
3. Inspect governor body (19) for cracks, nicks, burrs, or other damage. Check for crossed or stripped threads.
4. Inspect adjuster screw (9) for crossed or stripped threads and distortion.
5. Examine the piston (15) for nicks, burrs, or other damage.
6. Check governor valve (16) for deterioration or other damage.
7. Examine the two filters in governor body. If damaged, use a sharp hooked tool and remove them. Use a suitable sleeve and press new filters in governor body ports.
8. Inspect all air passages in ports for obstructions.

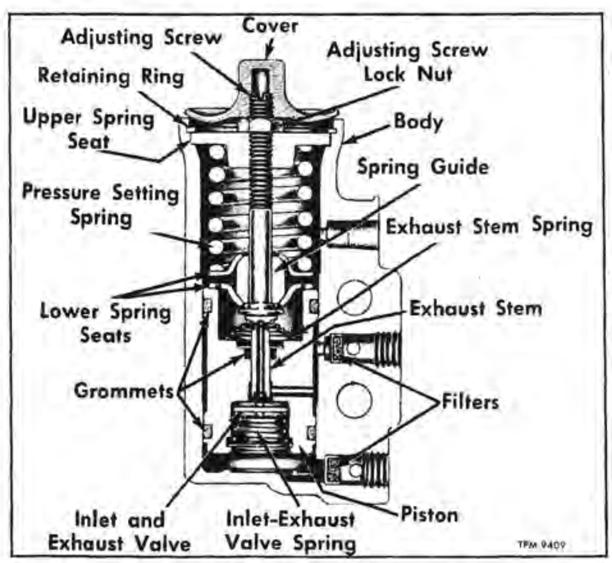


Figure 17—Type "D-2" Air Compressor Governor

AIR COMP. AND GOVERNOR (B-W)

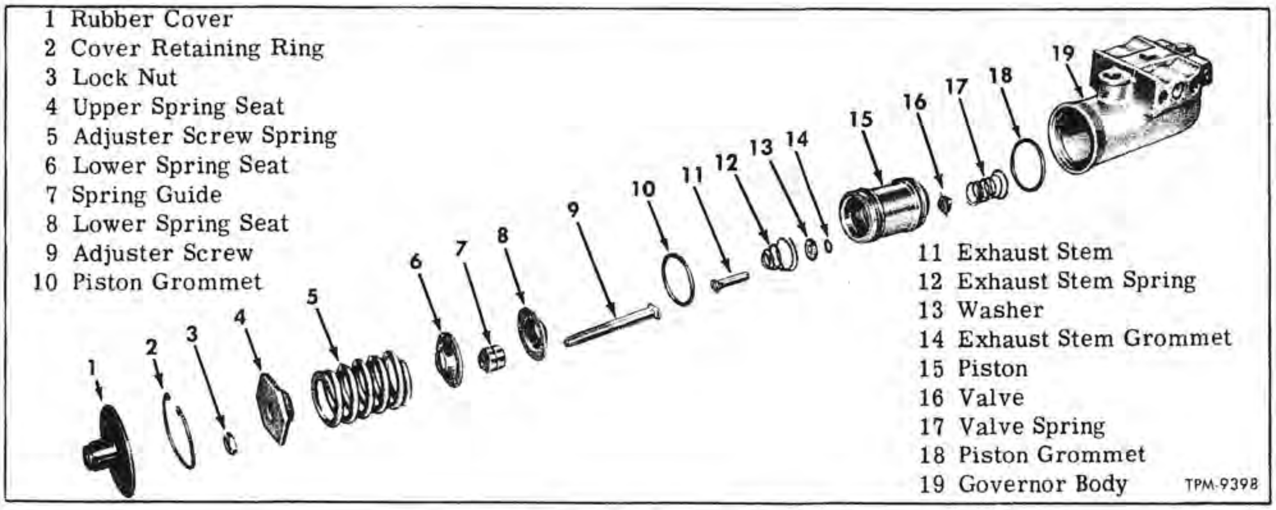


Figure 18—Type "D-2" Governor Components

ASSEMBLY

Key numbers in text refer to figure 18.

Prior to assembly of governor, lubricate governor body bore, top of piston, piston grooves, piston grommets, spring guide, and adjusting screw with special lubricant (S-17). Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17).

1. Position first lower spring seat (8), spring guide (7), second lower spring seat (6), and spring (5) on adjuster screw (9).

2. Thread adjuster screw (9) into upper spring seat (4); then mount adjuster screw and spring assembly in a vise having soft jaws.

3. Install lock nut (3) on adjuster screw (9). Turn nut on screw the same distance measured at disassembly.

4. Position new exhaust stem grommet (14) in groove inside piston (15). Install new washer (13) in piston (15). Prick punch washer in four places.

5. Install two new grommets (10 and 18) in grooves on outside of piston (15).

6. Position exhaust stem spring (12), exhaust stem (11), valve (16), and valve spring (17) in piston.

7. Insert piston assembly in bore of governor body.

8. Position adjusting screw and spring assembly in governor body; then using Tru-Arc pliers install the retaining ring (2).

9. Install new rubber cover (1) on governor body (19) over adjusting screw (9).

10. If previously removed, install two pipe plugs in governor body.

11. After the governor is installed in the vehicle, make "Governor Tests" described previously.

SPECIFICATIONS

AIR COMPRESSOR

MAKE	Bendix-Westinghouse
MODEL	Tu-Flo 500
TYPE	2 Cylinder, Water Cooled, Engine Oil Lubricated, and Flange Mounted
CAPACITY (AT 1250 RPM)	12 Cu. Ft.
CYLINDER BLOCK BORE	2.5005"
INLET VALVE SEAT WORN GROOVE	
Not to Exceed	0.003"
DISCHARGE VALVE SEAT WORN GROOVE	
Not to Exceed	0.003"
PISTON RING GAP (IN CYLINDER)	0.005"-0.015"
PISTON RING CLEARANCE (IN GROOVE)	
Narrow Ring	0.002"-0.004"
Wide Ring	0.0035"-0.0055"
CLEARANCE BETWEEN PISTON AND CYLINDER WALL	0.002"-0.004"
PISTON	
Length	2 11/32"
Number Ring Grooves	5
Width of Ring Grooves	0.0955"-0.0965"
Diameter at Top	2.484"-2.488"
Diameter at Ring Groove	2.223"
Diameter at Ring Land	2.487"-2.491"
WRIST PIN	
Length	2 5/16"
Inside Diameter	5/16"
Outside Diameter	0.4375"-0.4377"
BUSHINGS	
Cylinder Block Bushing	
Outside Diameter	0.473"-0.474"
Inside Diameter	0.376"-0.378"
Width	0.690"-0.693"
Wrist Pin Bushing	
Outside Diameter	0.6570"-0.6575"
Inside Diameter	0.508"-0.510"
Width	0.845"
CRANKSHAFT BUSHINGS	
Front	
Outside Diameter	1.5040"-1.5055"
Inside Diameter	1.3802"-1.3812"
Width	0.521"-0.541"
Rear	
Outside Diameter	2.2980"-2.2995"
Inside Diameter	2.1679"-2.1689"
Width	0.552"-0.572"
CRANKSHAFT	
Front Bearing Journal Diameter	1.3779"-1.3783"
Connecting Rod Journal Diameter	1.1242"-1.1250"
Rear Bearing Journal Diameter	2.1653"-2.1658"
Length	8 47/64"
CONNECTING ROD BEARING INSERT	
Width	1.235"-1.250"
Wall Thickness—Standard	0.05185"-0.05210"
0.010" Undersize	0.05685"-0.05710"
0.020" Undersize	0.06185"-0.06210"
0.030" Undersize	0.06685"-0.06710"
Length	0.924"
CRANKSHAFT THRUST WASHER	
Front	
Inside Diameter	1.476"
Outside Diameter	1.976"
Thickness	0.061"-0.063"
Rear	
Inside Diameter	2.263"
Outside Diameter	2.763"
Thickness	0.061"-0.063"
SPRINGS	
Unloader Spring	
Free Length	3/4"
Solid Length	5/16"
No. of Active Coils	5
Discharge Valve Spring	
Free Length	1 1/64"
Solid Length	13/16"
No. of Active Coils	13
Inlet Valve Spring	
Free Length	29/64"
Solid Length	13/64"
No. of Active Coils	6

GOVERNOR

MAKE	Bendix-Westinghouse
MODEL	"D-2"
CUT-OUT PRESSURE	115-120 PSI
CUT-IN PRESSURE	100-105 PSI
SPRINGS	
Valve Spring	
Free Length	53/64"
Solid Length	5/32"
No. of Active Coils	4
Exhaust Stem Spring	
Free Length	19/32"
Solid Length	3/64"
No. of Active Coils	3
Adjuster Screw Spring	
Free Length	1 23/32"
Solid Length	1 1/64"
No. of Active Coils	4 1/2

Air Compressor and Governor

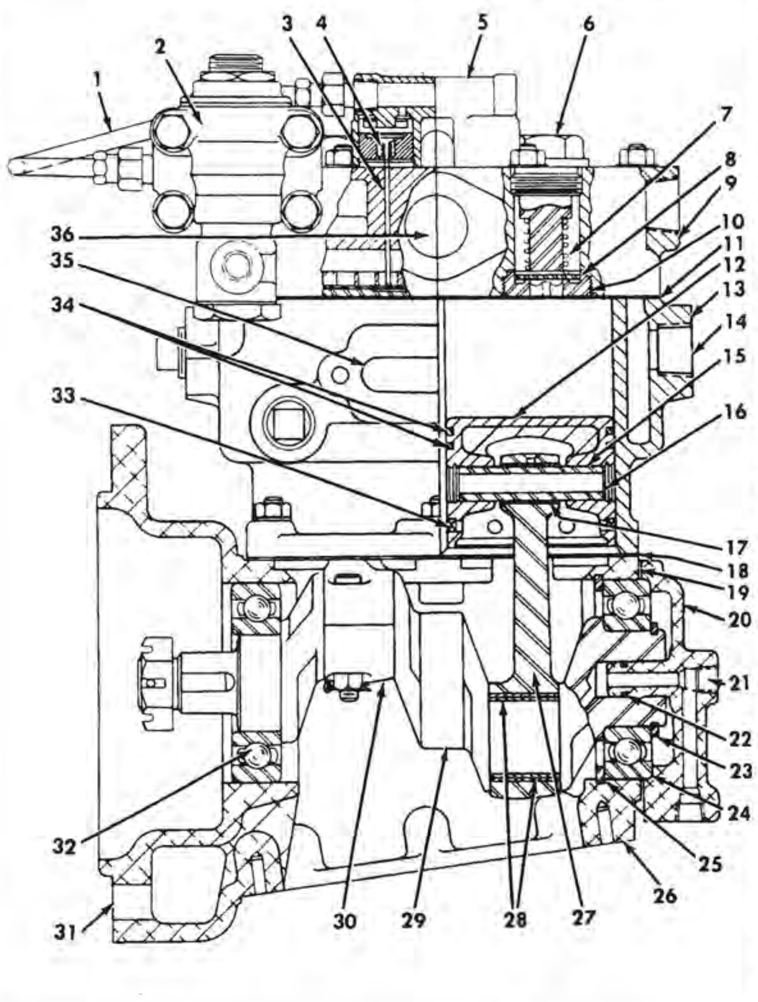
(MIDLAND-ROSS)

AIR COMPRESSOR

DESCRIPTION

The air compressor (fig. 1) is a two-cylinder, single acting reciprocating type unit. Compressor is flanged mounted to gear train cover at rear end of engine. Drive is direct from camshaft and lubrication is supplied by engine lubrication system. The cylinder block and the cylinder head are cooled by engine cooling system. Compressor has a rated capacity of 12 cubic feet of air per minute. This rating is based on piston displacement at 1250 rpm.

Compressor governor, bracket mounted to top of compressor cylinder head, controls compression of air. Crankshaft is mounted in two ball bearing assemblies or one ball (front) and one insert (rear) bearing. Connecting rod bearings are replaceable half type. Upper ends of connecting rods are equipped with replaceable bushings. Each piston has two compression rings at top and one oil ring at bottom. Piston pins are held in pistons with snap rings at both ends of piston pin. The compressor is connected to the air system by a line from discharge port to wet air tank.



1 Governor to Unloader Tube
2 Governor Assembly
3 Inlet Valve Plunger
4 Plunger Spring
5 Unloader Assembly
6 Discharge Valve Cap Nut
7 Discharge Valve Spring
8 Discharge Valve
9 Cylinder Head
10 Discharge Valve Seat
11 Cylinder Head Gasket
12 Piston
13 Cylinder Block
14 Water Inlet
15 Piston Pin
16 Piston Pin Lock Ring
17 Connecting Rod Bushing
18 Cylinder Block Gasket
19 Bearing Cap Gasket
20 Rear Bearing Cap
21 Oil Inlet
22 O-ring Seal
23 Bearing Lock Ring (Small)
24 Crankshaft Rear Bearing
25 Bearing Lock Ring (Large)
26 Crankcase
27 Connecting Rod
28 Rod Bearing Halves
29 Crankshaft
30 Rod Bearing Cap
31 Oil Outlet
32 Crankshaft Front Bearing
33 Oil Ring
34 Compression Rings
35 Air Inlet Port
36 Air Discharge Port

TPM-8750

Figure 1—Air Compressor and Governor (Midland-Ross)

COMPRESSOR DRIVE AND LUBRICATION

A hub with internal fiber teeth is keyed to the front end of the compressor crankshaft and secured by a nut and cotter pin. An internal-toothed fiber drive disc is attached to the engine camshaft gear by four cap screws. A drive coupling with external teeth at each end is carried in the internal teeth of the hub and drive disc, transmitting power from drive disc to air compressor crankshaft hub.

Oil, under pressure from the engine lubrication system, enters drilled crankshaft through crankshaft rear end cover and is forced through the crankshaft and drilled connecting rods, lubricating bearings, piston pins, and pistons. Oil drains from the crankcase into the engine gear train cover, and then into the engine crankcase.

COMPRESSOR AIR INTAKE

The air compressor air inlet manifold is connected by a tube to the engine air cleaner manifold. The air drawn into the air compressor is cleaned by the engine air cleaners.

COMPRESSOR AND GOVERNOR OPERATION

AIR COMPRESSOR OPERATION (Fig. 1)

1. Compressing

During downstroke of each piston, air is drawn into the cylinder through a flapper-type inlet valve in cylinder head. As each piston begins an upstroke, air above piston is compressed. When air pressure in cylinder becomes greater than air pressure in the cylinder head above the discharge valve, discharge valve is forced off valve seat. Air passes through discharge port into air line leading to air tank. As piston starts downstroke, the discharge valve returns to valve seat. Compressed air is prevented from returning to the cylinder and intake and compression cycle is repeated.

2. Not Compressing

When air pressure in system reaches maximum pressure for which governor is set, the governor operates and causes inlet valve plungers to hold inlet valves off valve seats. With inlet valves open, air passes freely back and forth between cylinders and compression is stopped. When air pressure in system is reduced to governor cut-in setting, governor again operates. Inlet valve plungers release the inlet valves, and compression of air is resumed.

GOVERNOR OPERATION

The air compressor governor consists of two separate units, a governor assembly and an unloader valve (figs. 2 and 3). The unloader valve is mounted directly on cylinder head. The governor assembly is bolted to a mounting bracket attached to two of the cylinder head studs.

Governor inlet port admits tank air to bottom of inlet valve. As air pressure increases, inlet valve is gradually forced upward from valve seat. When cut-out pressure is reached, inlet valve snaps to full open position. Plunger is also forced upward, compressing spring and seating exhaust valve. Tank air then passes through a small orifice in inlet valve, around outside of exhaust valve, through body cavity and connecting tube, to cavity in top of unloader. The pressure in unloader cavity forces unloader valves downward. Valves, in moving downward, depress inlet valve plungers. Plung-

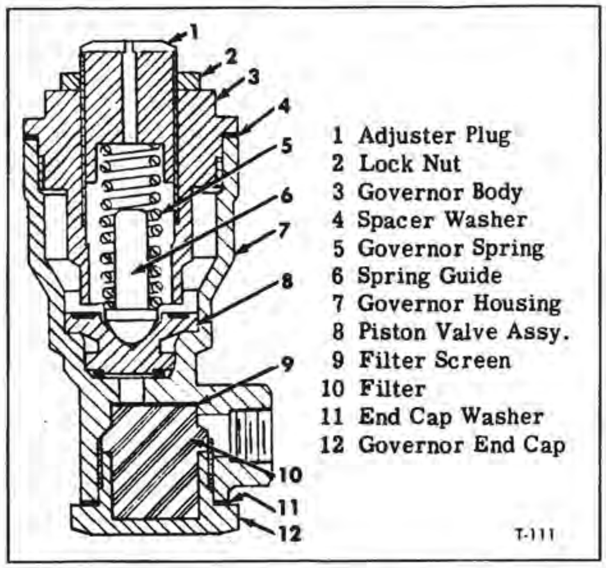


Figure 2—Air Compressor Governor

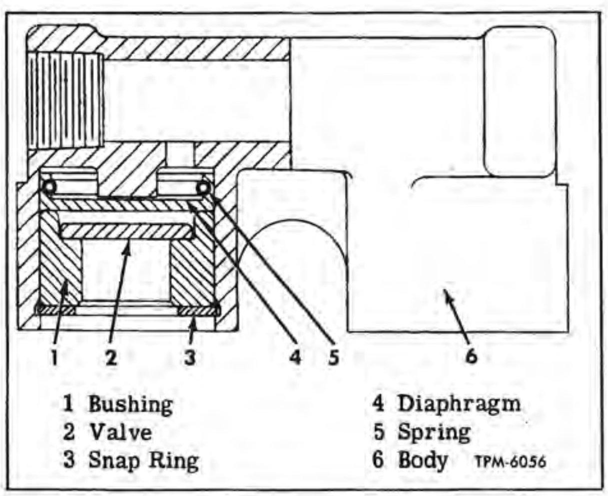


Figure 3—Governor Unloader

ers, in turn, open inlet valves in head to interrupt compression of air in cylinders. Pistons then merely move air back and forth between cylinders.

When tank pressure drops to cut-in point, plunger spring forces plunger, inlet valve, and exhaust valve downward. Inlet valve is returned to valve seat and exhaust valve is opened. Open exhaust valve allows unloader air to escape through exhaust port in governor adjusting screw. As air pressure above unloader valves decreases, inlet valve plunger springs force unloader valves upward. Expanding springs also retract plungers. As inlet valves are released, compression of air is resumed.

AIR COMPRESSOR AND GOVERNOR MAINTENANCE

Perform the inspection and maintenance operations listed below, at intervals determined by severity of service.

1. Remove cylinder head and clean carbon from inlet and discharge valves. If valves are damaged in any way. replace with new parts.
2. Make sure compressor discharge line is not choked with carbon.
3. Check governor cut-in and cut-out pressures and adjust if necessary. Refer to "Governor Adjustment" later in this section.
4. Check compressor mounting bolts for looseness and tighten if necessary.
5. Lubricate compressor governor as directed in LUBRICATION (SEC. 13) of this manual.
6. Make sure all oil and air line connections are tight and not leaking.

GOVERNOR ADJUSTMENT

The following procedure covers adjustment with compressor installed on vehicle. Governor is mounted on compressor as shown in figure 1.

1. Loosen lock nut (2, fig. 2). Use a screwdriver on adjusting plug (1, fig. 2).
2. Turn adjusting screw in (clockwise) to increase cut-out setting, or out (counterclockwise) to decrease setting. One complete turn of adjusting screw will change cut-out pressure 20 psi.
3. When cut-out pressure setting of 120-127 psi is attained, lock adjusting plug with lock nut.

NOTE: Correct governor adjustment is to cut-in at 105 psi and to cut-out at 120-127. Range: 15 to 22 psi.

AIR COMPRESSOR REPLACEMENT

REMOVAL

1. Exhaust compressed air from air system.
2. Drain engine cooling system as directed in COOLING SYSTEM (SEC. 6) of this manual.
3. Disconnect water, air, and oil lines from compressor.
4. Remove nuts and lock washers from four studs attaching air compressor to gear train cover. Pull compressor straight back off studs and remove from vehicle.

INSTALLATION

1. Before installing compressor, examine drive hub on compressor crankshaft and drive disc on camshaft gear for worn or broken teeth. Check backlash between teeth in hub and teeth on drive coupling, also between teeth in drive disc and teeth on coupling. New limits are 0.000" to 0.001" backlash. If backlash is appreciably greater than this, drive disc or hub (or both) must be replaced.
2. Make sure mating surfaces of air compressor flange and gear train cover are clean. Place new compressor to gear train cover gasket on studs. Make sure that oil drain hole is free from gasket material.
3. Insert damper spring in drive coupling and place spring end of drive coupling into hub on compressor crankshaft. Place compressor in position on gear train cover, guiding teeth on coupling into mesh with teeth in drive disc. Install nuts and lock washers on studs and tighten firmly.
4. Connect all water, air, and oil lines, making sure connections are tight.
5. Make sure drain plug is installed in compressor cylinder head; then fill cooling system as directed in COOLING SYSTEM (SEC. 6) of this manual.

AIR COMPRESSOR OVERHAUL

COMPRESSOR DISASSEMBLY

(Refer to Figure 1)

The compressor crankcase, cylinder block, and cylinder head are so designed that these parts may be assembled in different ways to meet various installation requirements. Therefore, these parts should be marked with alignment marks prior to disassembly; assuring proper installation.

REMOVE GOVERNOR ASSEMBLY

1. Disconnect governor tube assembly from governor and unloader. Remove tube assembly.

2. Remove two governor bracket to compressor attaching bolts and lock washers. Remove governor and bracket assembly. Governor disassembly is covered under "Compressor Governor Overhaul" later in this section.

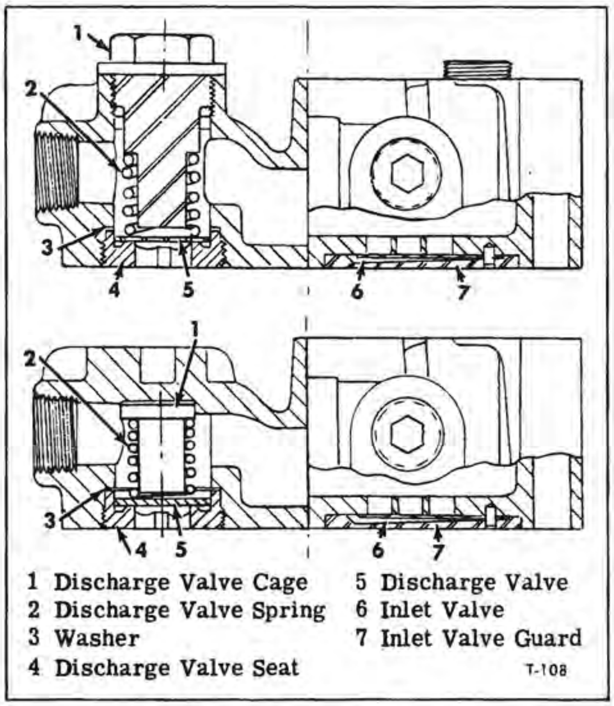


Figure 4—Cross Sections of Cylinder Heads

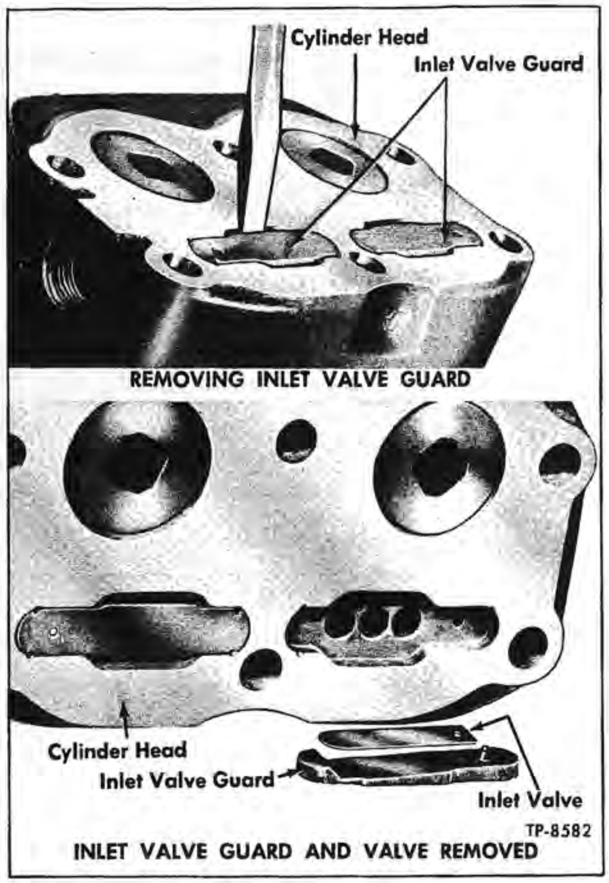


Figure 5—Inlet Valve and Guard Removal

REMOVE UNLOADER ASSEMBLY

1. Remove two cap screws and lock washers attaching unloader assembly to cylinder head.
2. Remove unloader assembly. Remove two inlet valve plungers and plunger springs.
3. Unloader disassembly is covered under "Governor Unloader Overhaul" later in this section.

REMOVE CYLINDER HEAD

Remove ten bolts and lock washers attaching cylinder head to cylinder block; then lift head assembly off block. Remove cylinder head gasket and discard.

DISASSEMBLE CYLINDER HEAD

Two different cylinder heads are used on these compressors (see fig. 4). On one type the discharge valve is removed from the top; on the other, the discharge valve is removed from the bottom. Proceed as follows:

1. If valves are to be removed from the top (top view, fig. 4), remove two discharge valve cages from top of the cylinder head; then lift two discharge valve springs out of head. Invert head to permit two discharge valves to fall out.
2. If valves are to be removed from the bottom (bottom view, fig. 4), remove discharge valve seat from bottom of cylinder head, using a short length of 7/16-inch square tool stock with corners ground off as a wrench adapter. Refer to figure 6 for adapter dimensions and application. Then set head upright and tap lightly to permit discharge valves, springs and cages to fall out of cylinder head.
3. Using a screwdriver, pry inlet valve guard and pin assemblies from bottom of cylinder head; then remove inlet valves in manner illustrated in figure 5.
4. On those cylinder heads on which the discharge valves were removed from the top, remove the discharge valve seats as instructed in paragraph 2, above.
5. Note location of pipe plugs in cylinder head; then remove plugs to permit thorough cleaning of internal passages.

REMOVE CYLINDER BLOCK

Remove six nuts and lock washers from studs attaching cylinder block to crankcase. Lift cylinder block off crankcase and pistons. Remove gasket from top of crankcase and discard.

REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

1. Remove eight bolts and lock washers attaching crankcase bottom cover to crankcase; then remove cover and gasket. Discard gasket.
2. Before removing pistons, mark each piston

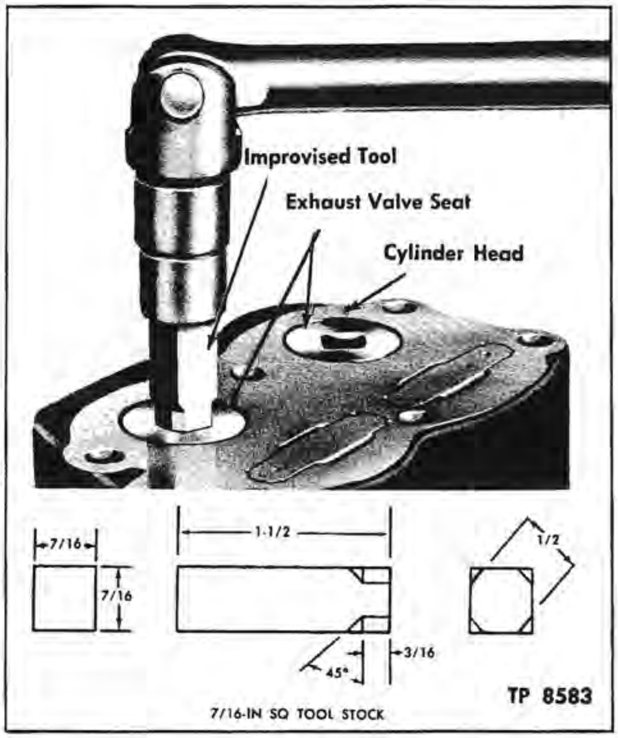


Figure 6—Removing or Installing Discharge Valve Seats

so it may be re-installed in original position in proper cylinder. Connecting rods and caps are marked to show position of cap on rod.

3. Remove cotter pins and nuts from connecting rod bolts.

4. Remove connecting rod bearing caps and bearing halves. Do not remove bolts from rods.

5. Lift pistons and connecting rods from crankcase. Replace caps in original position on rods with halves in place to prevent damage to halves. Temporarily install nuts on bolts.

DISASSEMBLE PISTONS AND CONNECTING RODS

1. Remove piston pin lock rings from inside of piston; then press piston pin out of piston and connecting rod.

2. Remove compression and oil rings from piston. Use a conventional piston ring expander.

REMOVE CRANKSHAFT BEARING CAP

1. Remove four nuts and lock washers from studs at end of crankcase. Remove crankshaft rear bearing cap and gasket from studs. Discard gasket.

2. Remove crankshaft seal ring from groove in stem.

REMOVE CRANKSHAFT AND BEARINGS

Model With Two Ball Bearings

1. Position crankshaft so that connecting rod rear bearing journal is aligned with cut-out section of crankcase rear bearing core. Spread ends of small lock ring and remove from end of crankshaft.

2. Press crankshaft and rear bearing away from large lock ring and remove ring. Press out crankshaft and rear bearing assembly.

3. Leave rear bearing assembly on crankshaft unless replacement is necessary as indicated later under "Cleaning, Inspection, and Repair."

4. Press front bearing out of crankcase.

Model With Insert Type Rear Bearing

1. Position crankshaft so that connecting rod rear bearing journal is aligned with cut-out section of crankcase rear bearing bore.

2. Press crankshaft out of front bearing and remove from crankcase through rear cut-out section.

3. Rear insert type bearing was removed as part of rear bearing cap. Remove front lock ring and press front ball bearing out of crankcase.

CLEANING, INSPECTION, AND REPAIR

CLEANING

After disassembly and before inspection, wash all parts thoroughly in a suitable cleaning solvent. Make sure all carbon deposits are removed from pistons and cylinder head. Probe drilled oil passages in crankshaft to make sure passages are open. Scrape all carbon from piston ring grooves in pistons.

INSPECTION AND REPAIR

Discard all gaskets, and crankshaft seal ring and obtain new parts for assembly. Inspect balance of parts and make necessary repairs or replacements as directed below, referring to figure 1 for identification of parts.

1. Cylinder Head and Valves

a. Examine cylinder head for cracks and for damaged threads in tapped openings. Replace head if any damage is evident.

b. Examine discharge valves and valve seats. If valves are deeply grooved on one side where they contact the seats, they may be turned over to use the unworn side. If valves have been previously turned over so that both sides are worn, or if otherwise damaged, replace with new parts. If valve seats are pitted or otherwise damaged, replace with new parts. If discharge valves are to be turned over or if new valves or seats are to be used, valves must be lapped to seats, using lapping compound. After lapping, thoroughly clean lapping compound from valves and seats.

NOTE: After lapping each valve to a seat, keep valve and seat together as a matched set; each valve must be installed on the seat to which it was lapped.

c. Inspect inlet valves and inlet valve guards for pitting or corrosion. If corrosion does not readily clean off without leaving pits, replace with new parts. Make sure dowel pin is tight in valve guard.

d. Inspect inlet valve plungers for distortion and for evidence of wear at both ends.

e. Check inlet valve plunger springs and discharge valve springs for free length, compressed length, distortion, or collapsed coils. If not within limits listed in "Specifications" at end of this group, replace with new parts.

2. Pistons, Connecting Rods, and Bearings

a. Examine pistons for scoring, cracks, or other damage. Measure outside diameter at each piston and compare this diameter with inside diameter of cylinder bore. If lower part of piston is more than 0.004-inch smaller in diameter than the cylinder bore, piston must be replaced with a new part.

b. Check fit of piston pins in pistons and connecting rod bushings. Pin must be light tap fit in piston and in bushing. Determine which part is worn and replace as necessary. To replace bushing in connecting rod, press old bushing out and press new bushing into place. Bushing must be finished after installation to inside diameter listed in "Specifications" at end of this group.

c. Check fit of compression and oil rings in ring grooves in pistons. Clearance between ring and ring groove must not exceed 0.003-inch. Place each ring in cylinder bore and measure ring gap. Gap must be within 0.006 to 0.013-inch. If clearances are not within these limits, new rings must be used at assembly.

d. Examine connecting rod bearing halves for scoring, pitting, or visible wear. If damage is evident, new halves must be installed. To check fit of bearings on crankshaft, install each connecting rod with bearing halves on crankshaft journal from which they were removed, using a 1/4 x 3/4-inch piece of 0.002-inch brass shim stock between bearing journal and bearing half (fig. 7). Tighten connecting rod bolt nuts to 5 to 8 foot-pounds torque. If bearing fit is correct, the 0.002-inch shim should lock the bearing on the journal. Check clearance between side of connecting rod and cap and cheek on crankshaft (fig. 7). If clearance exceeds 0.006-inch, new rods and caps must be used.

NOTE: Do not file or lap bearing caps or rods to take up clearance, always use new bearing halves if clearances are excessive.

3. Cylinder Block

a. Examine inside of cylinder bores for scoring or pitting. Check bores for out-of-round and taper. If out-of-round more than 0.002-inch from top to bottom of bore, replace with new cylinder block.

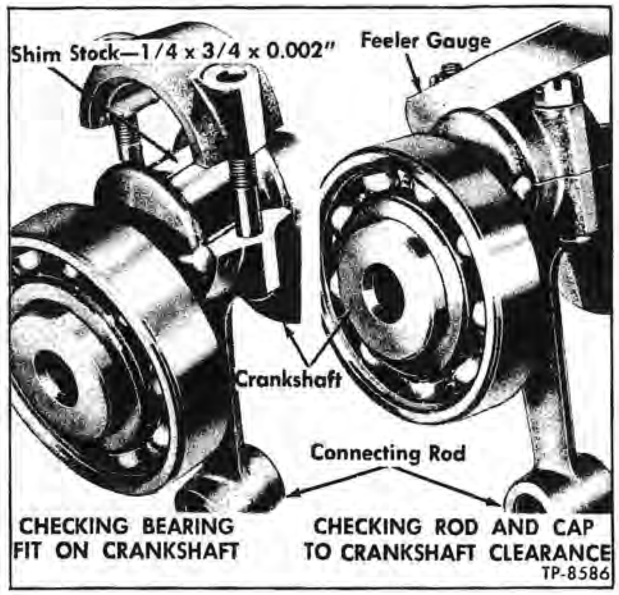


Figure 7—Checking Fit of Connecting Rod on Crankshaft

b. Examine studs in top of cylinder block. Replace bent stud or stud having damaged threads. When installing new stud, make certain that replacement stud is the same length as stud removed.

c. Examine cylinder block for cracks. Replace block if damaged in any way.

4. Crankshaft and Bearings

a. A bent or twisted crankshaft cannot be repaired. If connecting rod journals are scored on more than 20 percent of the bearing area or worn more than 0.003-inch under original diameter listed in "Specifications," replace with new crankshaft.

b. Threads, keyway, and all ground and machined surfaces must not be mutilated or worn.

c. Examine rear ball bearing on crankshaft and front bearing for worn or damaged balls; rotate bearings by hand to detect roughness. If wear, roughness, or damage is evident, bearings must be replaced. Pull damaged rear bearing off crankshaft, using a suitable puller. If insert type rear bearing is used, remove from bearing cap using a suitable puller, if replacement is indicated.

5. Crankcase

a. Examine crankcase for cracks or other damage. Replace with new part if damaged.

b. Inspect studs in crankcase and replace any which are bent or have damaged threads. When replacing studs, be sure and install studs of proper length in same holes from which they were removed.

6. Crankshaft Bearing Cap

Examine crankshaft rear bearing cap and replace if cracked.

AIR COMPRESSOR ASSEMBLY

Coat crankshaft and bearings, connecting rods and bearings, pistons, pins, and bushings with engine oil before assembling. Refer to figure 1 for assembled position of parts.

INSTALL CRANKSHAFT AND BEARINGS

Model With Two Ball Bearings

1. Press rear bearing on crankshaft (if removed) until inner race seats firmly against shoulder on crankshaft.
2. Insert crankshaft through rear of crankcase; then press in until rear bearing is just short of ring groove in bore of case.
3. Install the large snap ring in groove of case; then press rear bearing firmly against the snap ring.
4. Install small snap ring in groove of crankshaft, making sure snap ring is well seated in groove.
5. Press front bearing on crankshaft and into bore of crankcase.

Model With Insert Type Rear Bearing

1. Install new insert type bearing in bearing cap (if necessary).
2. Press front ball bearing in crankcase and install front lock ring.
3. Insert crankshaft through rear cut-out section of crankcase and press into front ball bearing.
4. Install rear insert bearing and cap assembly.

INSTALL CRANKSHAFT BEARING CAP

Model With Two Ball Bearings

1. Place new crankshaft O-ring seal in stem groove of crankshaft bearing cap. Install new gasket over studs at rear end of crankcase.

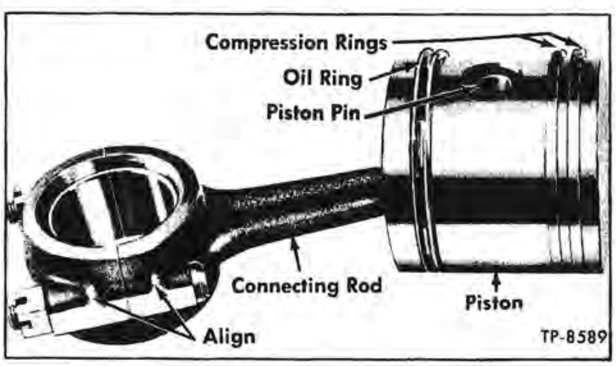


Figure 8—Piston and Connecting Rod Assembly

2. Install rear bearing cap with stem on cap entering hole in crankshaft. Attach cap to crankcase with four lock washers and four nuts.
3. Tighten stud nuts to 9-1/2 to 13 foot-pounds torque.
4. Rotate crankshaft. Relieve any binding in bearings by using extra gasket or shim stock between bearing cap and crankcase.

ASSEMBLE PISTONS AND CONNECTING RODS

1. Position connecting rod in piston and press piston pin into place.
2. Install lock rings in grooves at each end of piston pin.
3. Install compression and oil rings on pistons. Three rings are used on each piston, two compression rings at top and one ventilated oil ring at bottom (fig. 8).

NOTE: Compression rings must be installed with surface marked "TOP" facing top of piston.

4. Install connecting rod bearing halves into connecting rod and cap, making sure locks on bearing halves engage locking slots in rod and cap.
5. Tag or mark bearing caps and rods so that each cap will be installed on rod from which it was removed.

INSTALL PISTON AND CONNECTING ROD ASSEMBLIES AND CYLINDER BLOCK

1. Insert pistons into cylinder block from bottom side, compressing piston rings to permit rings to enter cylinder bores.
2. Place new gasket over studs on top of crankcase. Hold cylinder block over crankcase with lower ends of connecting rods extending just below top of crankcase; then lower cylinder block onto crankcase.

NOTE: Cylinder block must be positioned on crankcase using alignment marks made earlier. If a new unmarked part is being used, position cylinder block so the short stud on top of block is at the left-hand side when viewed from drive end of crankshaft. Attach cylinder block to crankcase with six lock washers and six nuts. Tighten nuts to 9-1/2 to 13 foot-pounds torque.

3. Turn the assembly over and position connecting rods on crankshaft journals, making sure bearing halves are in place. Install connecting rod bearing caps and bearing halves, matching bearing cap and rod as shown in figure 8. Install nuts on connecting rod bolts. Tighten to 5 to 8 foot-pounds torque and secure with new cotter pins.
4. Place new gasket and bottom cover on crankcase. Attach with cap screws and lock washers. Tighten firmly.

ASSEMBLE CYLINDER HEAD

1. If discharge valves are removed from bottom of head, insert cages, springs and valves into

cavities in bottom of cylinder head and install discharge valve seats with copper washers and tighten firmly (fig. 6). Bottom of valve seats must be flush with or slightly inside the bottom face of cylinder head when fully tightened.

2. If discharge valves are removed from the top of head, install seats and washers first from the bottom. Then turn head right side up and drop discharge valves through top of cylinder head onto discharge valve seats, making sure each valve is installed on seat to which it was lapped. Place discharge valve springs over discharge valve cages; then thread cages into cylinder head and tighten firmly.

3. Place one inlet valve in recess in bottom of cylinder head, with hole in valve aligned with valve guard pin hole in head. Place inlet valve guard on top of inlet valve, with dowel pin inserted through hole in inlet valve into cylinder head. Tap guard firmly into place; then stake in place at four points (fig. 9). Install the other inlet valve and valve guard in the same manner. After both valves are installed, turn cylinder head over and check operation of valves. Using one of the inlet valve plungers without spring, insert plunger down through cylinder head onto inlet valve. Press inlet valve down against valve guard; then make sure inlet valve springs back up when released.

INSTALL CYLINDER HEAD

Place new cylinder head gasket on top of cylinder block so cut-out portion of large holes will be adjacent to discharge valve seats when cylinder head is installed. Install cylinder head, aligning the marks made before disassembling. Install ten attaching bolts and tighten to 9-1/2 to 13 foot-pounds torque.

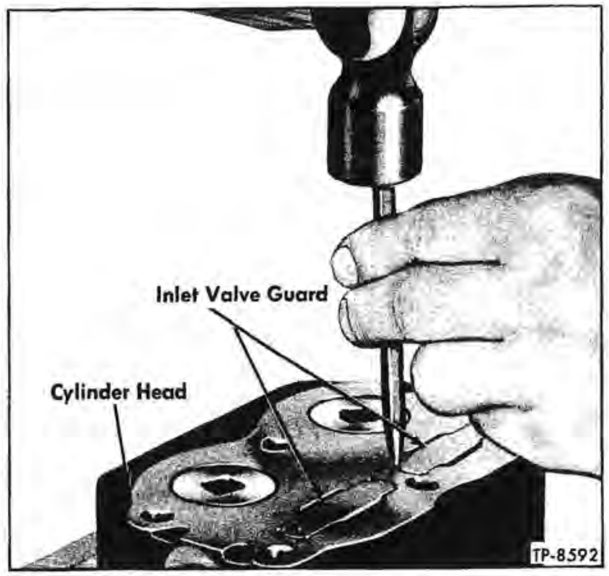


Figure 9—Staking Inlet Valve Guard in Cylinder Head

INSTALL UNLOADER ASSEMBLY

1. Install two inlet valve plungers and plunger springs in cylinder head.

2. Position unloader assembly on cylinder head and attach with two bolts and lock washers. Tighten bolts securely.

INSTALL GOVERNOR ASSEMBLY

1. Position governor and bracket assembly on two studs on cylinder head.

2. Install two nuts and lock washers on studs. Tighten nuts firmly.

3. Connect tube assembly to unloader and governor assemblies. Make sure connections are tight.

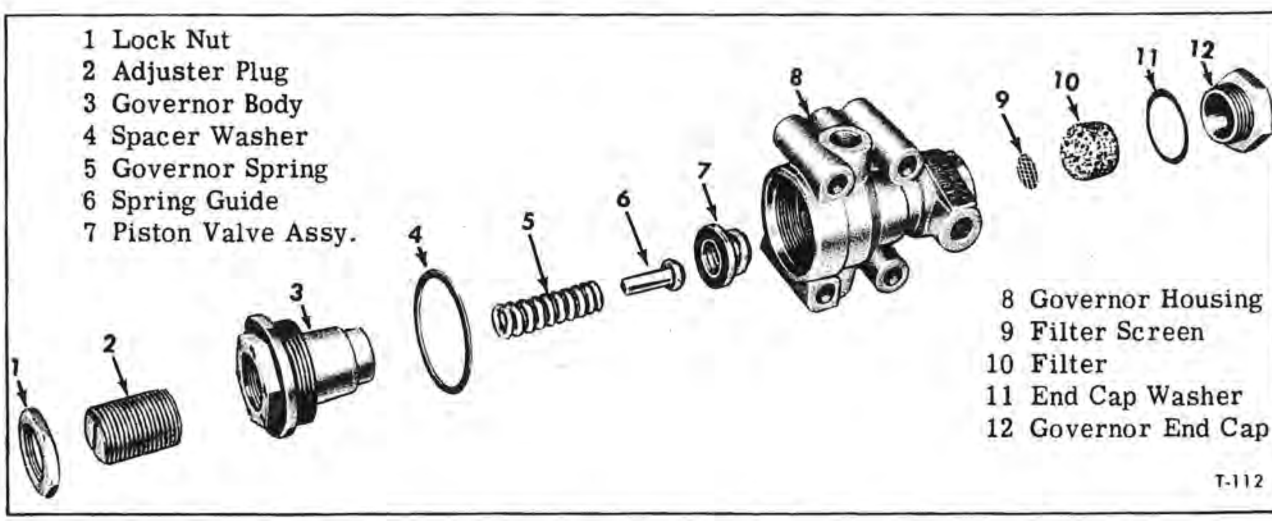


Figure 10—Air Compressor Governor Components

TESTING REBUILT AIR COMPRESSOR

Connect an oil supply line having at least 15 pounds pressure to crankshaft rear bearing cap; provisions must be made for unrestricted draining of oil from crankcase during test. If tests are being made in dusty atmosphere, connect a suitable air strainer to compressor air inlet opening.

1. Run-in Test

With compressor connected to a source of power (at least 2-3/4 horsepower) to run it at 1250 rpm, run compressor for one-half hour with discharge port open to atmosphere. Check during this test for oil leaks, overheating, and excessive noise.

2. Oil Passing Test

Oil passing test is made by running air compressor for one-half hour at 1250 rpm, pumping against 50 pounds air pressure, with an oil trap connected into discharge line. Oil passed during this test must not exceed two cubic centimeters.

3. Efficiency Test

Efficiency test is made by running compressor for one-half hour at 1250 rpm, with discharge port connected to an air tank. With a 1/16-inch diameter relief hole in discharge line open continuously compressor should maintain a pressure of at least 105 psi in air tank.

COMPRESSOR GOVERNOR OVERHAUL

Remove governor from air compressor as directed previously in "Air Compressor Overhaul."

DISASSEMBLY

Key numbers in text refer to figure 10.

1. Remove lock nut (1); then remove adjuster plug (2), spring (5), and spring guide(6).

2. Remove governor body (3), and spacer washer (4) from housing (8). Remove piston valve assembly (7) from housing (8).

3. Remove end cap (12), washer (11), filter (10), and filter screen (9) from housing (8).

CLEANING AND INSPECTION

1. Wash all metal parts in cleaning solvent. Blow parts dry.

2. Check governor spring (5) for free length, compressed length, distortion, or collapsed coils.

3. Inspect governor housing (8) and body (3) for cracks or other damage. Check for crossed or stripped threads.

4. Check adjuster plug (2) and end cap (12) for crossed or stripped threads.

5. Inspect piston valve (7) for roughness or damage. Replace parts if not in first class condition.

6. Check spring guide (6) for distortion or other damage.

ASSEMBLY

Key numbers in text refer to figure 10.

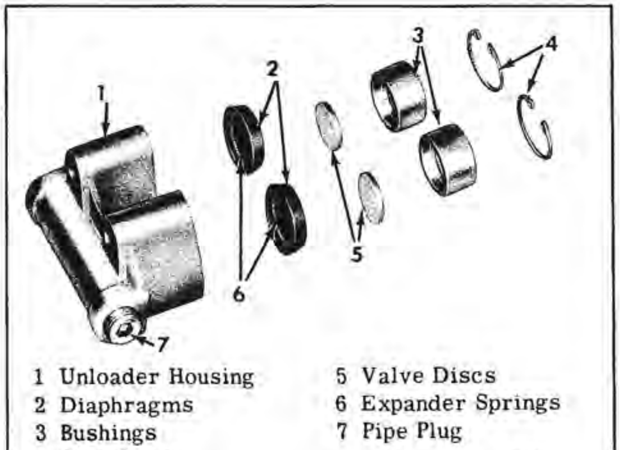
1. Apply a thin film of light engine oil to valve (7). Position piston valve (7) in housing (8).

2. Position washer (4) on body (3), then thread body (3) into housing (8).

3. Install spring guide (6) and spring (5); then thread adjuster plug (2) into body (3). Install lock nut (1).

4. Install filter screen (9), filter (10), washer (11), and end cap (12) in governor housing (8).

5. After installing governor on air compressor, perform "Governor Adjustment" as previously directed in this section.



1 Unloader Housing
2 Diaphragms
3 Bushings
4 Snap Rings
5 Valve Discs
6 Expander Springs
7 Pipe Plug

TPM-9411

Figure 11—Governor Unloader Components

GOVERNOR UNLOADER OVERHAUL

Remove unloader assembly from air compressor as directed previously in "Air Compressor Overhaul." Key numbers in text following refer to figure 11.

DISASSEMBLY

1. Remove two snap rings (4) from housing (1).

2. Remove bushings (3), two valve discs (5), diaphragms (2), and expander springs (6) from housing. Should difficulty be encountered in removing these parts, apply air pressure to body to force out parts.

CLEANING AND INSPECTION

1. Clean all parts in cleaning solvent. Blow parts dry.

2. Inspect all parts for wear or damage. Replace all parts that are not in first class condition.

ASSEMBLY

1. Apply a thin film of light engine oil to bushings (3), diaphragms (2), and housing (1) before assembly.

2. Install expander springs (6) around inside of diaphragms (2); then install these parts in housing.

3. Place two valve discs (5) in recess of bushings (3); then install in housing.

4. Install snap rings (4) retaining previously installed parts in housing.

5. Test assembly with air. Unloader should withstand a pressure of 100 psi without leaking.

SPECIFICATIONS

MAKE .... Midland-Ross

MODEL .... (2 Ball Bearings) N-5904
(1 Insert, 1 Ball Bearing) N-5904-C)

TYPE .... 2 Cylinder, Water Cooled, Engine Oil Lubricated, and Flange Mounted

CAPACITY (at 1250 rpm) .... 12 Cu. Ft. Per Min.
Cylinder Bore .... 2.3745"-2.3750"

PISTON
- Diameter at top lands .... 2.366"-2.368"
- Diameter from 2nd groove down .... 2.3720"-2.3725"
- Diameter at top grooves .... 2.123"-2.133"
- Diameter at bottom groove .... 2.110"-2.120"

PISTON PIN
- Outside Diameter .... 0.4998"-0.500"
- Inside Diameter .... 0.28125"
- Length .... $2\frac{1}{16}$"
- Material .... SAE #1020 Steel

PISTON OIL RING
- Outside Diameter .... 2.375"
- Inside Diameter .... 2.225"-2.245"
- Width .... 0.1860"-0.1870"
- Thickness .... 0.065"-0.075"
- Gap .... 0.005"-0.010"

PISTON TOP COMPRESSION RING
- Outside Diameter .... 2.375"
- Inside Diameter .... 2.145"-2.165"
- Width .... 0.0925"-0.0935"
- Thickness .... 0.105"-0.115"
- Gap .... 0.005"-0.010"

PISTON 2ND COMPRESSION RING
- Outside Diameter .... 2.375"
- Inside Diameter .... 2.145"-2.165"
- Width .... 0.0925"-0.0935"
- Thickness .... 0.105"-0.115"
- Gap .... 0.005"-0.010"

SPECIFICATIONS (CONT.)

CONNECTING ROD BUSHING (PISTON PIN)

Outside Diameter	0.562"-0.563"
Inside Diameter	0.5002"-0.5003"
Thickness	0.042"-0.044"
Width	0.80"

CONNECTING ROD BEARING HALVES

Lock Fit on Crankshaft Journal ¼" x ¾" x 0.002" Shim Between Half and Journal.

CRANKSHAFT

Connecting Rod Journal Diameter	1.1230"-1.1235"
Rear Bearing Journal Diameter	1.3779"-1.3784"
Front Bearing Journal Diameter	1.3779"-1.3784"
Length	7.44"

CRANKSHAFT BALL BEARINGS (Front and Rear)

Outside Diameter	2.8341"-2.8346"
Inside Diameter	1.3775"-1.3780"
Width	0.6688"-0.6693"
Number of Balls	9
Size of Balls	7/16"

SPRINGS

Discharge Valve Springs	
Free Length	31/32"
Length Under 3.5 lb. Load	47/64"
Solid Height	21/32"
Unloader Springs	
Free Length	27/32"
Length Under 3 lb. Load	15/32"
Solid Height	11/32"
Governor Spring	
Free Length	1.36"
Length Under 30.8 lb. Load	1.22"
Solid Height	0.89"
Unloader Expander Spring	
Diameter Free Position	0.750"-0.770"
Coils Per Inch	64

AIR GOVERNOR PRESSURE SETTING

Cut-In	105 Psi
Cut-Out	120-127 Psi
Pressure Range	15-22 Psi

Rotary Air Compressor

GENERAL

Rotary air compressor is used as special equipment on some vehicles. Air dome and reservoir assembly is attached to a mounting plate at the rear end of the compressor. The compressor control valve assembly is also mounted on this plate and is connected to the compressor intake by a tube. Compressor is flange mounted to engine gear train cover and is driven from the engine camshaft gear.

Compressor air intake is connected to the engine air cleaner manifold so that air drawn into the compressor is cleaned by the engine air cleaners. The compressor stator is water-jacketed and connected to the engine cooling system. Engine oil, under pressure from the engine lubrication system, is introduced into the oil reservoir through the lubricating valve.

OPERATION

(Refer to Figures 1 and 2)

COMPRESSOR

Basically, the rotary compressor consists of a cylindrical stator, two end plates, and a rotor and shaft assembly. Stator end plates are equipped with sleeve bearings (bushings) which support the rotor shaft. The diameter of the rotor is smaller than the bore of the stator, and the bearings are located in the end plates so that the rotor is positioned eccentric in relation to the stator bore. Rotor to stator bore clearance is 0.001" at the top (between air discharge and air intake ports) and approximately 1/4 inch at the bottom.

Four rotor blades are carried in slots in the rotor. The slots are equally spaced and are arranged so that the trailing edge of each blade forms an acute angle with the stator bore. Two springs and push pins are installed behind each blade, assisting centrifugal force in keeping the blades in contact with the stator bore. The rotor blades divide the clearance between the rotor and stator into four chambers, which have their volume progressively increased and reduced each revolution of the rotor. The four chambers each pass through three stages each revolution of the rotor -- intake, compression, and discharge.

Intake

Chamber between rotor blades is open to air intake port. As rotor and blade progress, chamber area increases, creating vacuum, drawing air into the chamber from the engine air cleaner manifold.

Compression

As rotor and blades continue to progress, the chamber trailing blade closes the intake port. Chamber area is reduced, compressing the trapped air.

Discharge

Rotor and blades complete the revolution as the leading blade passes the stator discharge port, and the compressed air, with oil, is forced out the port and through the discharge tube into the air dome.

The intake check valve in the stator intake port closes to prevent "blow-back" which might occur if the compressor is pumping against high reservoir pressure at low speed.

SEPARATION OF AIR AND OIL

Compressed air, mixed with oil, is discharged into the air dome where it spins at high velocity. Centrifugal force and baffling separate the oil from the air. Compressed air discharges through the dome outlet check valve into the line leading to the air tanks. The oil drains into the reservoir, from where it is fed back to the compressor for lubrication purposes, with the excess returning to the engine crankcase.

COMPRESSOR LUBRICATION

Oil is supplied to the compressor through the tube connecting the bottom of the oil reservoir to the compressor rear end plate cap. Oil in the reservoir is always subjected to air pressure, providing a force feed system circulating oil to all bearings and sealing surfaces. Oil which circulates through the compressor is discharged, with the compressed air, into the air dome.

LUBRICATING VALVE

Engine oil, under pressure from the engine lubrication system, enters the lubricating valve through a port containing a screen and a restriction orifice. A gravity feed oil return tube is connected to the same cavity in the lubricating valve; when the lubricating valve poppet valve is closed, oil simply drains back into the engine crankcase through the oil return tube.

A tube connects the air inlet cavity in the control valve to the inner side of the piston in the lubricating valve. Vacuum developed in the air intake cavity during the "cycle-off" permits atmos-

ROTARY AIR COMPRESSOR

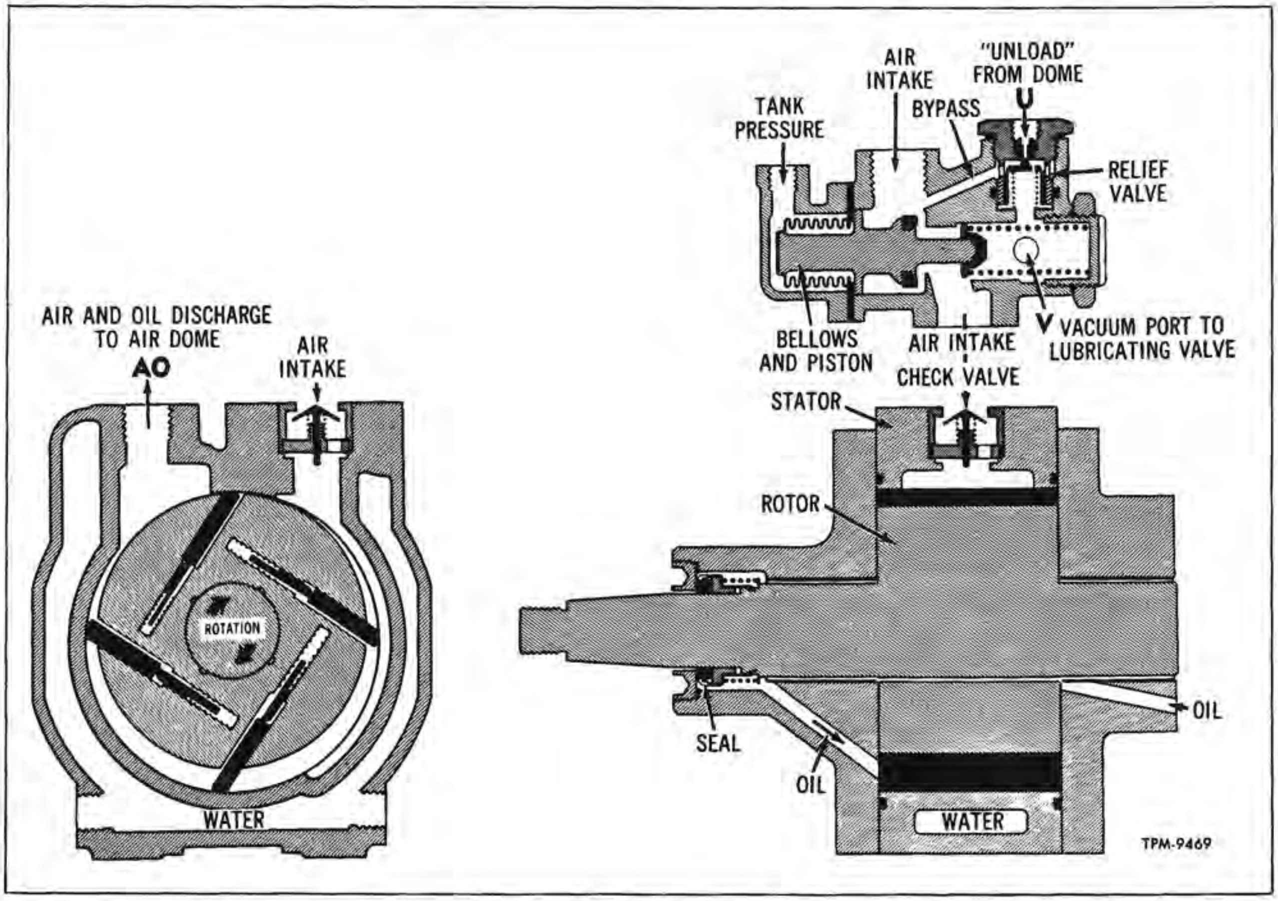


Figure 1—Compressor and Control Valve Operation

pheric pressure against the outer side of the lubricating valve piston to stroke the piston, unseating the poppet valve into the oil reservoir. Unloading dome pressure blows off through the oil return tube as well as through the control valve. Oil then enters the reservoir through the poppet opening, or excess oil in the reservoir above the proper level spills out through the poppet valve into the oil return tube. When "cycle-on" occurs, vacuum drops and spring pressure closes the poppet valve.

TEMPERATURE CONTROL

The operating temperature of the compressor is controlled by three mediums: water, oil, and air. Water from the engine cooling system is circulated through the cored passages which surround the stator bore. Oil in excess of lubrication requirements is circulated through the compressor, carrying heat back into the dome. Heat carried by the oil and compressed air is dissipated into the air through the oil and air discharge tube and from the dome itself.

ROTOR SHAFT SEAL

A positive drive seal prevents loss of air and oil through the rotor shaft clearance at the front end plate. A seal retainer, holding a synthetic seal ring which grips the shaft, is driven by lugs which engage slots machined into the rotor shaft. The retainer also drives a carbon seal ring located between the synthetic seal ring and the seal retainer ring threaded into the front end plate. The carbon seal ring and the seal retainer ring have matching flat sealing surfaces. Seal surface pressure is provided by a seal spring compressed between the seal retainer and a spring retaining washer.

CONTROL VALVE

The air pressure control valve attached to the mounting plate, controls the air system pressure by starting and stopping the compressor pumping cycle. Control valve is adjusted to stop compression when air system pressure reaches 117-120 psi, and starts compression when system pressure drops 10 to 15 pounds below the maximum pressure limit. The control valve is connected to the compressor by a tube.

Two valves in the control valve assembly operate to stop and start the pumping cycle as follows:

1. Stopping the Pumping Cycle

a. Closing the air intake port. The control valve bellows is always subjected to air system pressure through an air line from vehicle air tank connected to the bellows cap. When system pressure reaches the maximum pressure limit, the increasing force against the bellows overcomes the pressure of the pressure regulating spring, forcing the control valve piston toward its seat in the intake chamber. As the piston approaches its seat, the intake opening is restricted and the compressor creates a vacuum ahead of the piston which accelerates its movement. With piston cup seated, air intake is closed and compression is stopped.

b. Unloading air pressure from dome. The air dome is connected to the control valve relief valve by the relief valve tube. The relief valve is vented to the air intake chamber, ahead of the control valve piston seat, through a drilled bypass in the control valve body. The cavity below the relief valve piston opens into the vacuum side of the intake chamber. Vacuum, created when the intake closes, permits air pressure from air dome to unseat the relief valve. Air pressure in the dome then exhausts through the drilled bypass into the air intake and back to the engine air cleaner manifold. A limited amount of air passes through the bleed hole in the top of the relief valve into the compressor air intake, maintaining pressure lubrication and cooling.

2. Starting the Pumping Cycle

a. Opening the air intake port. As air pressure in system is reduced, the pressure on the control valve bellows also decreases. When pressure has dropped 10 to 15 pounds below the cut-out point, the pressure regulating spring overcomes the vacuum and the force of the bellows and forces the control valve piston off its seat, opening the air intake port.

b. Closing dome relief valve. Opening the air intake port, admitting air into the compressor stator, destroys the vacuum below the relief valve. This permits the relief valve spring to close the relief valve, closing off the vent to the dome.

CONTROL VALVE ADJUSTMENT

To check and adjust pressures at which the control valve stops and starts the pumping cycle, remove pipe plug (12, fig. 4) from outlet check valve guide and connect a test air pressure gauge to this port.

1. Start engine and run at a fast idle until pressure reading on gauge stops increasing. This indicates that the control valve has stopped the compressor pumping cycle. Pressure reading on gauge should be 117-120 psi.

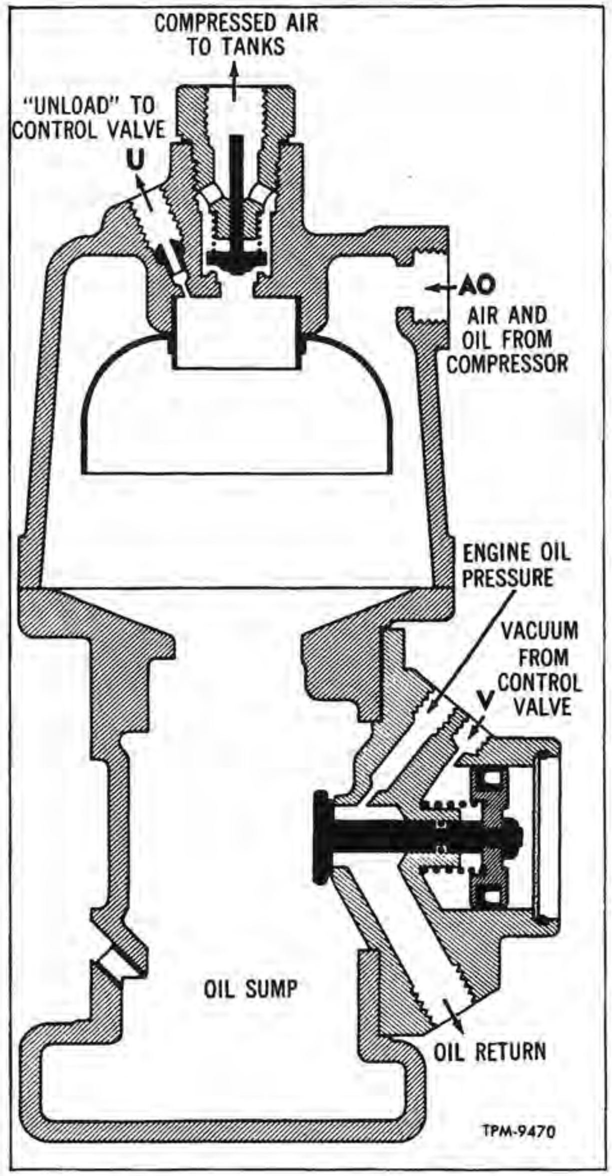


Figure 2—Air Dome, Reservoir, and Lubricating Valve Operation

2. To adjust cut-out pressure, loosen lock nut (16, fig. 3) and turn adjusting screw (15, fig. 3) clockwise to increase cut-out pressure or counterclockwise to decrease it. One complete turn of adjusting screw will change the cut-out pressure about 10 psi. Tighten lock nut on adjusting screw after correct adjustment is obtained.

3. With engine idling, reduce air pressure in system by a series of brake applications until pressure on gauge stops decreasing. This indicates that the control valve has started the pumping cycle. Pressure reading on gauge should be 10-15 psi below the cut-out pressure. If the control valve does

not start the pumping cycle at 10-15 psi below the cut-out pressure, it indicates dirty or sticking control valve parts or a weakened pressure regulating spring. This requires disassembling and cleaning or replacing control valve parts.

UNIT REPLACEMENT

The compressor and control valve assembly, together with the air dome and reservoir assembly, can be removed and installed as a complete assembly. The air dome and reservoir assembly or the control valve assembly can be replaced without removing the compressor from the engine.

CONTROL VALVE REPLACEMENT

Removal

1. Exhaust air pressure from system by opening drain cock in air tank. Close drain cock after air pressure is exhausted.
2. Disconnect air inlet hose from top of control valve.
3. Disconnect vacuum tube and relief valve tube from control valve.
4. Disconnect tank to control valve air line from control valve bellows cap.
5. Disconnect compressor air inlet tube from control valve.
6. Remove two bolts, nuts, and lock washers attaching control valve to mounting plate. Remove control valve assembly and gasket.
7. Overhaul control valve as directed later under "Control Valve Overhaul."

Installation

1. Install control valve assembly and gasket to mounting plate. Secure with two bolts, nuts, and lock washers. Tighten firmly.
2. Connect tank to control valve air line to control valve bellows cap.
3. Connect vacuum tube and relief valve tube to control valve ports.
4. Connect air inlet hose to control valve.
5. Connect compressor air inlet tube to control valve.
6. Make sure mounting bolts and all air tube connections are firmly tightened.
7. Build up air pressure in system, then adjust control valve cut-out pressure setting, if necessary, as previously directed under "Control Valve Adjustment."

AIR DOME AND RESERVOIR REPLACEMENT

Removal

1. Exhaust air pressure from system by opening drain cock in air tank. Close drain cock after air pressure is exhausted.
2. Place a receptacle under reservoir to catch oil, then disconnect oil inlet tube from elbow at bottom of reservoir and drain oil from reservoir.
3. Disconnect oil return tube and vacuum tube from lubricating valve body.
4. Remove two bolts attaching elbow on flexible discharge tube to discharge fitting at top of air dome.
5. Disconnect compressor discharge tube from air dome.
6. Remove cap screws and lock washers attaching reservoir to mounting plate, then remove dome and reservoir assembly.
7. Overhaul air dome and lubricating valve components as directed later under "Air Dome and Reservoir Overhaul."

Installation

1. Position air dome and reservoir assembly at mounting plate and attach with cap screws and lock washers. Tighten cap screws firmly.
2. Connect vacuum tube, relief valve tube, compressor discharge tube, oil inlet tube, and oil return tube. Tighten connector nuts firmly.
3. Connect flexible discharge tube to discharge fitting at top of air dome, using two bolts, lock washers, and nuts.
4. Remove pipe plug (13, fig. 4) from upper rear corner of oil reservoir and pour a sufficient amount of oil (same as used in engine) into the reservoir to provide initial compressor lubrication.

COMPRESSOR REPLACEMENT

Removal

1. Exhaust air pressure from system by opening drain cock in air tank. Close drain cock when air pressure is exhausted.
2. Open drain cock and permit water to drain from compressor stator.
3. Remove two bolts attaching elbow on flexible discharge tube to discharge fitting at top of air dome.
4. Disconnect tank to control valve air line from control valve bellows cap.
5. Disconnect air inlet hose from control valve.
6. Disconnect water lines from compressor stator.
7. Remove nuts and lock washers from four compressor mounting studs. Lift compressor, with dome and reservoir assembly, straight off studs in gear train cover. Remove gasket from mounting studs.
8. If compressor is to be overhauled, remove interconnecting tubes, then remove dome and reservoir assembly and control valve assembly from compressor.

Installation

1. Before installing compressor, examine hub on compressor rotor shaft and drive disc on engine camshaft gear for worn or broken teeth. Check backlash between teeth on drive coupling and teeth in drive disc and hub. New limits are 0.000 to 0.001 inch. If backlash is appreciably greater than this, drive disc or hub (or both) must be replaced.

2. Make sure mating surfaces of compressor mounting flange and engine gear train cover are clean. Place new gasket over studs in gear train cover.

3. If control valve assembly and dome and reservoir assembly were removed from compressor, assemble these parts to compressor.

4. Insert one end of drive coupling into hub on compressor rotor shaft; then position compressor on gear train cover, guiding teeth on drive coupling into mesh with teeth in drive disc. Install lock washers and nuts on studs and tighten firmly.

5. Connect air inlet hose to elbow and nipple on top of control valve.

6. Connect tank to control valve air line to control valve bellows cap.

7. Connect elbow on flexible discharge tube to discharge fitting at top of air dome, using two bolts, lock washers, and nuts.

8. Connect water lines to compressor stator.

9. Make sure all hose and tube connections are securely tightened. Close stator drain cock and fill engine cooling system.

10. If oil reservoir was drained, remove pipe plug (13, fig. 4) and pour a sufficient amount of oil (same as used in engine) into the reservoir to provide initial compressor lubrication.

11. Build up air pressure in system and adjust control valve cut-out pressure, if necessary, as previously directed under "Control Valve Adjustments."

CONTROL VALVE OVERHAUL

(Key Numbers in Text Refer to Figure 3)

DISASSEMBLY

1. Unscrew relief valve cap (10) from control valve body and remove relief valve assembly. Remove cap gasket (11). Use a pointed instrument to remove O-ring (8) and piston seat (7).

2. Remove four cap screws and lock washers attaching bellows cap (1) to body. Remove bellows cap (1), gasket (2), bellows (3), and piston (4). Remove cup (5) from piston.

3. Loosen lock nut (16), then unscrew adjusting screw (15) from body. Remove O-ring (14), pressure regulating spring (13), and spring seat (12).

CLEANING AND INSPECTION

1. Thoroughly wash all parts in cleaning solvent and wipe dry. Blow out internal passages with compressed air.

2. Discard O-rings (8 and 14), gaskets (2, 11, and 17), and piston cup (5) and obtain new parts for assembly.

3. Check tension of springs (8 and 13) against "Specifications" at end of this section. Replace springs not within specified limits.

4. Inspect relief valve piston and cap (10). If seat on piston or in cap are worn or damaged, replace with new parts. Cap and piston are furnished in matched, lapped sets and must be replaced as a set.

5. Make sure seat in body contacted by piston cup (5) is clean and smooth.

6. Examine bellows for evidence or cracks or other damage. Replace if not in good condition.

ASSEMBLY

1. Install new cup (5) in groove in piston (4) with lip of cup facing small end of piston.

2. Insert piston assembly into body, then install bellows (3), gasket (2), and end cap (1). Air line port on end cap must be at top. Attach end cap to body with four cap screws and lock washers. Tighten cap screws firmly.

3. Install spring seat (12), pressure regulating spring (13), and adjusting screw (15) in body. Thread adjusting screw in until approximately one-half inch of screw extends out of body. Place O-ring (14) over adjusting screw and work into chamfer in body, then install lock nut (16).

4. Place relief valve piston seat (7) in relief valve bore. Install O-ring (8) in groove in relief valve bore. Place gasket (11) on relief valve cap and place piston and spring (9) in relief cap, then thread cap into body. Be sure end of cap does not dislodge O-ring from groove as cap is threaded into place. Tighten cap firmly.

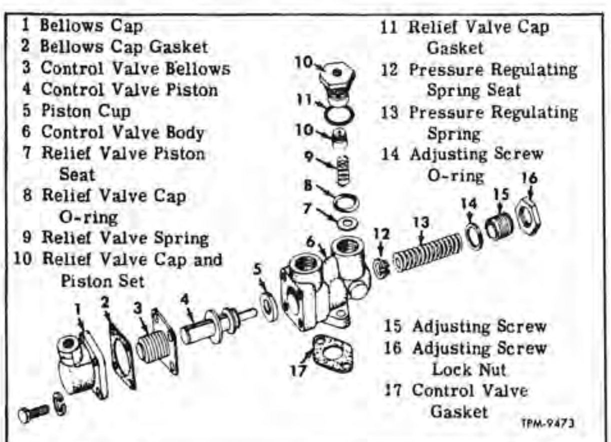


Figure 3—Control Valve Components

ROTARY AIR COMPRESSOR

AIR DOME AND RESERVOIR OVERHAUL

(Key Numbers in Text Refer to Figure 4)

DISASSEMBLY

1. Remove four special cap screws attaching air dome (5) to reservoir body (3). Separate dome from body and remove gasket (4).

2. Unscrew outlet check valve guide (11) from top of dome, then remove discharge fitting (7), check valve spring (10), and check valve (9). Remove gasket (8) from valve guide.

3. Remove six cap screws (4 short, 2 long) and lock washers attaching lubricating valve assembly to reservoir body. Separate valve assembly from body and remove gasket (14).

4. Remove filter retaining ring (26) and filter (25) from lubricating valve body (18). Using pliers on knurled edge of poppet (15) and wrench on valve stem nut (24), separate parts at one end. Remove parts from body, then hold valve stem in soft vise jaws to separate parts at remaining end. Remove seal (16) from poppet (15), remove O-ring (20) from valve stem (19), and remove cup (23) from piston (22).

5. It is not necessary to remove spacer (1) or cover (28) from reservoir.

CLEANING AND INSPECTION

1. Thoroughly wash all parts in cleaning solvent and wipe dry. Blow out drilled passages with compressed air. Blow air through pressure port in lubricating valve body from inside to clean strainer which is pressed into port. Make sure restriction orifice in lubricating valve body pressure port and in dome relief tube port are open.

2. Discard gaskets (4, 6, 14), poppet valve seal (16), valve stem O-ring (20), and piston cup (23)

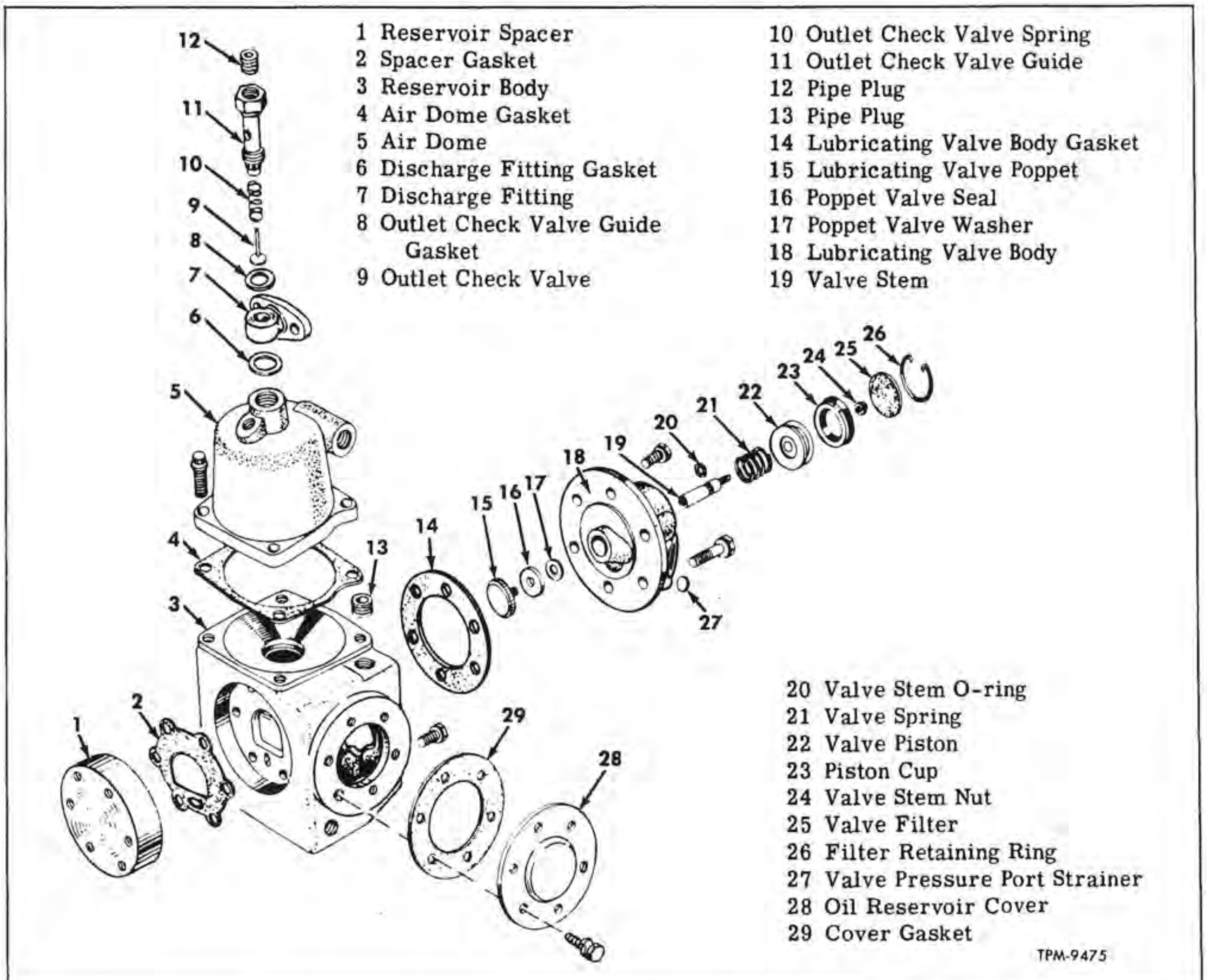


Figure 4—Air Dome, Reservoir, and Lubricating Valve Components

and obtain new parts for assembly.

3. Make sure check valve seat in air dome, poppet seal seat on lubricating valve body, and piston bore in lubricating valve body are clean and smooth.

4. Check tension of springs (10 and 21) against "Specifications" at end of this section. Replace springs not within specified limits.

ASSEMBLY

1. Dip all internal parts of lubricating valve assembly (15 through 23) in oil (same as used in engine). Place seal (16) and washer (17) over stem of lubricating valve poppet (15), making sure seal is fully seated in counterbore in poppet. Thread poppet into end of valve stem (19). Install O-ring seal (20) in groove in valve stem.

2. Install piston cup (23) in groove in piston (22) with lip of cup away from the deep recess on the spring side of the piston. Insert valve stem through lubricating valve body from inner side, then install valve spring (21) and piston assembly in body bore and over valve stem. Install nut (24) on valve stem. While holding knurled edge of poppet with pliers, tighten nut to 25 inch-pounds. Make sure valve stem and piston move freely in valve body. Install filter (25) in valve body and secure in place with retaining ring (26).

3. Using a new gasket (14), install lubricating valve assembly on reservoir and attach with six cap screws (2 long, 4 short). Tighten cap screws firmly.

4. Install gasket (8), discharge fitting (7), and gasket (6) over outlet check valve guide (11). Insert outlet check valve spring (10) and check valve (9) into valve guide. Insert valve guide into top of air dome and thread into place. Discharge fitting flange must be toward the compressor discharge tube port when valve guide is tightened.

5. Using new gasket (4), install air dome assembly on reservoir and attach with four special cap screws. Tighten cap screws firmly.

AIR COMPRESSOR OVERHAUL

(Key Numbers in Text Refer to Figure 5, Unless Otherwise Indicated)

DISASSEMBLY

1. Install two 3/8-16 x 3 cap screws in two tapped holes in bottom of stator. Mount in vise with vise jaws gripping the cap screws.

2. If air dome and reservoir assembly and control valve assembly have not been removed, remove as follows:

a. Remove tubes.

b. Remove nuts and lock washers from studs attaching mounting plate to compressor. Remove

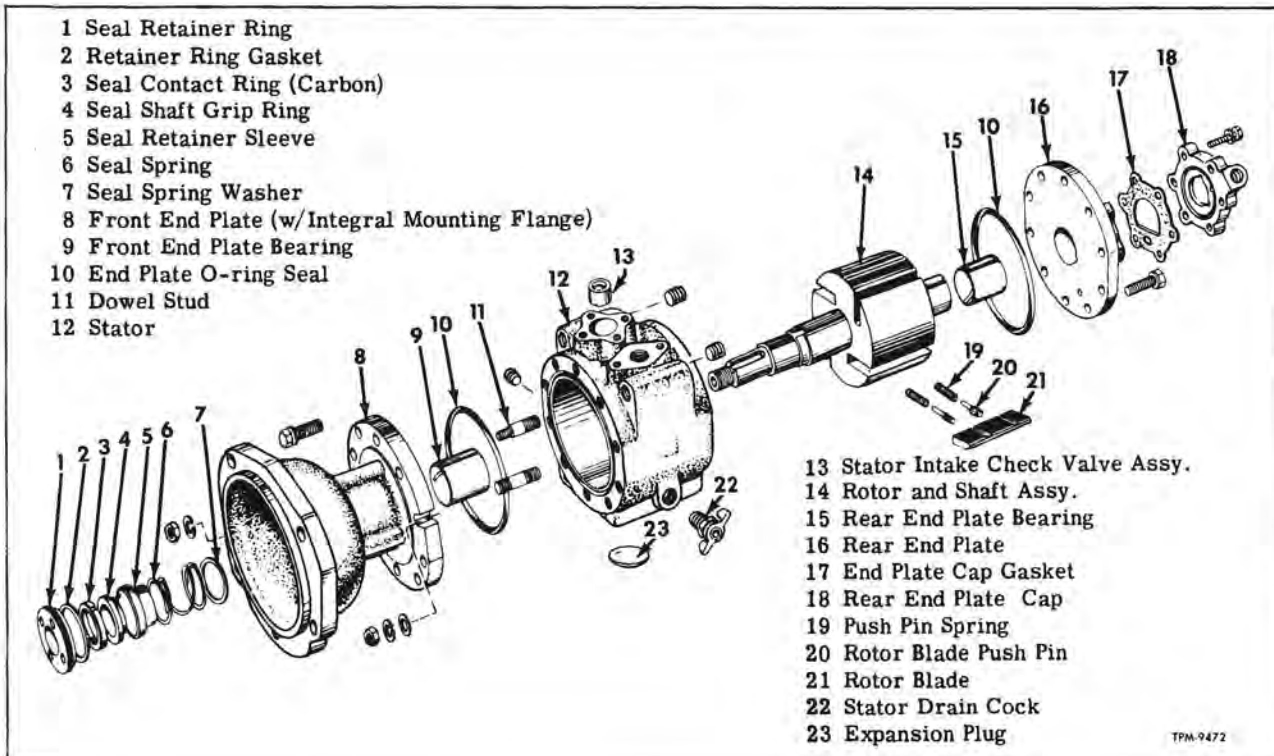


Figure 5—Air Compressor Components

mounting plate, dome and reservoir assembly and control valve as a unit.

3. Remove intake tube adapter from top of stator. Lift stator intake check valve assembly (13) out of intake bore in top of stator.

4. Using a punch, mark relationship of rear end plate (16) to stator (12), end plate cap (18) to end plate (16), and mark location of the six double end studs used to attach the reservoir mounting plate so these parts can readily be reassembled in correct position.

5. Remove cotter pin and nut from end of rotor shaft, then pull drive hub off shaft, using a suitable puller. Remove spacer from rotor shaft.

6. Remove eight cap screws attaching front end plate (8) to stator. Remove nut and washer from two studs (11), but do not remove studs from stator. Separate end plate from stator and pull end plate with seal components off rotor shaft.

7. Using a spanner wrench (AL74), remove seal retainer ring (1) from end plate bore, then remove balance of seal components (2 through 7).

8. Lift rotor and shaft assembly out of stator, then remove rotor blades (21), push pins (20), and springs (19).

9. Remove six cap screws attaching rear end plate cap (18) to rear end plate, then remove cap and gasket (17).

10. Remove six double end studs and lock washers, and four cap screws attaching rear end plate (16) to stator. Separate end plate from stator, then remove O-ring seal (10) from groove in each end of stator.

11. It is not necessary to remove the end plate bearings (9 and 15) from end plates unless replacement is necessary as indicated later under "Cleaning, Inspection, and Repair."

CLEANING, INSPECTION, AND REPAIR

Cleaning. Wash all parts thoroughly in cleaning solvent and wipe dry. Blow out internal passages in stator and in rear end plate cap.

Inspection.

1. Discard the following parts and obtain new parts for assembly: All seal components (1 through 7, except spring 6); O-ring seals (10), and gasket (17).

2. Inspect intake check valve assembly (13) for free action, condition of spring, and condition of valve seat. Replace assembly if damaged in any way.

3. Inspect inner surfaces of end plates (8 and 16), bore of stator (12), and ends and outer diameter of rotor (14) for evidence of wear. Do not reuse these parts if wear marks can be felt with finger nail. Minor wear marks can be polished out.

4. Check condition of bearing surfaces on rotor shaft and of bearings (9 and 15) in end plates. Slide end plates over shaft ends in operating position and check shaft to bearing clearance against limits listed in "Specifications" at end of this section. If clearance is excessive, replace bushings as directed under "Repair."

Repair

1. Press bearings out of end plates, using special arbor (AL52).

2. When installing new bearings, position bearings with oil grooves facing the rotor. Use installing arbor and guide sleeve (AL52 and AL51) to press new bearings into place. Avoid shaving metal from outer diameter of bearings while pressing in. If rotor shaft fits the new bearings too snugly, pass burnishing bar (AL53) through bearings one time only.

ASSEMBLY

1. Place O-ring seal (10) in groove in front end of stator. Assemble front end plate (8) to stator and install eight end plate to stator cap screws. Install nuts and washers on the two end plate to stator studs. Tighten cap screws and nuts finger-tight only.

2. Stand stator and end plate on end with end plate down. Insert rotor and shaft, without blades, into the stator, placing a 0.001-inch shim (1 inch wide) the full length of the rotor between the rotor and stator, midway between the intake and discharge ports. Shift the end plate position as necessary to solidly pinch the feeler shim, tapping end plate lightly to shift its position. Tighten end plate cap screws and stud nuts firmly, then turn rotor to remove shim.

3. With rotor seated against front end plate, use a straight-edge across top of stator to check rotor-to-end plate clearance. Total clearance is listed in "Specifications" at end of this section. Also drop rotor blades into slots in rotor against front end plate, and again using straightedge across stator, measure blade-to-end-plate clearance against limits listed in "Specifications."

4. Lift rotor and shaft out of stator, then install two cap screws in bottom of stator and install in vise with the vise jaws gripping the cap screws.

5. Coat inner faces of end plates, end plate bearings, and rotor and shaft assembly with engine oil.

6. Assemble rotor blades (21), push pins (20), and push pin springs (19) in slots in rotor. Use rubber band or O-ring seal to hold blades in place while inserting shaft and rotor into the stator.

7. Install O-ring seal (10) in groove in rear end of stator, then install rear end plate over shaft and position against stator with marks made prior to disassembly aligned. Attach end plate to stator with four cap screws and six double end studs with lock washers. Be sure studs are located in correct

holes (as marked prior to disassembly) so the reservoir mounting plate will be correctly positioned. Tighten cap screws and studs firmly.

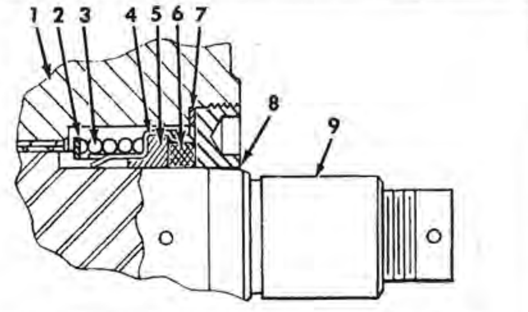
8. Install rotor shaft seal components (1 thru 7) over rotor shaft and into front end plate in the order shown in figure 5. Seal components installed are shown in figure 6. Use spanner wrench (AL74) to tighten seal retainer ring (1) to 125 foot-pounds torque.

9. Install gasket (17) and cap (18) on rear end plate, with marks made prior to disassembly aligned. Attach cap to end plate with six cap screws. Tighten cap screws firmly.

10. Install stator intake check valve (13) in intake bore in top of stator, and install drain cock (22) in side of stator.

11. Install intake tube adapter on top of stator.

12. Install dome and reservoir and mounting plate assembly, control valve assembly, and interconnecting tubes.



1 Front End Plate
2 Seal Spring Washer
3 Seal Spring
4 Seal Retainer Sleeve
5 Seal Shaft Grip Ring
6 Seal Contact Ring (Carbon)
7 Retainer Ring Gasket
8 Seal Retainer Ring
9 Rotor Shaft TPM-9468

Figure 6—Rotor Shaft Seal Components Installed

SPECIFICATIONS

Make	Wagner Electric Corp.
Capacity	12 cu. ft. per min.
Clearances	
Rotor to Stator (top center)	0.00075"-0.00100"
Rotor to End Plate (total, both ends)	0.0045"-0.0055"
Blade to End Plate (total, both ends)	0.0025"-0.0035"
Bearing to Shaft	0.0010"-0.0018"
Diameters	
Rotor Shaft O.D.	1.2488"-1.2493"
End Plate Bearing I.D.	1.2503"-1.2506"
Springs—Load Length and Load	
Rotor Shaft Seal Spring	½" at 25-27.5 lbs.
Dome Outlet Check Valve Spring	⅜" at 4-5 oz.
Relief Valve Piston Spring	17/32" at 1.75-1.92 lbs.
Control Valve Pressure Regulating Spring	1 11/16" at 45.6-50.4 lbs.
Lubricating Valve Piston Spring	13/32" at 14⅛-15⅞ lbs.
Air Pressure Setting	
Cut-out Pressure	117-120 psi.
Cut-in Pressure (not adjustable)	15-20 psi. below cut-out

Refer to LUBRICATION (SEC. 13) in this manual for recommended lubricants and intervals of application.

Parking Brake

Parking brake shoes are mounted on rear axle differential housing carrier as illustrated in figure 1. Parking brake is two-shoe, internal-expanding type. Brake lever is located at left side of driver. Parking brake lever is connected to an adjustable lever on brake camshaft by a series of rods and idler levers as shown in figure 2. Movement of brake lever rotates camshaft and forces brake shoes outward against brake drum. Brake drum is bolted to rear axle pinion companion flange.

PARKING BRAKE SHOES

Flanges on rear axle pinion bearing cage form the brake spider for brake shoes. Shoes pivot at one end on anchor pins which are retained in brake spider by lock screws and lock wire. Snap rings fit in grooves in ends of anchor pins to hold oil seal felts and retainers in place. Anchor pin ends of brake shoes are equipped with replaceable bushings. Cam end of each shoe is fitted with a roller which forms contact between brake shoes and cam. Roller pins for rollers are retained in shoes with set screws. One-piece lining is riveted to each brake shoe.

PARKING BRAKE CAMSHAFT

Camshaft is mounted at one end in a bushing in differential carrier housing, and at the other end in a bushing in parking brake spider (pinion bearing cage). Lubrication fitting in differential carrier housing supplies lubricant to both bushings. Oil seal in brake spider prevents passage of lubricant into brake drum. Adjustable lever is retained on splined end of camshaft by a flat washer and snap ring.

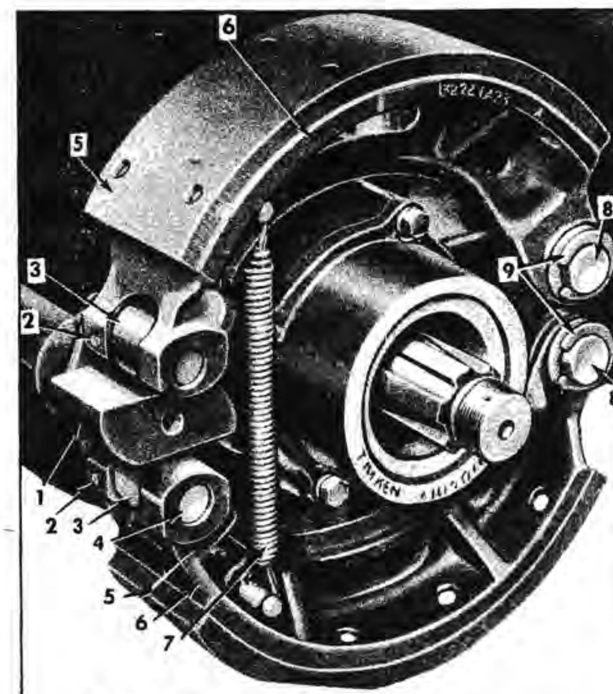
PARKING BRAKE ADJUSTMENT

Adjustment for normal brake lining and drum wear is made with adjustable lever (fig. 3). Before adjusting brake, check the following linkage dimension: Two levers are located one above the other in a bracket on bulkhead near parking brake. Center of upper lever clevis pin (fig. 2) should be from 3.16" to 3.19" away from bulkhead. Adjust nut on opposite side of bulkhead, if necessary, to obtain this dimension.

1. Place parking brake lever in fully released position.
2. Clean all dirt and grease from adjustable lever.
3. Measure clearance between brake shoe lining and brake drum with feeler gauge.
4. If clearance exceeds 0.015" by an appreciable amount, turn adjustable lever adjusting bolt until clearance is reduced to 0.015".
5. Move brake lever to applied position. Movement of two or three notches from completely released position should be sufficient to give full parking brake application.

BRAKE SHOE REMOVAL

1. Remove brake drum by performing applicable steps under "Propeller Shaft Removal" in PROPELLER SHAFT (SEC. 18) of this manual.
2. Remove brake shoe return spring.
3. Remove snap rings, oil seal retainers, and oil seals from ends of anchor pins.
4. Cut lock wire; then loosen anchor pin set screws. Drive anchor pins out of brake spider and remove brake shoes.



1 Camshaft
2 Set Screw
3 Roller
4 Roller Pin
5 Brake Lining
6 Brake Shoe
7 Brake Shoe Return Spring
8 Anchor Pin
9 Anchor Pin Lock

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Figure 1—Parking Brake Shoes Installed

PARKING BRAKE

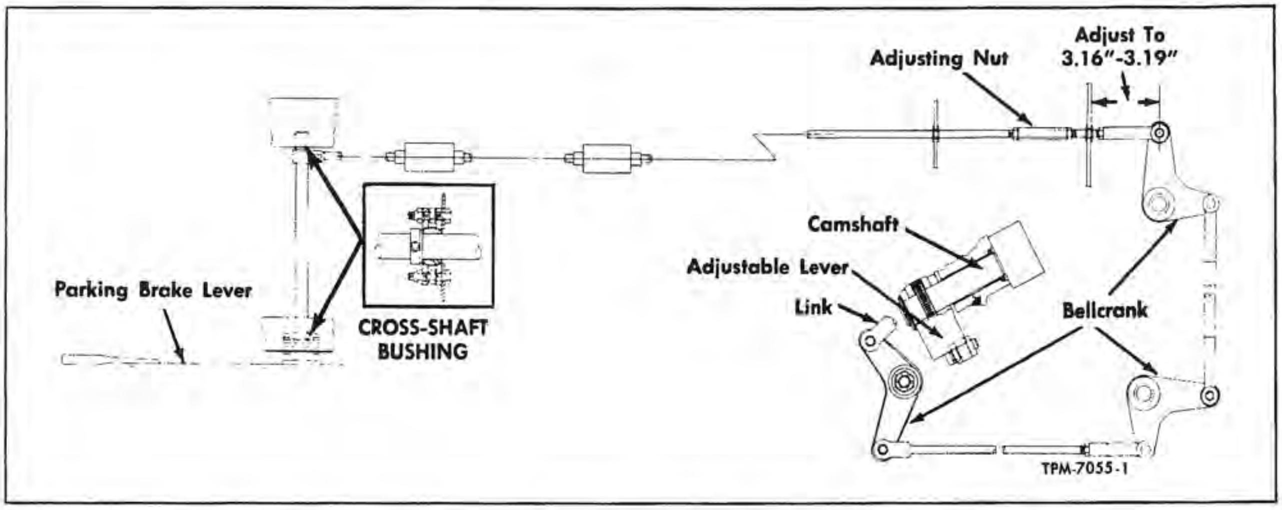

Figure 2—Parking Brake Control Linkage

BRAKE SHOE INSPECTION

1. Inspect brake lining and replace if worn down close to rivet heads. When making replacement, be sure brake lining fits firmly against brake shoe.

2. Examine anchor pin bushings in brake shoes and replace if worn excessively. After new bushings are installed, burnish to size listed in "Specifications" at end of this section.

3. Check brake shoe anchor pins for wear and replace if necessary.

4. Test brake shoe return spring for proper tension. Replace if weak or broken.

5. Examine rollers in brake shoes for wear or flat spots. Replace if not in good condition.

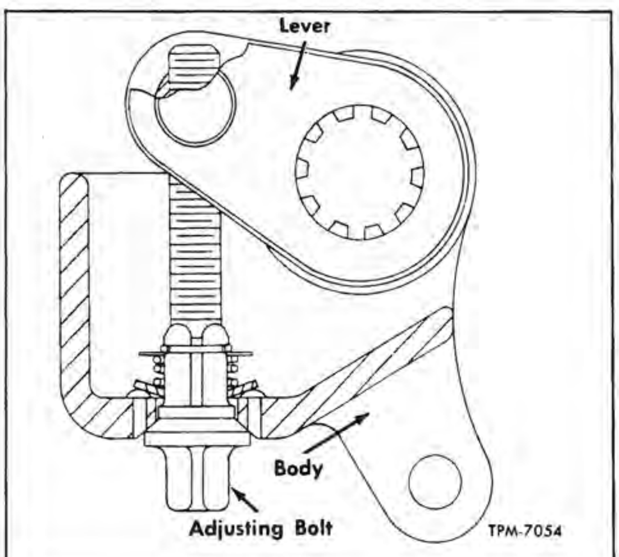

Figure 3—Parking Brake Adjustable Lever

6. Inspect brake shoe contact surface of brake drum for wear, scoring, or out-of-round. Refinish or replace drum as required.

BRAKE SHOE INSTALLATION

1. Coat brake shoe anchor pins and bushings with grease.

2. Place brake shoes on brake spider and install anchor pins. Anchor pins must be installed with milled flats aligned with set screw holes in brake spider.

3. Install new oil seals, seal retainers, and new snap rings on ends of anchor pins. Install anchor pin set screws, tighten firmly; then wire set screw heads together.

4. Install brake shoe return spring. Coat cam and brake shoe rollers sparingly with chassis grease.

5. Install brake drum and propeller shaft as directed in applicable steps under "Propeller Shaft Installation" in PROPELLER SHAFT (SEC. 18) of this manual.

6. Adjust brake as previously directed under "Parking Brake Adjustment" in this section.

CAMSHAFT REMOVAL

If necessary to remove camshaft, follow instructions previously given in steps 1 and 2 under "Brake Shoe Removal," then proceed as follows:

1. Remove propeller shaft flange from differential pinion shaft.

2. Disconnect link assembly from adjustable lever. Remove snap ring and washers securing adjustable lever on camshaft; then slide lever off camshaft.

3. Pull camshaft straight out through brake

spider. Do not lose spacing washer used between adjustable lever and differential carrier housing.

CAMSHAFT INSPECTION

1. Examine camshaft bushings in brake spider (pinion bearing cage) and in differential carrier housing. If worn excessively, install new bushings. After installing new camshaft bushings, burnish to correct size shown in "Specifications" at end of this section.

2. Inspect camshaft oil seal in brake spider and replace if wear, or deterioration is evident. When installing new oil seal, lip of seal must point inward toward bushing.

3. Examine camshaft and replace with new part if cam is scored or worn, or if shaft diameter is appreciably less than original diameter.

CAMSHAFT INSTALLATION

1. Coat camshaft and camshaft bushings with grease.

2. Insert splined end of camshaft through brake spider and differential carrier housing; be careful not to damage camshaft bushings or oil seal in brake spider.

3. Position brake shoes against cam; then install brake shoe return spring.

4. Make sure camshaft is turned so brake shoe rollers are resting on low points on cam. Place spacing washer over splined end of camshaft.

5. Place adjustable lever on camshaft in the position permitting connecting link assembly with least possible movement of camshaft.

6. Install washers and snap ring to secure adjustable lever on camshaft. Coat cam and brake shoe rollers sparingly with graphite grease.

7. Connect link assembly to adjustable lever. Install companion flange on differential pinion shaft.

8. Install brake drum and propeller shaft as directed in applicable steps under "Propeller Shaft Installation" in PROPELLER SHAFT (SEC. 18) of this manual.

9. Adjust brake as previously directed under "Parking Brake Adjustment" in this section.

PARKING BRAKE LINKAGE

(Refer to Figure 2)

Parking brake lever, located to left of driver, is attached to outer end of cross shaft. Cross shaft is solid and is supported at each end in permanently lubricated, self-aligning, bushing type bearings. Inner end of cross shaft carries a lever to which the front end of brake rod is connected. Brake rod incorporates spring type dampers and is connected to bell crank mounted on rear axle differential carrier housing. Bell crank is connected to an adjustable lever on camshaft by a link assembly and pins. Lubrication fittings are provided for idler levers and hand brake bell cranks. All other moving parts should be lubricated with oil can.

LUBRICATION

Periodic lubrication is required at the following points: Camshaft, brake shoe rollers and cam, bell crank, idler levers, hand lever, and all clevis connections in brake linkage. Refer to LUBRICATION (SEC. 13) for recommended intervals, type of lubricant, and method of application. Anchor pins require lubrication only at installation, using lubricant specified in LUBRICATION (SEC. 13). Whenever hand brake rods have been removed from loom, inside of loom must be lubricated, as directed in LUBRICATION (SEC. 13), before reinstalling rods.

Refer to next page for "Specifications."

PARKING BRAKE

SPECIFICATIONS

Type	Two-Shoe Internal-Expanding
Location	On Rear Axle Differential Carrier
Brake Drum Inside Diameter	12″
Shoe Lining	
Length (Each shoe)	11½″
Width	4½″
Thickness	½″
Area (both shoes)	104 sq. in.
Brake Shoe Return Spring	
Free Length	7″
Length at 27-33 Lbs. Pull	7 11/16″
Cam Roller In Shoe	
Roller Outside Diameter	1.248″-1.252″
Roller Inside Diameter	0.771″-0.776″
Roller Pin Diameter	0.748″-0.749″
Camshaft and Bushings	
Shaft Diameter (at Bushings)	1.243″-1.245″
Bushing Inside Diameter (burnish in place)	
In Brake Spider	1.249″-1.251″
In Differential Carrier Housing	1.249″-1.251″
Anchor Pins and Bushings	
Pin Diameter (at Bushings)	0.996″-0.994″
Pin Length	2⅞″
Bushing Diameter	
Inside (burnish)	0.998″-1.000″
Outside	Must Be Tight in Shoe
Bushing Length	0.470″-0.490″
Diameter of Hole in Shoe	1.0615″-1.0630″
Brake Lever Bushing	
Inside Diameter	0.875″-0.876″
Outside Diameter	1.064″-1.065″
Width	1.710″-1.730″

Cooling System

DESCRIPTION

Engine is cooled by liquid which is circulated within a sealed system. Cooling system units include: water pump, radiator, surge tank, and engine thermostats. A fluid-driven fan mounted on housing at front of engine (fig. 1) forces air through radiator core for cooling. Some radiators are equipped with shutters which aid in controlling temperature.

On coaches with hydraulic transmission, cooling system liquid is used to carry heat away from heat-exchanger on transmission. Pressure valve at surge tank is used to maintain pressure within cooling system. Temperature of coolant within engine is controlled by engine thermostats in thermostat housing at front of engine. Cooling system is filled through filler cap at surge tank (fig. 2).

Water for heating coach is supplied from the engine cooling system.

An alarm buzzer and tell-tale warning light at instrument panel warns the driver in case engine becomes overheated. In addition some vehicles have a temperature gauge at instrument panel which is operated from electrical sending unit on engine.

A water filter is installed as special equipment on some coaches to prevent corrosion and accumulation of sediment in cooling system.

CIRCULATION

Coolant circulation during warm-up differs from circulation after engine has reached normal operating temperature as explained in following paragraphs. See schematic of cooling system (fig. 15).

ENGINE WARM-UP

The two temperature control thermostats are located in a housing at front of engine. Water pump pumps coolant into cylinder block, by way of engine

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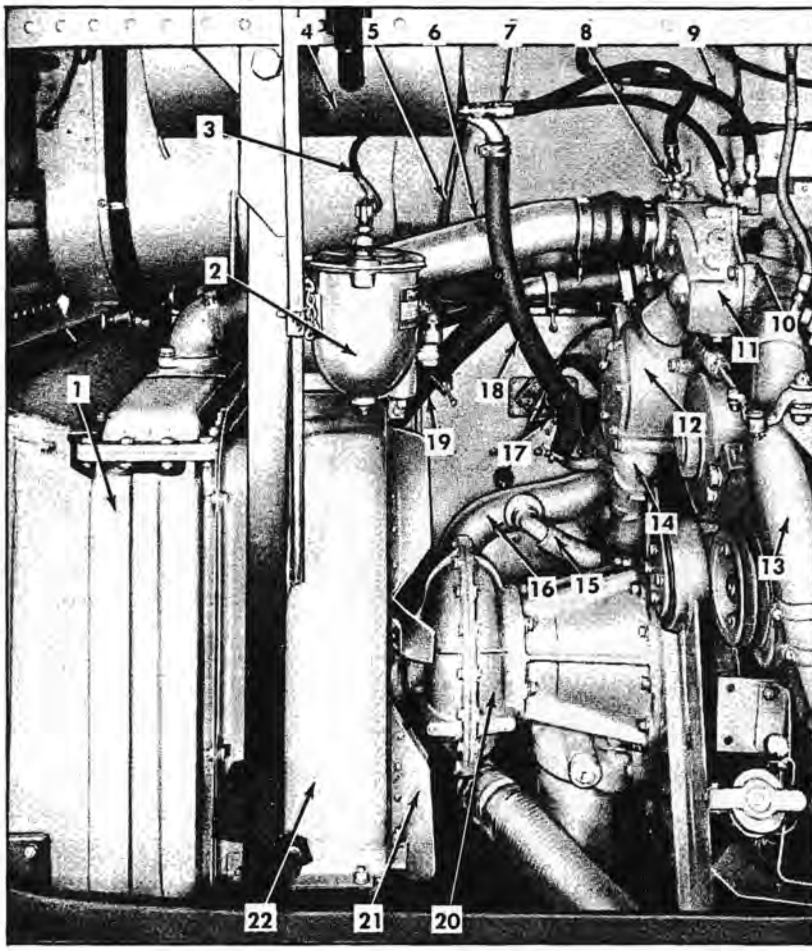

1 Radiator Assembly
2 Water Filter Assembly
3 Water Filter Outlet Line
4 Surge Tank
5 Surge Tank Overflow Tube
6 Water Line to Radiator
7 Vent Line
8 Vent Cock
9 Deaeration Line
10 Thermostat Housing
11 Thermostat Housing Cover
12 Water Pump Assembly
13 Cylinder Head to Thermostat Housing Water Line
14 Water Pump to Oil Cooler Line
15 Water Line From Heat Exchanger
16 Radiator to Water Pump Line
17 Heater Return Line
18 Surge Tank to Water Pump Line
19 Water Line to Heater
20 Fluid Fan Torus Housing
21 Fan Blades
22 Radiator Shroud

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Figure 1—Cooling System Units—6 Cylinder Shown

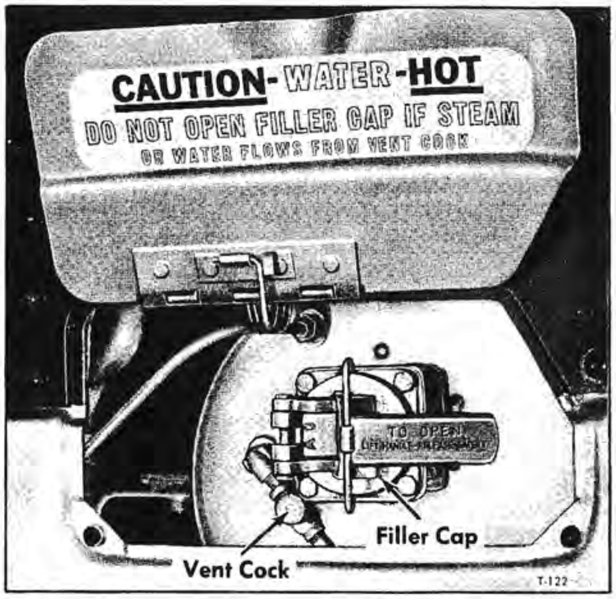


Figure 2—Surge Tank Filler and Vent Cock

oil cooler. After circulating through block and cylinder heads coolant enters thermostat housing. When engine is cold (below 165°) the thermostats are closed and prevent coolant from flowing to radiator, so the coolant returns to water pump through by-pass openings in housing. During warm-up, coolant also circulates through air compressor cylinder head, through heat-exchanger at transmission (TDH Models), through heater lines in coach body, and through surge tank.

AFTER WARM-UP

When coolant reaches temperature at which engine thermostats open, coolant begins to flow through radiator. Heat at this time is sufficient to actuate fan control valve and cause the fan to operate. Coolant continues to circulate through air compressor, heat exchanger at transmission (TDH Models), coach heating system, and surge tank. Refer to DIESEL ENGINE MANUAL for operation and maintenance of Fluid Fan and Controls.

FILLING COOLING SYSTEM

Only pure, soft water and ethylene glycol type antifreeze should be used in cooling system. Additional information concerning use of antifreeze is given later in this section.

CAUTION: On coaches equipped with water filters, follow the procedure given later when servicing the water filter.

FILLING EMPTY SYSTEM

1. Close all drain cocks and install drain plugs, referring to draining procedure for location of drain points.

2. Open shut-off cock in vent line at top of thermostat housing at front of engine (fig. 1).

3. If heater line shut-off valve has been closed, open valve.

4. Through filler cap (fig. 2) slowly fill system to level of filler cap opening.

5. Refer to "HEATING AND VENTILATION" in BODY (SEC. 3) for instructions on bleeding heat-

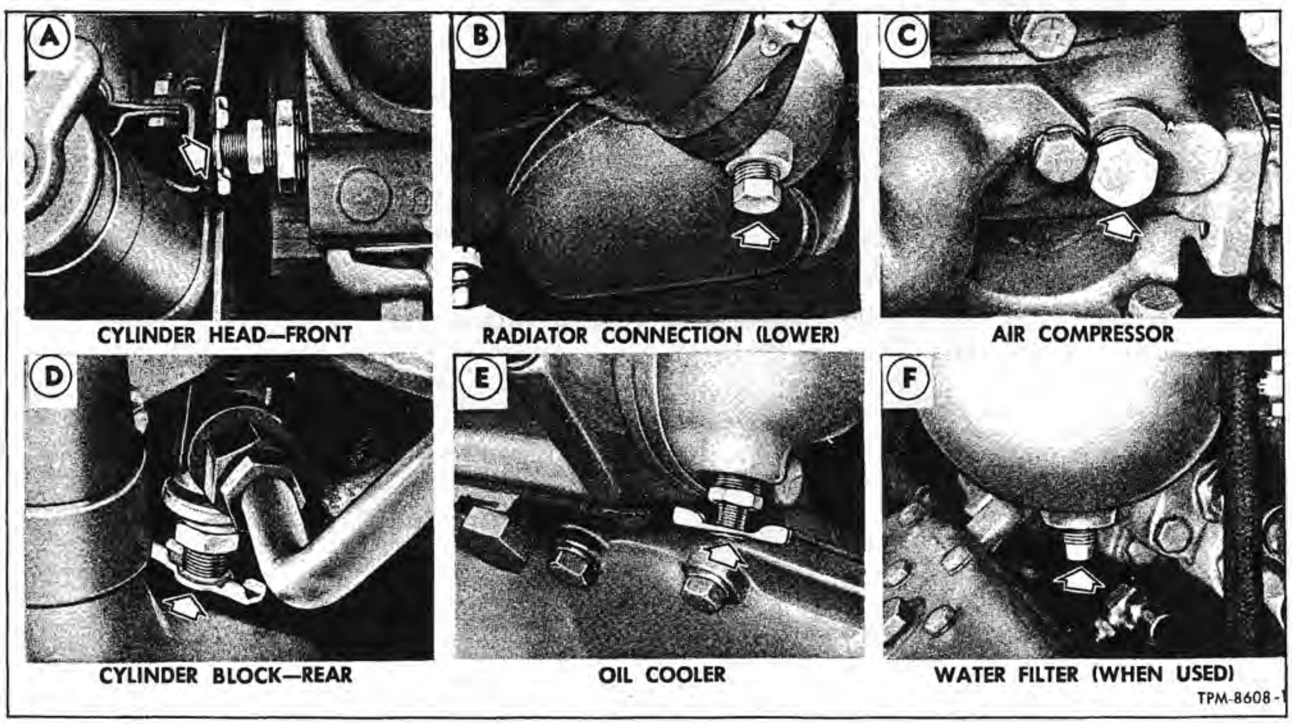


Figure 3- Location of Cooling System Drain Points

ing units when filling a completely empty system.

6. After bleeding, close vent line shut-off cock (8, fig. 1). CAUTION: During winter operation, without anti-freeze solution, leave vent cock open.

REPLENISHING COOLING SYSTEM

1. Press relief valve button (vent cock) on surge tank, and hold in depressed position until all pressure is relieved from system.

CAUTION: If engine is overheated, wait until boiling stops and engine has cooled before adding cold water. Then with engine running, add water slowly as directed in step 2 below.

2. At surge tank (fig. 2) open filler cap, and add water to level of cap opening.

3. If water in cooling system was very low bleed heating system units to make sure all air is expelled. Refer to "HEATING AND VENTILATION" in BODY (SEC. 3) of this manual.

DRAINING COOLING SYSTEM

Drain cocks are provided at engine, radiator, and in heating system. A shut-off valve in heater line can be closed to permit draining engine without draining heater lines. Press and hold relief valve (vent cock) at surge tank to relieve pressure, then block filler cap open to vent cooling system while draining. Open drain cocks and remove plugs at points indicated below.

ENGINE COOLING SYSTEM DRAIN POINTS

1. Remove drain plug from radiator outlet connection at bottom of radiator (B, fig. 3).

2. At bulkhead side of engine open drain cock at oil cooler (E, fig. 3).

3. Remove pipe plug at air compressor (C, fig. 3).

4. At rear side of engine, open drain cock at front of cylinder head (A, fig. 3), also at rear of cylinder block (D, fig. 3).

5. When used as special equipment, remove plug from bottom of filter housing (F, fig. 3).

6. Refer to "HEATING AND VENTILATION" in BODY (SEC. 3) for instructions covering draining of heater lines.

COOLING SYSTEM INSPECTION AND MAINTENANCE

At regular intervals, cooling system units should be inspected to determine if service is required. Regular systematic checks will indicate condition of various units and indicate necessity of servicing or replacement of units which can be made before failures occur.

1. At surge tank, check coolant level by pressing relief valve button (vent cock). If liquid flows out, system contains adequate solution. If coolant is low add water as necessary. NOTE: Refer to previous instructions for filling cooling system.

2. Check hose connections and tighten clamps as necessary. Cracked, swollen, or deteriorated hoses must be replaced.

3. Check radiator core and heater cores for leaks and for accumulation of dirt which obstructs air passage. Clean cores with air hose using low pressure. Repair all cooling system leaks at first opportunity. Refer to DIESEL ENGINE MANUAL for procedure to remove and overhaul water pump.

4. Inspect the radiator mountings and tighten mounting bolts when necessary.

5. If radiator is equipped with shutters, check operation of shutter air cylinder, and service the air filter assembly as directed in "Radiator Shutters" later in this section.

6. Check operation of fluid fan (fig. 1) which must not run at full speed when engine is cold, but must operate when engine has reached normal operating temperature.

7. Inspect for clearance between fan blades and radiator core and fan shroud. Correct as necessary.

8. Inspect air recirculation seals at baffles around radiator assembly. Seals must be in good condition.

9. Inspect and service water filter (if used) as directed in this section.

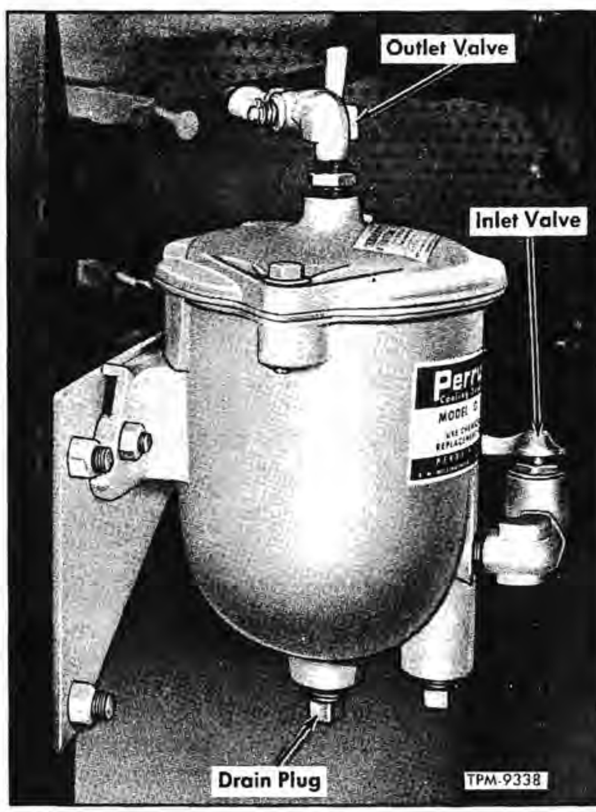
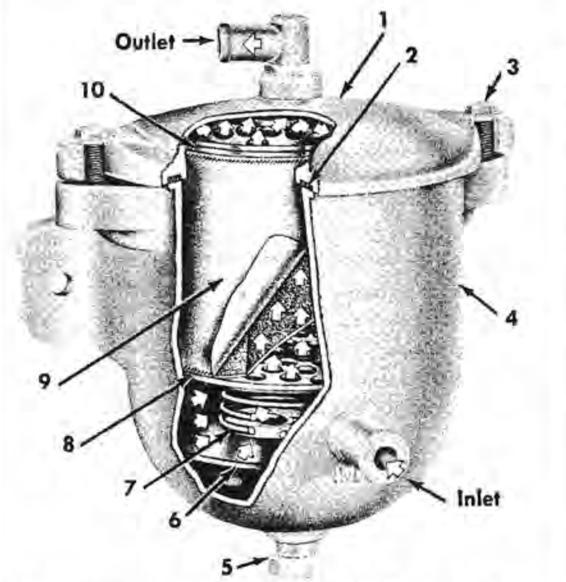


Figure 4—Water Filter Installed—Typical



1 Cover
2 Gasket
3 Bolt
4 Body
5 Drain Plug
6 Sump Plate
7 Spring
8 Lower Plate
9 Element
10 Upper Plate

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Figure 5—Sectional View of Water Filter

WATER FILTER

Water filter (fig. 4) as installed on some vehicles is used to filter and condition water in cooling system. On a new engine, the filter element should be initially changed after 2,500 to 3,000 miles. After initial change, the filter should be serviced periodically 7,500 to 10,000 miles or 300 to 500 hours depending upon engine workload, conditions, etc.

Except when antifreeze is used, color of water in system should be a golden yellow. No rust preventive or inhibitor should be used in system when water filter is used.

IMPORTANT: Some permanent-type antifreeze solutions may contain inhibitor which will produce a green residue or precipitation. If this is noted more frequent element change periods will be necessary and if this fails to correct condition, the filter element should be removed, or the filter disconnected.

ELEMENT REPLACEMENT

NOTE: Key numbers in text refer to figure 5.

1. For convenience in changing element, close off filter supply and return hose by closing two cocks.
2. Remove two bolts (3) which attach cover (1) to filter. Remove cover and cover gasket (2).
3. Remove drain plug (5) from bottom of filter.
4. Remove upper plate (10), element (9), lower plate (8), spring (7), and sump plate (6) from filter body (4). Flush out filter body.
5. Discard filter element, then clean all parts. Examine element lower plate for excessive corrosion. Deep pits in the plate do not warrant replacement. Clean plate by wire brushing. This plate generates current for the electrochemical action of filter element. If excessively corroded, replace.

NOTE: During winter, when using ethylene glycol antifreeze solutions, install element identified by letters "PAF," also when operating in mild climates where no antifreeze is required use the standard chromate type filter element.

6. Referring to illustration, position sump plate (6), spring (7), lower plate (8), new element (9), and upper plate (10) in filter body (4). Install cover (1) using new gasket (2). Tighten cover attaching bolts evenly and firmly.
7. Open two shut-off cocks. Start and operate engine until water in cooling system is warm. Check for air lock in filter. If cover of filter becomes warm no air-lock condition exists in system. If cover remains cool, vent system same as for a hot water heater system.
8. Refill system to proper level.
9. IMPORTANT: Make sure that filter body is grounded, otherwise electro-chemical action of filter element will be affected.

ENGINE TEMPERATURE CONTROL

ENGINE THERMOSTATS

Engine thermostats are located in outlet housing at front of engine (fig. 1).

When engine is cold, the thermostats are closed and prevent water from circulating through radiator, instead, the coolant passes through a bypass to water pump where it is recirculated through engine oil cooler, cylinder block and cylinder heads.

Proceed as follows to replace thermostats.

1. Remove muffler (when installed in engine compartment), which is accessible with engine compartment rear door open.
2. Close shut-off valve in heater line and open drain cocks at each end of cylinder block to drain water level below thermostat housing. Plug at bottom of radiator may be removed to drain water more rapidly.
3. Remove heat shield and loosen hose clamps

on by-pass hose and the hose connecting housing to pipe.

4. Remove bolts which attach cover to housing, then remove cover and two thermostats (fig. 6).

5. Place thermostats in position in cover with element toward engine. Install cover using new gasket. Fit the thermostat cover into by-pass and radiator pipe hoses before installing cover bolts.

6. After installing cover bolts, position hose and tighten clamps. Fill cooling system, start engine and inspect hose connections for leaks. Install heat shield at upper hose near muffler as shown in figure 1.

7. Install muffler (8-cylinder only).

TEMPERATURE GAUGE AND SENDING UNIT (SOME COACHES)

Some coaches have an electrically operated temperature gauge in instrument panel which registers engine temperature. Sending unit is installed in engine thermostat housing. Circuit does not operate when "MASTER" control switch is in "OFF" position.

Refer to "Alarm and Signal Wiring Diagram" for electrical wiring circuits when tracing wiring between sending unit and gauge. When used, the sending unit is installed in tapped boss adjacent to engine overheat switch. DO NOT USE THREAD COMPOUND ON SENDING UNIT THREADS when installing.

WATER TEMPERATURE (OVERHEAT) SWITCH

A tell-tale light at instrument panel and alarm buzzer are used to warn driver of overheated engine. Overheat switch is installed in engine thermostat housing and is connected to wiring harness. Switch is a sealed unit and is not adjustable.

OPERATION

Engine overheat switch has internal contact points which are normally open at temperature below $210^{\circ}F$. In case engine temperature rises to $210^{\circ}F$. to $214^{\circ}F$., the contact points will close and complete the electrical circuit which causes tell-tale light and buzzer to operate.

OVERHEAT SWITCH REPLACEMENT

1. Disconnect wire from terminal on switch, then use wrench to screw switch body out of thermostat housing.

2. Screw switch into housing and tighten firmly. DO NOT USE COMPOUND ON SWITCH BODY THREADS. Threads are dry-seal type. Use of compound may prevent proper transfer of heat and hinder flow of electric current.

3. Connect wire to terminal.

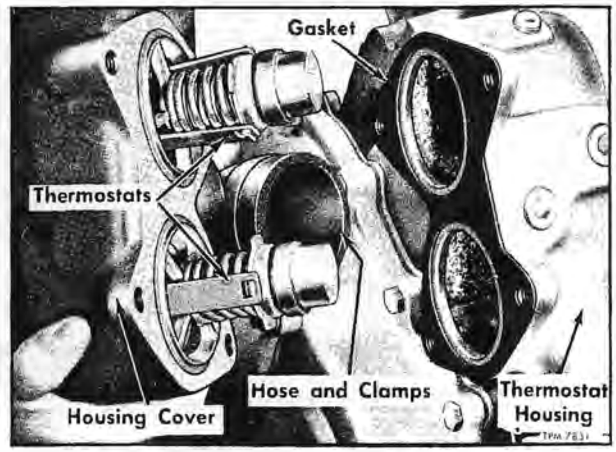


Figure 6—Engine Thermostat Replacement

FLUID DRIVE FAN

Fan for cooling radiator is installed at front end of engine as shown in figure 1.

The fan is driven by torus members located in fan drive torus housing. Oil from engine crankcase is used to fill torus housing to operate fan. Construction, operation, and repair of fluid fan and control valve are covered in GM DIESEL ENGINE MANUAL. The fluid fan control valve is thermostatically actuated by temperature of water in pipe between water pump and oil cooler. The fan blade assembly is bolted to flange on drive hub.

RADIATOR AND SURGE TANK

Radiator is located at left rear corner of coach and is covered by a grille door. Radiator on 6-cylinder is stationary, while 8-cylinder is hinged.

MOUNTING - 6-CYLINDER

Radiator is mounted on support member attached to bracket on engine compartment bulkhead and to engine cradle member. Top of radiator is held in position by a bolt and rubber spacers. Radiator is supported at two bottom corners on fabric washers, which provides a semi-rigid mounting.

MOUNTING - 8-CYLINDER

Radiator is mounted to body by two rubber insulated hinges (fig. 7) which permits radiator to swing outward, thereby providing accessibility to fan blades, hoses, and so forth at front of engine. A latch and handle (fig. 8) is used which permits radiator assembly to be locked in place or released when it is to be hinged outward.

SURGE TANK

Surge tank installed above radiator is equipped with pressure valve assembly. Pressure valve in-

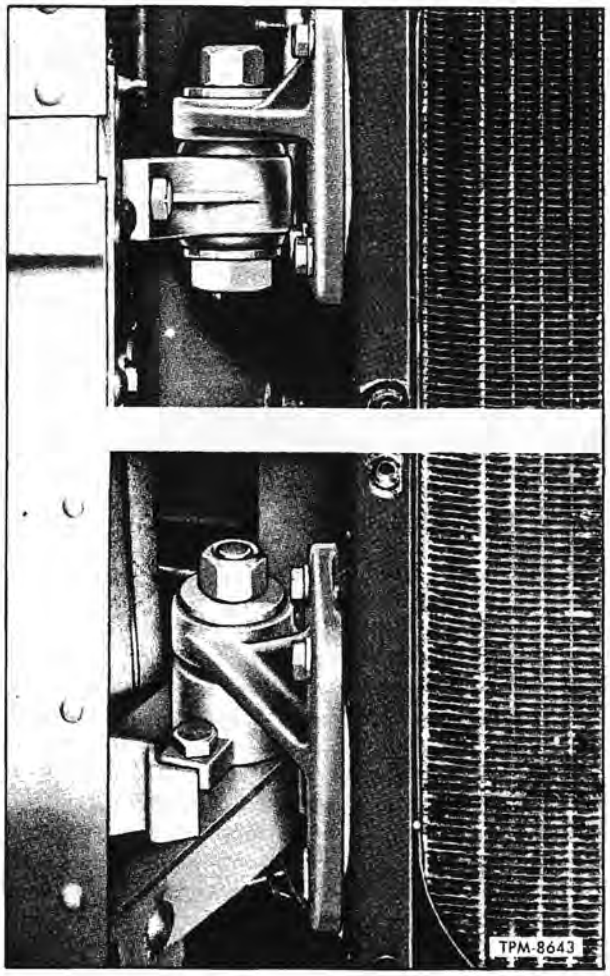


Figure 7—Radiator Hinges—8 Cylinder

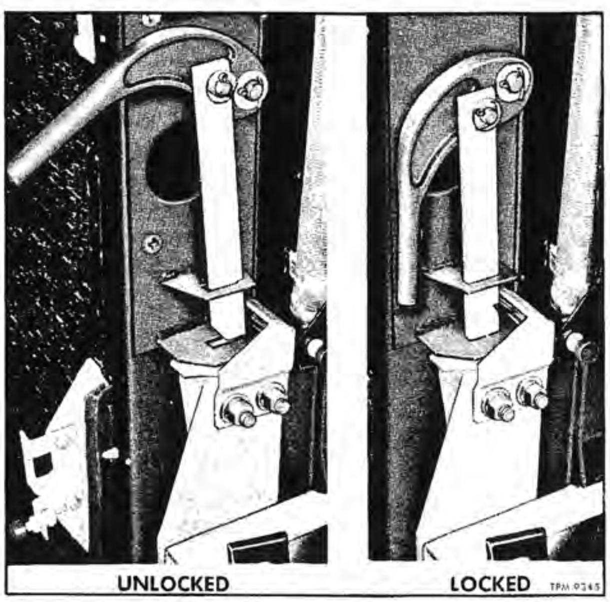


Figure 8—Radiator Latch and Handle—8 Cylinder

corporates two valves; one of which relieves excessive pressure and another which admits atmosphere as coolant contracts after engine is stopped. An overflow tube is connected to pressure valve.

RADIATOR INSPECTION

At regular intervals, check core attaching bolts for tightness. Check lower mounting for worn or deteriorated insulators, and loose or missing nuts. Check condition of support upper rubber mountings.

At regular intervals, or when operating conditions warrant, examine radiator core for leaks and bent fins. A damaged or clogged radiator should be serviced by a radiator specialist or replaced with a new one. Efficient repair of radiators requires the use of special tools and equipment as well as provisions for making proper tests. If radiator core requires painting, spray with special radiator paint; do not use paint mixed with oil, as oil mixed paint will form an insulation and prevent efficient dissipation of heat.

Check for clearance between fan blades and radiator shroud. Distance between blades and shroud should be equal all around. Whenever adjustment is necessary shroud attaching bolts can be loosened and shroud adjusted to provide proper clearance.

Radiator on 8-cylinder equipped vehicles is adjustable at latch bracket (fig. 9), so that radiator may be moved inward or outward as necessary to

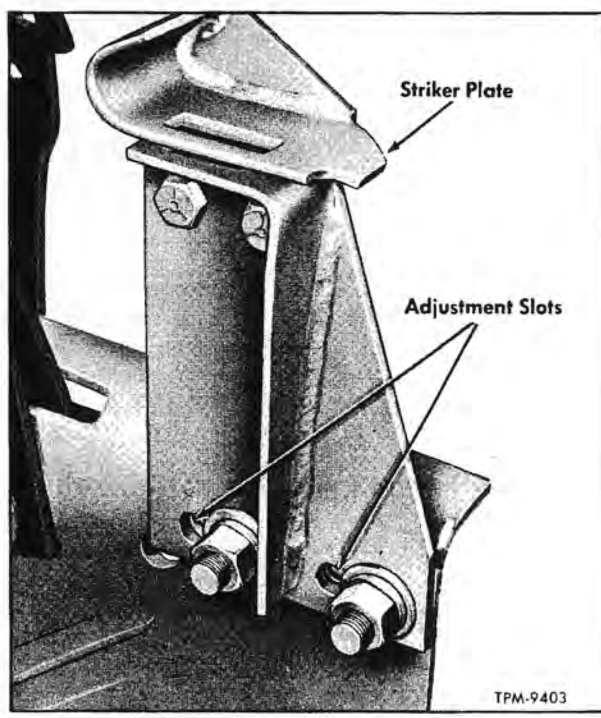


Figure 9—Radiator Latch Adjustable Bracket—8 Cylinder

obtain proper fit between grille door and radiator. Radiator latch strike plate is also adjustable to obtain tight fit of latch plunger in latch bracket slot.

RADIATOR, SHUTTERS, AND CONTROLS

Radiator shutters are installed on some coaches which operate in cold climate. Shutters are held open by springs except when closed by action of air cylinder (fig. 10) which occurs when temperature of coolant is low enough to cause shutter thermostat (fig. 13) to act.

An air filter (fig. 12) is mounted on panel above engine (fig. 11) and filters air used to operate the shutter air cylinder.

The radiator shutter thermostat is installed in water outlet housing at front of engine as shown in figure 11.

SHUTTER MAINTENANCE

Maintain radiator shutter unit in free working condition by cleaning vane bearings thoroughly with brush or spray gun, or both. Use gasoline or penetrating oil until all dirt is removed. After shutter is once worn in, lubricating oil may be omitted after cleaning.

Frictional wear is very slight, and excessive lubricant may increase rapid collection of dirt. This attention is recommended every 2,000 to 5,000 miles, depending upon the nature of operation and the tendency toward dirt collection.

AIR FILTER

Air filter, mounted as shown in figure 11, prevents moisture from entering shutter thermostat. Sectional view of filter is shown in figure 12. As

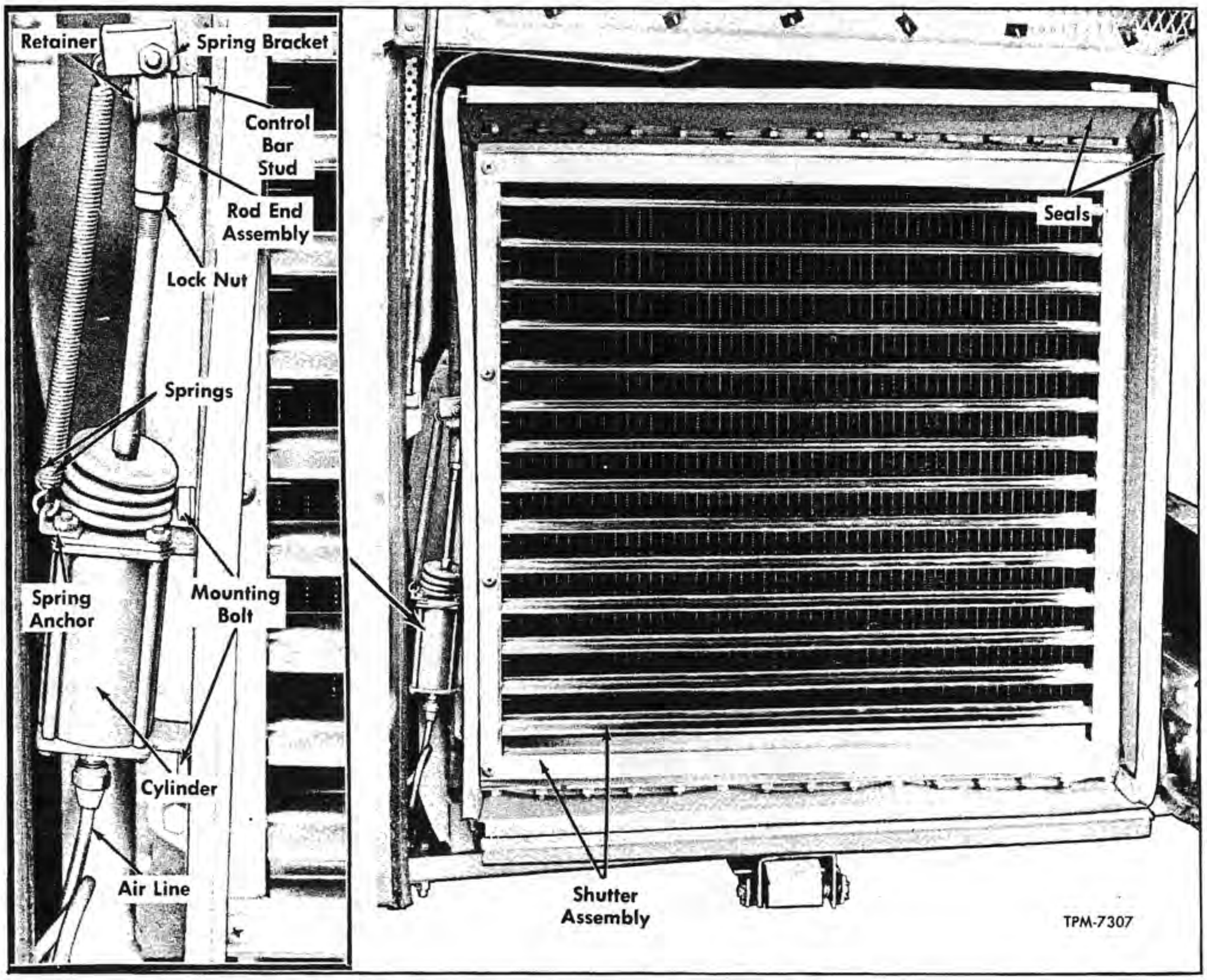
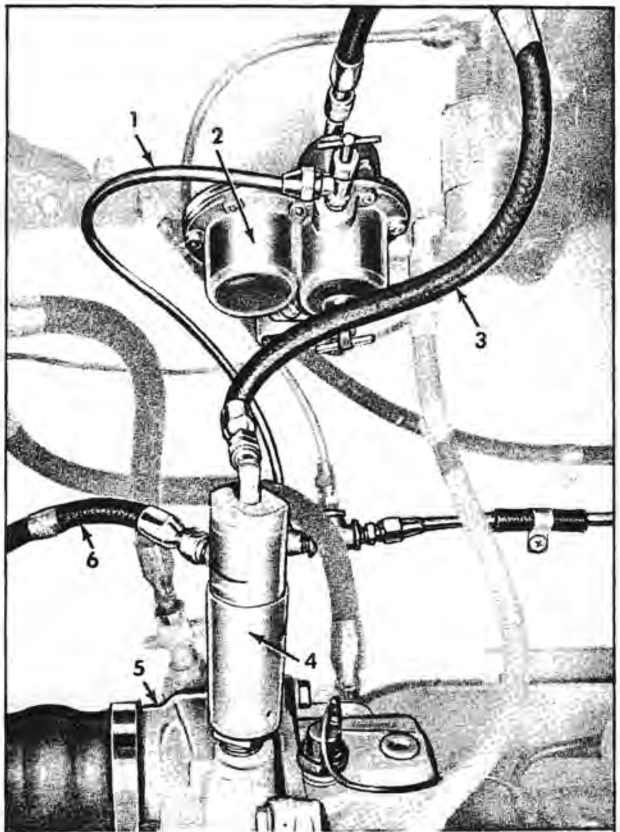


Figure 10—Radiator Shutters and Air Cylinder Installed



1 Air Supply Line	5 Thermostat Housing Cover
2 Shutter Air Filter	6 Thermostat to Air Cylinder Air Line
3 Filter to Thermostat Air Line	
4 Shutter Thermostat	

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Figure 11—Shutter Air Filter and Thermostat Installed

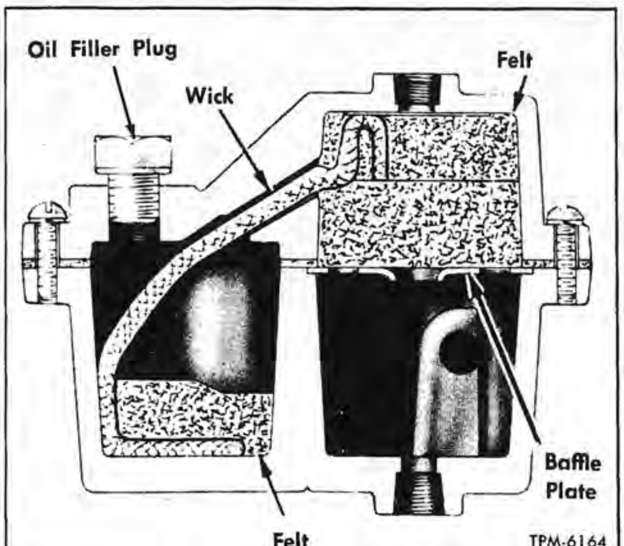


Figure 12—Sectional View of Shutter Air Filter

air from air tank enters filter, it strikes against baffle which diverts moisture in air stream to bottom of housing. Air then passes through filtering element. Air is again filtered through felt before entering thermostat air valves. Periodic check should be made for leakage at filter connections. Tighten if necessary.

CAUTION: Valve at filter inlet line must be closed before removing plugs or disconnecting outlet line.

Add fluid to filter through filler plug. Refer to Lubrication Chart in LUBRICATION (SEC. 13), for intervals, quantity, and type of fluid. Larger quantities or more frequent filling may overload the system.

Air filter should be drained at regular intervals by opening pet cock at bottom. This operation should be performed with pressure in air lines.

Every 10,000 miles, air filter should be disassembled and the felt cleaned with cleaning solvent or replaced.

RADIATOR SHUTTER THERMOSTAT

Radiator shutter thermostat, mounted in housing, as shown in figure 11, functions automatically to open and close air line to power unit, which operates radiator shutter.

CLEANING

Key numbers in text refer to figure 13.

1. Remove end cap (9) and needle valve seat cap (1). Wash needle (2) thoroughly in a cleaning solution.

IMPORTANT: Do not use abrasive or metal tools to remove deposits from needle or seats.

A pointed wooden stick provides a practical method of cleaning tapered seats. All parts must be thoroughly cleaned before reassembling. Felts must be renewed, or thoroughly washed in solvent.

2. Apply a drop or two of engine oil on needle (2) then insert needle (2), blunt end toward push pin (5) and into unit. Install seat cap (1) (without spacing gasket (7)) and tighten firmly against needle. Repeat operation a few times, until new seat has been formed.

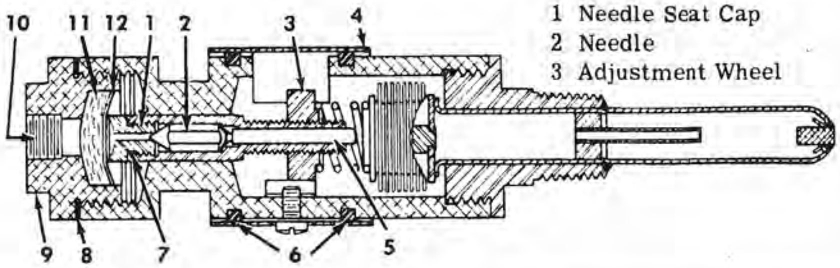
3. Remove seat cap (1) and needle (2) and clean. Reinstall needle and seat cap, using new gasket (7) under seat cap.

4. Install screen (12), felt (11), end cap gasket (8), and end cap (9). Tighten end cap firmly.

TESTING

Shutter thermostat should be tested for proper operation, before installation in vehicle. Test in water bath, as follows:

Connect air line to inlet port and an air pressure gauge to outlet port. Suspend thermostat in water, up to mounting threads. Use an accurate



1 Needle Seat Cap
2 Needle
3 Adjustment Wheel
4 Jacket
5 Push Pin
6 Seal Ring
7 Gasket
8 Cap Gasket
9 End Cap
10 Inlet
11 Felt
12 Screen

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Figure 13—Sectional View of Radiator Shutter Thermostat

thermometer, but make sureneither thermostat nor thermometer contacts bottom of container.

Raise water temperature gradually to closing temperature of thermostat, keeping water thorouthly agitated. Hold water temperature constant for two or three minutes, since thermostat operation may lag on initial cycle.

Note thermometer reading at which gauge shows pressure drop - this indicates closing of thermostat.

If thermostat fails to close at temperatures listed in "Specifications," adjust to proper operating point.

Adjust by turning adjustment wheel (3). Turning wheel one full turn will change operating point approximately 10^{O}F.

SHUTTER AIR CYLINDER

Shutter air cylinder (fig. 14) is installed to radiator shutter as shown in figure 10. Air cylinder may be tested on vehicle to determine whether cause of malfunction is in air cylinder or controlling thermostat. This is done by disconnecting thermostat-to-cylinder air line and applying air pressure directly to air cylinder, while observing action of cylinder. Cylinder should operate shutters at a minimum line pressure of 35 pounds.

Whenever air line has been disconnected, always check for air leaks with soap suds when air line is reconnected.

AIR CYLINDER REMOVAL (Refer to Fig. 10)

1. Close off air pressure by closing shut-off cock on shutter air filter.

2. Open access door in front of radiator, then disconnect air line from air cylinder and unhook springs.

3. Disconnect piston rod from shutter control stud. Remove bolts attaching cylinder mounting brackets and remove cylinder assembly.

AIR CYLINDER INSTALLATION (Refer to Fig. 10)

1. Position air cylinder and install mounting bolts and lock washers.

2. Connect piston rod to shutter operating stud.

3. Connect air supply line to air cylinder, and hook up two return spring. Open air shut-off cock, then check operation of shutters.

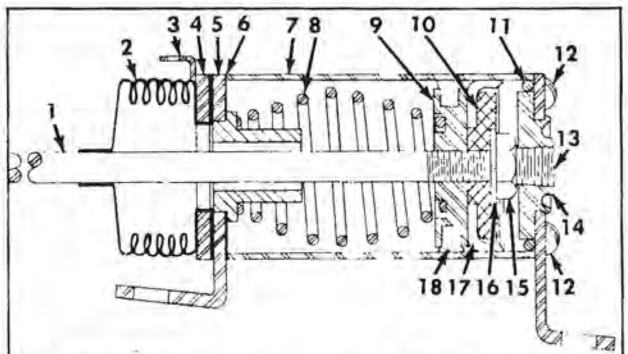
CYLINDER PISTON ROD ADJUSTMENT (Refer to Fig. 10)

Adjustment should be checked when engine is cold, and air pressure applied to air cylinder. Under these conditions cylinder piston should be extended with cylinder piston rod forcing shutter vanes to fully-closed position.

Adjustment is made by threading rod end inward or outward on piston rod as follows:

1. Unhook springs and remove retainer from control bar stud.

2. Loosen rod end lock nut, remove rod end from stud, then manually hold shutters in closed position. Turn rod end assembly as necessary to



1 Piston Rod
2 Boot
3 Spring Bracket
4 Cylinder End Plate
5 End Assembly
6 Gasket
7 Cylinder
8 Spring
9 Piston
10 Piston Follower
11 Seal Ring
12 Thru-Bolt
13 Air Connection
14 Cylinder Head and Bracket Assembly
15 Nut
16 Lock Washer
17 Piston Cup
18 Lubrication Felt

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Figure 14—Sectional View of Radiator Shutter Air Cylinder

allow rod end to be installed on stud with shutter vanes remaining closed.

3. Install retainer to secure rod end to stud and hook up the two shutter springs. Tighten rod end lock nut.

AIR CYLINDER REPAIR

Disassembly

NOTE: Key numbers in text refer to figure 14.

1. Remove two bolts which attach spring brackets (3) and remove brackets.

2. Mark cylinder body end plate (5) and cylinder head and bracket assembly (14) and cylinder (7) so original positions will be known when assembling. Remove two remaining thru-bolts (12), and separate cylinder components, carefully sliding boot (2) off piston rod (1).

3. To remove piston cup (17), grip piston rod in vise with soft jaws and remove nut and lock washer (15 and 16) from threads. Remove piston follower (10) and piston cup (17).

Cleaning and Inspection

1. Wash all parts in a cleaning solvent and allow to dry.

2. Inspect all parts for wear. If excessive wear is evident, replace with new parts.

Assembly

NOTE: Before assembling cylinder assembly, apply light coat of waterproof grease to all internal parts. Key numbers refer to figure 14.

1. Install piston cup (17) and follower (10), and retain with nut and lock washer (15 and 16).

2. If felt (18) is being replaced, install felt in groove in piston (9), then position spring (8) over piston rod.

3. From lower end of cylinder (7) install piston and rod assembly using care not to damage felt (18) or piston cup (17).

4. Assemble seal ring (11) on cylinder head and bracket assembly (14), and place gasket (6) at cylinder end assembly (5). Assemble boot (2) to cylinder end plate (4).

5. Referring to alignment marks made when disassembling, assemble components and install two thru-bolts (12) in two holes nearest mounting bracket flanges first. Install two remaining thru-bolts and install spring brackets (3). Tighten thru-bolt nuts firmly to seat the parts.

COLD WEATHER OPERATION

In cold regions, antifreeze must be used in cooling system to prevent damage by freezing. Before installing antifreeze solution, cooling system should be inspected and serviced as previously described under "Periodic Inspection."

Tighten cylinder head bolts and, if necessary, replace gasket, to prevent leakage if antifreeze into engine and blowing of exhaust gases into cooling system.

THAWING COOLING SYSTEM

If coolant freezes solid, place coach in a warm building until ice is completely thawed.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD ENGINE BE RUN WHEN COOLING SYSTEM IS FROZEN SOLID.

ANTIFREEZE SOLUTIONS

Only ethylene-glycol type antifreeze solution is recommended for use in these vehicles. Ethylene glycol solutions have the advantage of a higher boiling point and may be used at higher temperature without loss, resulting in more efficient performance of cooling system. Ethylene-glycol has the further advantage that, in a tight system, only water is required to replace evaporation losses. However, losses through leakage or foaming must be replaced by additional new solution. Under ordinary conditions, ethylene glycol solutions are not injurious to body finish.

Testing Antifreeze Solution

Always test solution before adding water or antifreeze. Engine should be warmed up to operating temperature. Fill and empty tester several times to warm tester before using. Keep tester clean inside and out.

Some testers will indicate correct freezing point only when test is made at a specific temperature. Other testers are provided with thermometers and tables and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperatures of solution may cause an error as large as 30°F. Read and be guided by instructions furnished by tester manufacturer.

SPECIFICATIONS

COOLING SYSTEM CAPACITIES

Quarts of Coolant Required—6 Cylinder Engine	*77
Quarts of Coolant Required—8 Cylinder Engine	*96

*Capacity is Approximate and Includes Heating System.

ANTI-FREEZE CHART

LOWEST EXPECTED TEMP. (F°)	QTS. OF ETHYLENE GLYCOL REQUIRED 6 CYL.	8 CYL.
+10	19¼	24
0	25	32
−10	30	37½
−20	34	42
−30	38	47

THERMOSTAT—WATER CIRCULATION

Number Used	2
Start Open	165°
Fully Open	180°

OVERHEAT SWITCH (ALARMSTAT)

Make	AC
Vendor No.	1513806
Points Set to Close at	212° F. ± 2°

SURGE TANK PRESSURE VALVE

Valve Opens at (Pressure in Lbs. per Sq. In.)	3½ to 4

FAN

Drive	Fluid Coupling—from Crankshaft
Drive Control	Thermostatically-Operated Valve
Number of Fan Blades	6
Diameter	26″
Direction of Rotation	Counterclockwise

TEMPERATURE GAUGE (When Used)

Make	AC
Type	Electrical
Operating Range	120°-280°
Voltage	12V

RADIATOR SHUTTER THERMOSTAT (When Used)

Make	Kysor
Model	C-5500-80
Valve Closes (Adjust to Close at)	180° F.

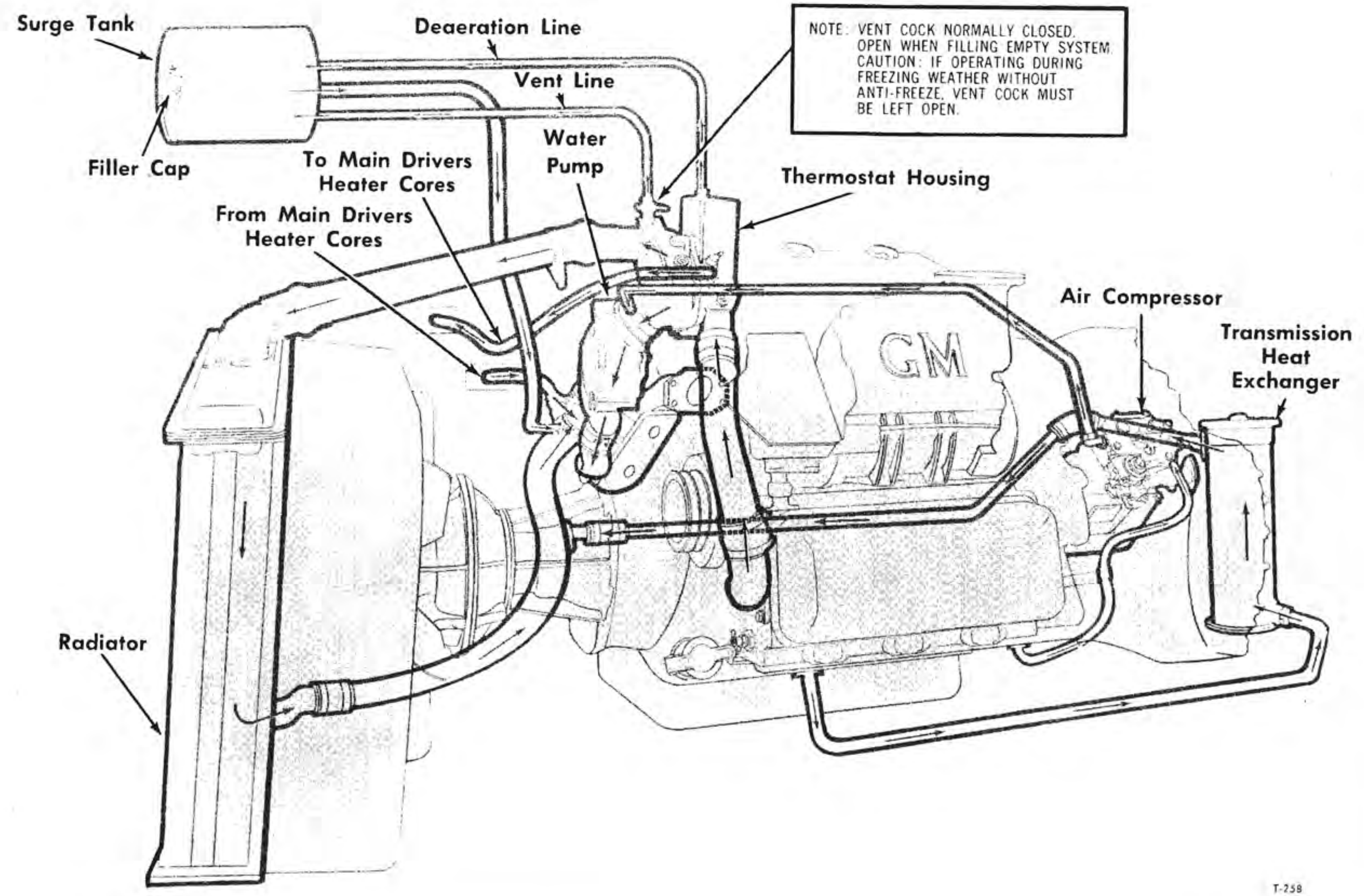


Figure 15—Schematic of Cooling System (SDH and TDH Models Shown)

Electrical System

This group, covering complete maintenance and repair information on Electrical Systems, is divided into six sections as shown in index below.

NOTE: Specifications are listed at end of each section.

INDEX OF ELECTRICAL UNITS

Certain electrical units, when closely associated with some other system or unit, are covered in other sections of this manual. The index following lists all major electrical units, together with the manual section in which they are covered and page number on which the section begins.

*Refer to "Hydraulic Drive - Model VH" Operation and Maintenance Manual.

Wiring and Miscellaneous Electrical

The electrical system is divided into several separate systems, each system being classified according to its function or purpose. A separate wiring diagram is provided for each major system. In some cases, a circuit on one diagram ties-in with circuits shown on other diagrams, and cross-references are made to other diagrams. Wiring diagrams are folded and bound in back of this manual in MD number sequence for easy reference. These diagrams include all standard diagrams, and diagrams covering the most commonly used special equipment such as air conditioning and automatic engine shut-off systems. Due to the many various combinations and types of special equipment used by different operators, it is impractical to include all special equipment wiring diagrams in this manual. Each operator can obtain wiring diagrams covering his particular special equipment upon request from the factory. Following is a list of wiring diagrams included in this manual, with a brief outline of the units shown on each diagram.

ELECTRICAL CIRCUIT DIAGRAMS

Engine Control and Generator Wiring Diagrams - MD-92662, MD-91275, MD-92663, and MD-91515

Four engine control and generator wiring diagrams are included - MD-92662 covers standard TDH and SDH models; MD-91275 covers standard TDM and SDM models; MD-92663 includes automatic engine shut-off system on TDH and SDH models; and MD-91515 includes automatic engine shut-off system on TDM and SDM models.

These diagrams show the generator, regulator, batteries, starter, solenoids, relays, and switches necessary to start and stop the engine. Also included on the special equipment diagrams is the engine stop time delay relay which is connected into the low oil pressure and hot engine alarm circuits.

Alarm and Signal Circuit Diagram - MD-86080

This diagram shows all switches, relay, buzzer and rectifier assembly, tell-tale lights, gauges, sending units, circuit breakers, and wiring circuits necessary for the operation and control of all audible and visual alarm and signal devices except stop and directional lights, which are shown on a separate diagram.

Hydraulic Transmission Wiring Diagram - MD-87492 (Std.) and MD-92205 (With Optional Overrule)

This diagram shows the hydraulic transmission control relay, direct drive solenoid, governor switch, transmission shift lever switch, and interconnecting circuits necessary for the automatic operation of the hydraulic drive transmission on TDH and SDH models.

Mechanical Transmission Wiring Diagram - MD-86076

This diagram shows the transmission reverse solenoid, reverse relay, reverse switch, and interconnecting circuits for TDM and SDM models. It also includes transmission low oil tell-tale and switch.

Lighting System Wiring Diagram - MD-85623 (TDH & TDM); MD-86366 (SDH & SDM)

These diagrams show all interior and exterior lights and their controlling switches, relays, and circuit breakers except tell-tale lights, and stop and directional signal lights, which are shown on other diagrams.

Heating and Ventilation Wiring Diagram - MD-86077

This diagram shows heating and defroster blower motors and water pump motor, together with their controlling switches, circuit breakers, and relays on coaches equipped with standard heating system without air conditioning.

Air Conditioning Wiring Diagram - MD-86084 (Early Models) and MD-93674 (Late Models)

These diagrams show the defroster, water pump, and blower motors and controls, together with the solenoids, switches, and relays required for the operation of the air conditioning system; schematic views of air conditioning switch operation are also included.

Door Control Wiring Diagram - MD-86083

This diagram shows the air-electric door control valve, relays, exit door solenoid, brake interlock magnet valve, and interconnecting circuits on coaches equipped with standard door controls only. Special equipment door control diagrams are not included in this manual. Each operator can obtain door control wiring diagrams for his specific equipment upon request from the factory.

Stop and Directional Light Wiring Diagrams - MD-86081, MD-86583, MD-92675, and MD-92824

MD-86081 shows standard front directional lights, combination rear stop and directional lights, and controlling units, and interconnecting circuits. MD-86583 shows stop and directional lights with special equipment foot-operated directional light switches. MD-92675 shows stop and self-cancelling directional lights with emergency flashing system. MD-92824 shows stop and foot-operated directional lights with emergency flashing system.

Speedometer Wiring Diagram - MD-86078

This diagram shows speedometer drive unit, circuit breaker, fuse, and circuits required to operate the electric speedometer.

Master Wiring Diagram

This is a simplified schematic wiring diagram showing all standard electrical circuits on one composite diagram.

WIRE SIZES AND COLORS

Each wire in the electrical system is of a specific size as designated on the Wiring Diagrams. When replacing wires, the correct size as indicated must be used. Never replace a wire with one of a smaller size.

The insulation on each wire is distinctly colored and patterned to assist in tracing and testing circuits, and to assist in making connections.

Abbreviations and symbols are used in wire insulation color and pattern designations on Wiring Diagrams and in the tabulations which follow. Abbreviations and symbols are as follows:

*Blk.	Black	Nat.	Natural
Brn.	Brown	Or.	Orange
Ch.	Check	Tr.	Tracer
Cr.	Cross	Yell.	Yellow
Grn.	Green	//	Parallel

*All wires leading from the engine compartment apparatus box junctions and circuit breakers into the engine compartment are covered with black heat-resistant insulation. To assist in making proper connections, a tag near end of each wire bears the number or abbreviation of the terminal to which it connects.

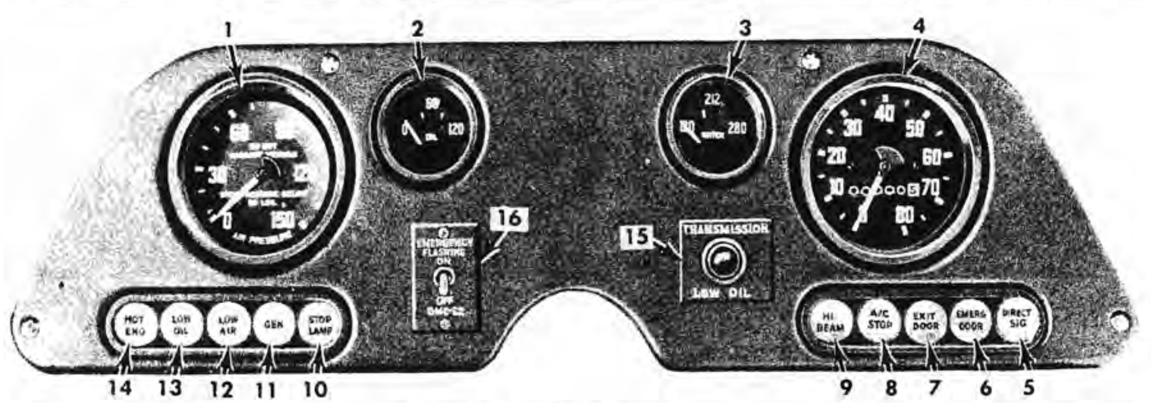
TESTING CIRCUITS

A careful study of the wiring diagrams should be made to determine the source and flow of current through each electrical circuit. When a circuit is thoroughly understood, a point to point check can be made with the aid of the applicable wiring diagram, to determine the location of the trouble. Any circuit can be tested for continuity or short circuits with a 2-candlepower test light or low-reading voltmeter.

All electrical connections must be kept clean and tight. Loose or corroded connections will cause discharged battery, difficult starting, dim lights, and improper functioning of other electrical circuits. Inspect all wiring connections at regular intervals. Make sure knurled nuts on all amphenol plugs are securely tightened. Refer to other sections previously listed under "Index of Electrical Units" for information on major electrical units and systems.

CAUTION: Voltage on output side of fluorescent lighting power supply unit is dangerous. When any malfunction in the fluorescent lighting system is indicated, observe precautions and trouble-shooting procedures outlined in "LIGHTING SYSTEM" section in this manual.

GAUGE AND TELL-TALE PANEL



1 Air Pressure Gauge
2 Oil Pressure Gauge*
3 Water Temperature Gauge*
4 Speedometer
5 Directional Signal Tell-tale
6 Emergency Door Tell-tale
7 Exit Door Tell-tale
8 Air Conditioning Stop Tell-tale*
9 Hi-Beam Tell-tale
10 Stop Light Tell-tale
11 Generator No-Charge Tell-tale
12 Low Air Pressure Tell-tale
13 Low Oil Pressure Tell-tale
14 Hot Engine Tell-tale
15 Transmission Low Oil Tell-tale (TDM & SDM Models)
16 Emergency Flashing Switch*

*Special Equipment

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Figure 1—Gauge and Tell-Tale Panel

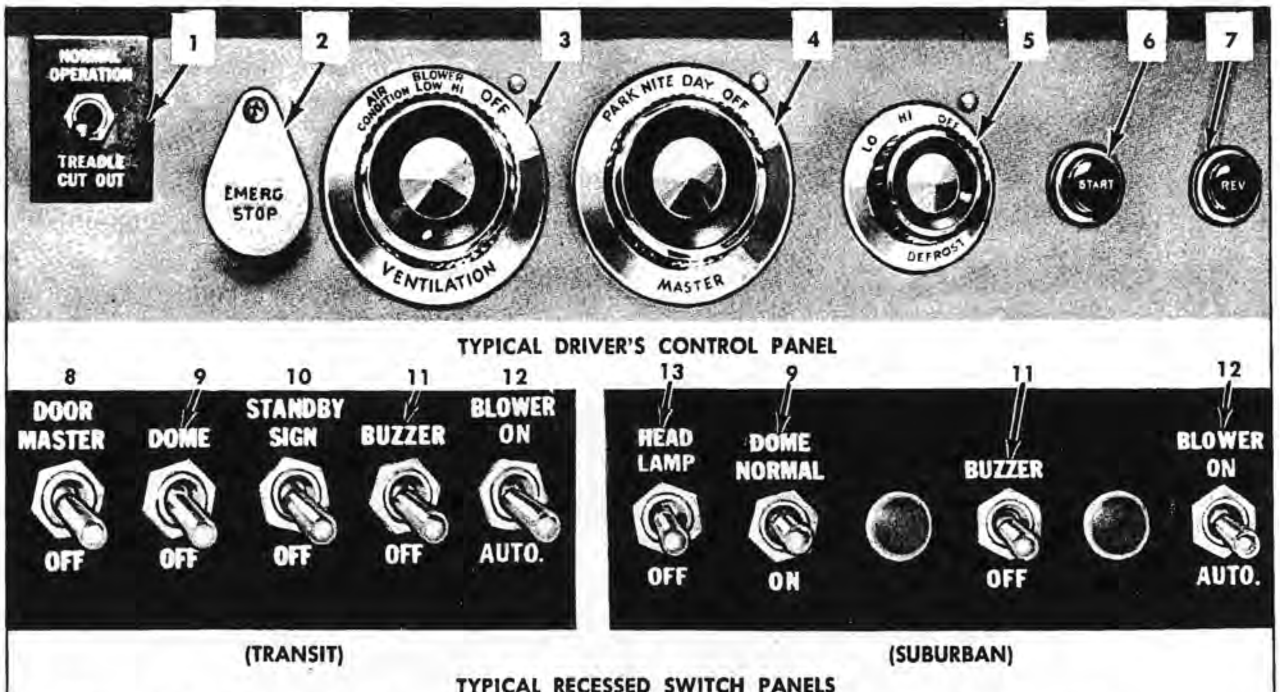
Gauge and tell-tale panel (fig. 1) is mounted directly in front of driver. Gauge and speedometer faces are illuminated by lights installed in gauge cases. Five tell-tale lights are used in each tell-tale panel. Names on tell-tale windows are visible only when tell-tale lights are illuminated. Tell-tale and instrument bulbs are mounted in snap-in type sockets. Operation of tell-tale lights is described later under "Tell-tale Alarm System." Gauges and tell-tale light holders are secured in instrument panel by studs, nuts, and mounting clamps.

DRIVER'S CONTROL PANEL

All switches used by the driver for normal operation of the vehicle are located on the control panel at left of driver and on a recessed switch panel directly below the control panel.

Control panel shown in figure 2 is for a coach equipped with air conditioning and a mechanical transmission. The "VENTILATION" switch is omitted on coaches not equipped with air conditioning, and the "REV" switch is omitted on coaches equipped with hydraulic transmission. The "TREADLE CUT OUT" switch at rear end of panel is used in conjunction with special door controls on some Transit Models. Refer to AIR CONDITIONING (SEC. 26) for operation of ventilation and air conditioning switch. Refer to applicable section in group 3 for operation of the defroster switch and the special equipment treadle cut-out switch.

Typical recessed switch panels for Transit and Suburban models are shown in lower views in figure 2. The "DOME" and "BUZZER" switches are common to all models. Other switches shown are used only on specific models or as special equipment as indicated in the legend below the illustrations. Refer to "LIGHTING SYSTEM" in this



1 *Treadle Cut Out Switch
2 Emergency Stop Switch
3 *Air Conditioning Control Switch
4 Master Switch
5 Defroster Switch
6 Starter Switch
7 Reverse Switch (TDM & SDM)
8 Door Master Switch (Transit)
9 Dome Light Switch
10 Standby Sign Switch (Transit)
11 Buzzer Switch
12 Blower Switch (Not used w/Air Cond.)
13 *Headlamp Switch (Used only on vehicles with separate headlamp switch)

*Special Equipment.

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Figure 2—Driver's Control Panel and Recessed Switch Panels (Typical)

group for use of all light switches. Refer to applicable section in group 3 for use of door master, blower, and buzzer switches.

"MASTER" SWITCH OPERATION

Switch is marked "MASTER" with circuit positions marked "OFF," "DAY," "NITE," and "PARK." Selected circuits become energized when circuit caption on switch is rotated into alignment with position indicator button on control panel. Switch positions, together with the various circuits controlled by each position, are listed below. In some cases, "MASTER" switch merely provides a feed to a circuit which is actually controlled by another switch or relay. Refer to "Engine Control and Generator Wiring Diagrams" for schematic diagrams of master control switch operation.

MASTER SWITCH POSITIONS

"OFF" Position

No circuits are energized.

"DAY" Position:

- Engine controls and alarm system
- Generating system controls
- Starting system controls
- Transmission reverse controls (TDM & SDM Models)
- Door controls (TDH & TDM Models)
- Stop and directional light controls
- Speedometer circuit
- Emergency door alarm system
- Heating system (when engine is running)
- Air conditioning (special equipment) (controlled by separate switch when engine is running)
- Fare box light

"NITE" Position:

- All circuits listed under "DAY" position
- Instrument panel lights
- Marker lights
- Headlights
- Tail lights
- Emergency door light
- License plate lights
- Rear step light (TDH & TDM)
- Front step light (operated through door switch)
- Entrance door dome light
- Rear lounge seat lights (SDH & SDM)
- Fluorescent dome and destination sign lights (TDH & TDM)
- Destination sign standby lights - TDH & TDM (operated by "STANDBY SIGN" switch on recessed switch panel)
- Fog Lights
- Spot Light

"PARK" Position:

- Marker lights
- Tail lights
- License plate lights
- Front and rear step lights
- Destination sign standby lights (TDH & TDM)
- Instrument panel lights
- Emergency door light
- Rear lounge seat lights (SDH & SDM)

NOTE: Additional special equipment lights and other special electrical equipment may also be controlled by the various master switch positions.

DRIVER'S CONTROL PANEL JUNCTIONS

Junction panel, located below the control panel at left of driver, is accessible after removing the junction, circuit breaker, and electrical apparatus panel cover (fig. 3). Junction panel contains 90 terminal posts, numbered consecutively from 1 through 90. Numbers on panel correspond to numbers on Wiring Diagrams and in tabulations which follow. The tabulation lists each terminal number, the circuit it carries, and the size, color, and pattern of the wire which connects to each terminal. Some of the unused terminals, marked "Open" or "Spare" in the tabulation, are available for use with additional special electrical equipment. Driver's control panel junction numbers appear in the symbol ⌐⌐ on Wiring diagrams.

Terminal No.	Circuit	Wire Size & Color
1	Directional Switch Amphenol "B" to Engine Comp't. Jct. 1 . .	No. 16 Nat. - Red Cr. Tr.
2	Emergency Stop Switch to Engine Comp't. Jct. 2	No. 12 Red - 2 Nat. // Tr.
3	Transmission Control - TDH & SDH	
	No. 20 Driver's Control Panel Circuit Breaker to Shift Switch "Comm"	No. 16 Nat. - 2 Red // Tr.
	Transmission Control - TDM & SDM	
	No. 20 Driver's Control Panel Circuit Breaker to Reverse Switch	No. 16 Nat. - 2 Red // Tr.
4	*Air Conditioning Control	
	Air Conditioning Switch Terminal 4 to Spliced Connection (See Air Conditioning Wiring Diagram)	No. 14 Nat. - Red Ch.
5	Oil Pressure Gauge (if used) to Engine Comp't. Jct. 5	No. 16 Nat. - Blk. & Grn. // Tr.

*Special Equipment.

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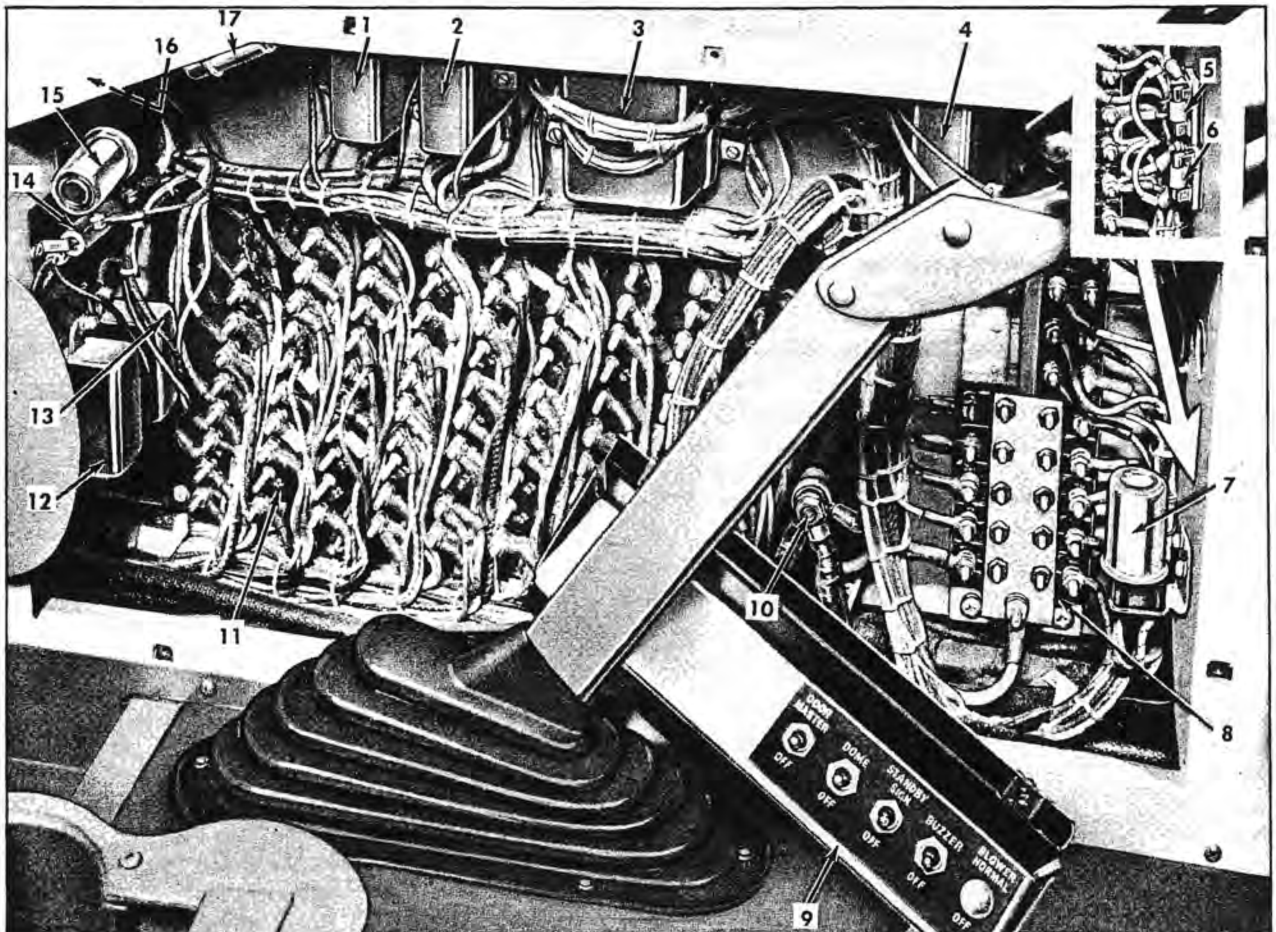

1 Door Control Relay (Transit Models)
2 Horn Relay
3 Alarm Buzzer and Rectifier
4 Dome Lamp Relay (Transit Models)
5 *Hot Engine Tell-tale Rectifier
6 *Low Oil Tell-tale Rectifier
7 *Express Lighting System Flasher
8 Circuit Breaker Panel
9 Recessed Switch Panel
10 Control Panel Battery Junction
11 Junction Panel
12 Destination Sign Relay (Transit Models)
13 *Blower Relay (Used w/ Air Conditioning)
14 Stop Lamp Resistor
15 Directional Signal Flasher
16 Generator Tell-tale Resistor
17 *Emergency Flashing System Flasher

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*Special Equipment.

Figure 3—Driver's Control Panel Junctions, Circuit Breakers, and Electrical Apparatus

DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
6	Lighting System	
	From No. 13 Driver's Control Panel Circuit Breaker . .	No. 14 Nat. - Blk. Tr.
	To Marker Lights, Taillights, etc.	No. 14 Nat. - Blk. Tr.
	To Instrument Panel Lights	No. 16 Nat. - Blk. Tr.
7	Speedometer Amphenol "D" to Engine Comp't. Jct. 7	No. 16 Brn. - Nat. & Blk. Cr. Tr.
8	Door Control - TDH & TDM	
	From Door Control Valve Switch "N.D."	No. 14 Blue - Nat. Tr.
	To Door Control Relay "VAC"	No. 16 Blue - Nat. Tr.
9	Spare to Engine Compartment Jct. 26	No. 14 Yellow
10	Directional Flasher "P" to Directional Lamp Tell-tale . . .	No. 16 Nat. - Red & Grn. Cr. Tr.
11	From Directional Switch Amphenol "D"	No. 16 Black - Nat. Tr.
	To Engine Compartment Jct. 11	No. 14 Black - Nat. Tr.
12	Open	

DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
13	Transmission Controls - TDH & SDH	
	Shift Switch "N.C." to Engine Comp't. Jct. 13	No. 16 Green
	Transmission Controls - TDM & SDM	
	Reverse Switch to Engine Compartment Jct. 13	No. 16 Green
14	From Blower Sw. or *Air Conditioning Switch Terminal . . .	No. 14 Blk. - Nat. Cr. Tr.
	To Regulator and Blower Control Jct. 3	No. 14 Black
15	Temperature Gauge (if used) to Engine Comp't. Jct. 15 . . .	No. 16 Nat. - Blk. & Red Cr. Tr.
16	Lighting System - TDH & TDM	
	From Dome Lamp Relay "SOL" to Power Supply Unit "4" .	No. 14 Blk. - Red Tr.
	Lighting System - SDH & SDM	
	From Dome Lamp Switch to Dome Lamps	No. 14 Blk. - Red Tr.
17	Speedometer Amphenol "A" to Engine Comp't. Jct. 17	No. 16 Nat. - Blk. & Red // Tr.
18	Exit Door Tell-tale & Brake Interlock (TDH & TDM)	
	From Exit Door Jct. 2	No. 14 Brn. - Red Tr.
	To Brake Magnet Valve	No. 16 Brn. - Red Tr.
	To Exit Door Tell-tale	No. 16 Brn. - Red Tr.
19	Starter Control - TDH & SDH	
	Starter Sw. to Neutral Safety Sw. & Engine Comp't. Jct. 19	No. 16 Red - Grn. Tr.
	Starter Control - TDM & SDM	
	Starter Switch to Engine Compartment Jct. 19	No. 16 Red - Grn. Tr.
20	*Overrule Sw. (Eng. Automatic Shut-off) to Eng. Compt. Jct. 22	No. 14 Brn. - Nat. Cr. Tr.
21	Directional Sw. Amphenol "E" to Engine Comp't. Jct. 21 . .	No. 16 Nat. - Blk. Cr. Tr.
22	Open	
23	Open	
24	*Air Conditioning Control	
	From Air Conditioning Switch Terminal 3	No. 14 Green
	To Regulator & Blower Control Jct. 4	No. 14 Black
25	Low Oil Tell-tale to Alarm Buzzer & Eng. Comp't. Jct. 25 .	No. 16 Nat. - Blk. & Grn. Cr. Tr.
26	Lighting System - TDH & TDM	
	From No. 15 Driver's Control Panel Circuit Breaker to	
	Standby Sign Switch and Front Door Jct. 6	No. 16 Brn. - Blk. Cr. Tr.
	Lighting System - SDH & SDM	
	From No. 14 Driver's Control Panel Circuit Breaker to	
	Front Door Jct. 6	No. 16 Brn. - Blk. Cr. Tr.
27	Speedometer Amphenol "B" to Engine Comp't. Jct. 27	No. 16 Grn. - 2 Red // Tr.
28	Spare to Exit Door Jct. 4 (TDH & TDM)	No. 14 Blue - 2 Nat. // Tr.
29	Starter Controls - TDH & SDH	
	Neutral Safety Sw. "N.D." to Eng. Comp't. Jct. 29	No. 16 Red - 2 Grn. // Tr.
	Starter Controls - TDM & SDM	
	From No. 18 Driver's Control Panel Circuit Breaker . .	No. 14 Natural
	To Engine Compartment Jct. 29	No. 16 Red - 2 Grn. // Tr.
30	Directional Lamp Flasher "L" to Directional Sw. Amphenol "G"	No. 16 Nat. - 2 Blk. // Tr.
31	Stop Lamp Tell-tale to Engine Compartment Jct. 31	No. 16 Red - Blk. Tr.
32	Engine Control	
	No. 17 Driver's Control Panel Circuit Breaker to	
	Engine Compartment Jct. 32	No. 16 Grn. - Red Tr.
33	Open	
34	*Air Conditioning Stop Tell-tale -- From Hi-Lo Pressure Sw.	
	"MI" to Air Conditioning Stop Tell-tale	No. 16 Nat. - Red Ch.
35	Hot Eng. Tell-tale to Alarm Buzzer 4 & Eng. Comp't. Jct. 35	No. 16 Yellow
36	Lighting System	
	From No. 9 Driver's Control Panel Circuit Breaker . .	No. 14 Blk. - 2 Grn. // Tr.
	To Dimmer Switch	Black
37	Speedometer Amphenol "C" to Engine Comp't. Jct. 37	No. 16 Blk. - 2 Brn. // Tr.
38	Spare to Exit Door Jct. 10 (TDH & TDM)	No. 14 Blue - Nat. Cr. Tr.
39	Open	
40	From Alarm Buzzer 3 to Engine Comp't. Jct. 40	No. 14 Brn. - Nat. Tr.
	To Engine Stop Time Delay Relay Rectifier	No. 14 Black
41	Directional Signals	
	Directional Sw. Amphenol "A" to Right Front Directional	
	Lamp	No. 16 Orange - Grn. Tr.
	To *Right Side Directional Lamps (When Used)	Red
42	Charging Circuit	
	From Engine Compartment Jct. 42	No. 12 Brn. - Blk. Tr.
	To Blower Switch (Std.)	No. 14 Brown
	To Modulating Valve Sw. (Std.)	No. 16 Brown
	*Feed to Air Condition Sw. "BAT" (with Air Cond.) . . .	No. 12 Brown
	*To Driver's Control Panel Circuit Breaker No. 12	
	(with Air Conditioning)	No. 14 Natural

*Special Equipment.

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DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
43	Open	
44	Defroster Control	
	Defroster Switch "1" to Defroster Motor "A"	No. 12 Natural
	To Modulating Valve Switch	No. 16 Natural
45	Low Air Tell-tale to Alarm Buzzer 2 and Low Air Switch	No. 16 Red - Nat. Tr.
46	Lighting System	
	From Dimmer Switch "LO"	Natural
	To Headlight Low Beams	No. 16 Nat. - Grn. Tr.
47	Open	
48	Door Control (TDH & TDM)	
	From Door Master Sw. to Door Control Valve Sw. "COM," to Exit Door Jct. 5, and to Front Door Jct. 7	No. 14 Blk. - Grn. Ch.
49	Speedometer	
	Feed From No. 16 Driver's Control Panel Circuit Breaker to Engine Compartment Jct. 36	No. 14 Maroon
50	Reading Lamps (SDH & SDM)	
	From Dome Lamp Switch	No. 14 Blk. - Red Ch.
	To Regulator & Blower Control Jct. 6	No. 14 Black
51	Directional Signals	
	Directional Sw. Amphenol "F" to Left Front Directional Lamp	No. 16 Orange - Blk. Tr.
	To *Left Side Directional Lamps (When Used)	Red
52	Open	
53	Open	
54	Defroster Switch "2" to Defroster Motor "F"	No. 14 Grn. - Nat. Tr.
55	Emergency Door Tell-tale to Alarm Buzzer 1 and Emergency Door Switch	No. 16 Blue - Blk. Tr.
56	Lighting System	
	From Dimmer Switch "HI"	Red
	To Headlight Hi-Beams	No. 14 Nat. - Grn. Cr. Tr.
	To Hi-Beam Tell-tale	No. 16 Nat. - Grn. Cr. Tr.
57	Open	
58	Spare to Exit Door Jct. 15 (TDH & TDM)	No. 14 Brn. - Grn. Tr.
59	Regulator Sensing Control Relay "S" to No-Charge Tell-tale	No. 16 Black
60	Spare to Exit Door Jct. 13	No. 16 Brn. - 2 Nat. // Tr.
61	Directional Sw. Amphenol "C" to Stop Lamp Resistor	No. 16 Natural
62	Lighting System (TDH & TDM)	
	From No. 14 Driver's Control Panel Circuit Breaker to Front Door Jct. 9	No. 16 Grn. - Blk. Cr. Tr.
63	Open	
64	Blower Switch to Modulating Valve Switch (Std.)	No. 16 Blk. - Brn. Tr.
	*With Air Cond. - Blower Relay "VAC" to Modulating Valve Switch "N.C."	No. 16 Blk. - Brn. Tr.
65	Alarm & Signal Controls	
	From No. 19 Driver's Control Panel Circuit Breaker	No. 14 Nat. - 2 Grn. // Tr.
	To Alarm Buzzer "BAT"	No. 16 Nat. - 2 Grn. // Tr.
	To Emergency Door Tell-tale	No. 16 Blue - Blk. Tr.
	To Engine & Low Air Alarm Tell-tales and to Gauges	No. 16 Nat. - 2 Grn. // Tr.
66	Spare (*Driver's Lamp)	No. 16 Brn. - Nat. Cr. Tr.
67	Open	
68	Spare to Front Door Jct. 4	No. 14 Grn. - Red Ch.
69	Spare to Engine Compartment Jct. 46	No. 14 Blue
70	Open	
71	Open	
72	Open	
73	Spare (in head lamp harness)	No. 16 Red - 2 Blk. // Tr.
74	Spare (*Driver's Fan)	No. 16 Blk. - Red Tr.
75	Buzzer Switch to Passenger Signal	No. 16 Orange - Nat. Tr.
76	Open	
77	Horn Relay "D" to Horn	No. 10 Brn. - Blk. & Red Cr. Tr.
78	Spare (Door Control Valve Sw. "N.C." to Exit Door Jct. 11)	No. 14 Brn. - 2 Blk. // Tr.
79	Spare (in head lamp harness)	No. 14 Orange - 2 Grn. // Tr.
80	Ground	Black
81	Transmission Low Oil Tell-tale (TDM & SDM)	
	From No. 20 Driver's Control Panel Circuit Breaker	No. 16 Natural
	To Transmission Low Oil Tell-tale	No. 16 Grn. - 2 Blk. // Tr.
82	Spare to Engine Comp't. Jct. 8	No. 16 Yellow - Blue Tr.

*Special Equipment.

DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
83	Spare(in head lamp harness)	No. 16 Red - Grn. Cr. Tr.
84	Transmission Low Oil Tell-tale (TDM & SDM) Transmission Low Oil Tell-tale to Eng. Comp't. Jct. 18	No. 16 Blk. - Grn. Tr.
85	Passenger Signal Switches to Passenger Signal	No. 16 Orange
86	Spare to Engine Compartment Jct. 28	No. 16 Brn. - Blk. & Red Cr. Tr.
87	Horn Button to Horn Relay "S"	No. 16 Brn. - Red Ch.
88	Door Control (TDH & TDM) From Door Control Relay "SOL" to Front Door Jct. 8 and Exit Door Jct. 9	No. 14 Blue - Red Tr.
89	Spare to Engine Compartment Jct. 38	No. 16 Grn. - Blk. Tr.
90	Ground - From Front Door Jct. 2 and Exit Door Jct. 14	Black

DRIVER'S CONTROL PANEL CIRCUIT BREAKERS

Circuit breaker panel, located on the apparatus panel at left of driver's seat, is accessible after removing the panel cover (fig. 3). Panel has space for 20 circuit breakers, however, they are not all used on coaches with standard electrical equipment. Additional circuit breakers may be used with special equipment; for example, No. 12 shown in figure 4 is used with air conditioning. Circuit breakers No. 10 and 11 are not used on SDH & SDM models.

Circuit breakers are automatic reset type, protecting various circuits as indicated in the tabulation which follows. Any condition which causes an overload on a circuit, such as a short, will cause circuit breaker bimetal element to open the circuit; when the element cools, circuit breaker will again close the circuit. This off and on cycle will repeat until the switch controlling the defective circuit is turned off, or until the cause of the overload has been located and corrected. In the event a circuit breaker becomes defective (burns out or sticks closed), the defective circuit breaker must be replaced.

Circuit breaker numbers shown on Wiring Diagrams and in the tabulation which follows do not appear on the circuit breakers or on the panel; to identify circuit breakers, it is necessary to refer to diagram shown in figure 4. Amperage rating of each circuit breaker is also shown in figure 4. Circuit breakers must be installed so the feed or battery wire (or bus bar) connects to the "BAT" or short terminal, and the wire carrying the circuit to the electrical units connects to the "AUX." or long terminal.

All circuit breakers connected by the bus bar (figs. 3 and 4) are fed from number 1 terminal on "MASTER" switch and are energized whenever the "MASTER" switch is in either "DAY" or "NITE" position.

The tabulation on next page lists each circuit breaker number (as identified in figure 4), the circuit it protects, and the size, color, and pattern of the wire (or wires) which connect to the circuit breaker terminals.

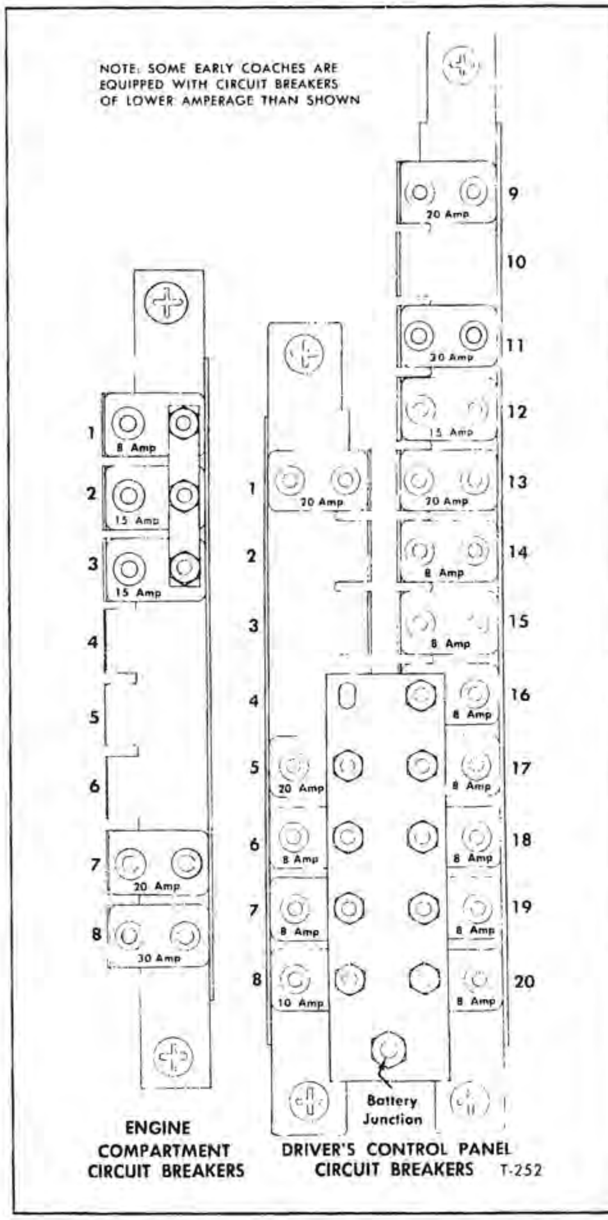

Figure 4—Circuit Breaker Identification

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DRIVER'S CONTROL PANEL CIRCUIT BREAKERS (CONT'D)

Circuit Breaker No.	Circuit	Wire Size & Color	Fed From
1	Feed From Control Panel Battery Jct.	No. 10 Red	Battery
	To Destination Sign Relay "BAT" (TDH & TDM)	No. 14 Red - Blk. Cr. Tr.	
	To Dome Lamp Switch	No. 14 Red - Blk. Cr. Tr.	
	To Horn Relay "B"	No. 10 Red - Nat. Cr. Tr.	
2	To Emergency Flasher	No. 10 Nat. - Red Tr.	
3	Open		
4	Open		
5	Defroster Switch	No. 12 Blk. - Red Tr.	No. 1 on Master Sw.
6	Directional Signal Flasher	No. 16 Blk. - Yellow Ch.	No. 1 on Master Sw.
7	Buzzer Switch	No. 16 Orange - Nat. Tr.	No. 1 on Master Sw.
8	Door Control Relay "BAT" and Door Master Sw. (TDH & TDM)	No. 14 Blk. Grn. Ch.	No. 1 on Master Sw.
9	Destination Sign and Headlights		
	From No. 3 on Master Switch	No. 14 Blk. - 2 Grn. // Tr.	No. 3 on Master Sw.
	To Driver's Control Panel Jct. 36	No. 14 Blk. - 2 Grn. // Tr.	
	To Destination Sign Relay "VAC" (TDH & TDM)	No. 16 Blk. - 2 Grn. // Tr.	
	To Dome Lamp Sw. (SDH & SDM)	No. 14 Blk. - 2 Grn. // Tr.	
10	Open		
11	Dome Lamp Relay (TDH & TDM)	No. 14 Black	Battery
12	Blower Relay (Air Conditioning)		
	From Driver's Control Panel Jct. 42	No. 14 Natural	Battery
	To Blower Relay "BAT"	No. 14 Grn. - 2 Blk. // Tr.	
13	Step, Instrument, Marker, & Tail Lamps	No. 14 Nat. - Blk. Tr.	No. 2 on Master Sw.
14	Front Door Switch		
	From No. 5 on Master Switch	No. 14 Grn. - Blk. Cr. Tr. (TDH & TDM)	No. 5 on Master Sw.
		No. 14 Brn. - Blk. Cr. Tr. (SDH & SDM)	No. 5 on Master Sw.
	To Driver's Control Panel Jct. 62 (TDH & TDM)	No. 16 Grn. - Blk. Cr. Tr.	
	To Driver's Control Panel Jct. 26 (SDH & SDM)	No. 16 Brn. - Blk. Cr. Tr.	
15	Destination Sign Standby Lamps and Switch (TDH & TDM)	No. 16 Brn. - Blk. Cr. Tr.	No. 4 on Master Sw.
	Dome Lamp Switch (SDH & SDM)	No. 14 Brn. - Blk. & Red Cr. Tr.	No. 4 on Master Sw.
16	Speedometer Feed	No. 14 Maroon	No. 1 on Master Sw.
17	Engine Controls	No. 16 Grn. - Red Tr.	No. 1 on Master Sw.
18	Starter Switch	No. 16 Red - Grn. Tr.	No. 1 on Master Sw.
19	Alarm System & Gauges	No. 14 Nat. - 2 Grn. // Tr.	No. 1 on Master Sw.
20	Transmission Controls		
	To Driver's Control Panel Jct. 3 (Shift Lever Sw. on TDH & SDH; Reverse Sw. on TDM & SDM)	No. 16 Nat. - 2 Red // Tr.	No. 1 on Master Sw.
	To Driver's Control Panel Jct. 81 (Trans. Low Oil Tell-tale (TDM & SDM)	No. 16 Natural	No. 1 on Master Sw.

NOTE: All Circuit Breakers Fed From No. 1 Terminal on Master Switch are Connected by a Bus Bar.

ENGINE COMPARTMENT APPARATUS BOX

Engine compartment apparatus box is located at right rear corner of coach in top of engine compartment. Junctions, circuit breakers, and electrical units installed in the box are accessible after the apparatus box cover is removed (fig. 5). The following units are installed in engine compartment apparatus box:

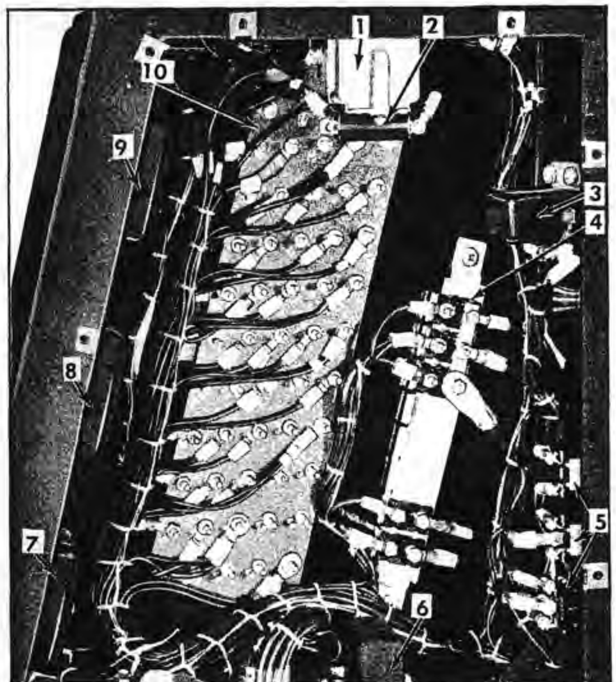
*Engine stop time delay relay
*Engine stop time delay relay rectifier
Engine modulating relay (TDH & SDH)
*Air conditioning control relay
Stop light tell-tale relay
Starter control and generator relay
Transmission control relay (TDH & SDH)
Reverse relay (TDM & SDM)
Engine compartment junction panel
Engine compartment circuit breaker panel
Engine control switch, starter switch, and engine compartment light switch are mounted on rear edge of apparatus box.

*Special Equipment.

ENGINE COMPARTMENT JUNCTION PANEL

Junction panel in engine compartment apparatus box (fig. 5) contains 48 terminal posts numbered consecutively from 1 through 48. Numbers on panel correspond to numbers on Wiring Diagrams and in the tabulation which follows: The tabulation lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to the terminal. Some of the unused terminals, marked "Open" or "Spare" in the tabulation, may be used for additional electrical equipment.

NOTE: Wires leading from the junction panel into the engine compartment are covered with a special black heat-resistant insulation. A tag near end of each black wire identifies the terminal to which it connects. Engine compartment junction panel numbers appear in the symbol ☐ on Wiring Diagrams.



1 *Engine Stop Time Delay Relay
2 *Time Delay Relay Rectifier
3 *Transmission Governor Overrule Relay (TDH & SDH) Reverse Relay (TDM & SDM)
4 Circuit Breakers
5 Engine Compartment Switches
6 Stop Lamp Relay
7 Starter Control and Generator Relay
8 Transmission Control Relay (TDH & SDH)
9 *Air Conditioning Control Relay
10 Junction Panel

*Special Equipment.

Figure 5—Engine Compartment Apparatus Box

ENGINE COMPARTMENT JUNCTIONS

Terminal No.	Circuit	Wire Size & Color
1	R.H. Stop & Directional Light	
	From Driver's Control Panel Jct. 1	No. 16 Nat. - Red Cr. Tr.
	To Engine Closure Door Amphenol "A"	No. 16 Black
2	Emergency Stop	
	From Driver's Control Panel Jct. 2	No. 12 Red - 2 Nat. // Tr.
	To Engine Amphenol "H"	No. 12 Black
3	Open	
4	*Air Conditioning Controls	
	From Low Air Switch	No. 14 Brn. - Blk. & Red Cr. Tr.
	To Oil Pressure Switch	No. 16 Black
5	*Engine Oil Pressure Gauge	
	From Driver's Control Panel Jct. 5	No. 16 Nat. - Blk. & Grn. // Tr.
	To Oil Pressure Sending Unit	No. 16 Black
6	Tail & License Lamps	
	From Spliced Junction	No. 16 Nat. - Blk. Tr.
	To Engine Closure Door Amphenol "C"	No. 16 Black
7	Speedometer	
	From Transmission Amphenol "B"	No. 16 Black
	To Driver's Control Panel Jct. 7	No. 16 Brn. - Nat. & Blk. Cr. Tr.
8	Spare From Driver's Control Panel Jct. 82	No. 16 Yellow - Blue Tr.
9	Generator-Regulator Field Circuit	
	From Regulator & Blower Control Jct. 5 to Engine Amphenol "A"	No. 14 Black

*Special Equipment.

ENGINE COMPARTMENT JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
10	Open	
11	Stop Lamp	
	From Driver's Control Panel Jct. 11	No. 14 Blk. - Nat. Tr.
	To Stop Lamp Relay "S"	No. 14 Black
12	Open	
13	Transmission Controls	
	From Driver's Control Panel Jct. 13	No. 16 Green
	TDM & SDM - To Reverse Relay "VAC"	No. 16 Black
	TDH & SDH - To Transmission Relay "3"	No. 16 Black
14	*Air Conditioning Control	
	Air Conditioning Control Relay to Oil Pressure Switch	No. 16 Black
	To Hi-Lo Pressure Switch "M2"	No. 16 Blk. - Yellow Ch.
15	*Engine Temperature Gauge	
	From Driver's Control Panel Jct. 15	No. 16 Nat. - Blk. & Red Cr. Tr.
	To Engine Amphenol "E"	No. 16 Black
16	Engine Comp't. Lamp Sw. to Engine Compartment Lamps	No. 16 Black
17	Speedometer	
	From Transmission Amphenol "A"	No. 16 Black
	To Driver's Control Panel Jct. 17	No. 16 Nat. - Blk. & Red // Tr.
18	Transmission Low Oil Tell-tale (TDM & SDM)	
	From Driver's Control Panel Jct. 84	No. 16 Blk. - Grn. Tr.
	To Transmission Amphenol "F"	No. 16 Black
19	Starter Control	
	From Driver's Control Panel Jct. 19	No. 16 Red - Grn. Tr.
	To Engine Compartment Starter Switch "OFF"	No. 16 Black
20	Spare From Driver's Control Panel Jct. 20	No. 14 Brn. - Nat. Cr. Tr.
21	Stop & Directional Lights	
	From Driver's Control Panel Jct. 21	No. 16 Nat. - Blk. Cr. Tr.
	To Engine Closure Door Amphenol "B"	No. 16 Black
22	Engine Controls	
	Engine Comp't. Engine Control Switch to Engine Stop Solenoid Valve	No. 16 Black
	*Engine Stop Overrule (when used) to Driver's Control Panel Jct. 20	No. 14 Brn. - Nat. Cr. Tr.
23	Open	
24	*Air Conditioning Control	
	From Air Conditioning Control Relay "5"	No. 14 Black
	To Air Conditioning Clutch Solenoid	No. 14 Blk. - Brn. Tr.
25	Low Oil Alarm	
	From Driver's Control Panel Jct. 25	No. 16 Nat. - Blk. & Grn. Cr. Tr.
	To Low Oil Pressure Switch	No. 16 Black
26	Spare From Driver's Control Panel Jct. 9	No. 14 Yellow
27	Speedometer	
	From Transmission Amphenol "D"	No. 16 Black
	To Driver's Control Panel Jct. 27	No. 16 Grn. - 2 Red // Tr.
28	Spare From Driver's Control Panel Jct. 86	No. 16 Brn. - Blk. & Red Cr. Tr.
29	Starter Control	
	From Driver's Control Panel Jct. 29	No. 16 Red - 2 Grn. // Tr.
	To Engine Compartment Starter Switch "NORMAL"	No. 16 Black
30	Engine Comp't. Circuit Breaker No. 2 to Stop Lamp Sw.	No. 14 Black
31	Stop Lamp Tell-tale	
	From Stop Lamp Relay "D"	No. 16 Black
	To Driver's Control Panel Jct. 31	No. 16 Red - Blk. Tr.
32	Engine Control	
	From Driver's Control Panel Jct. 32	No. 16 Grn. - Red Tr.
	To Engine Comp't. Engine Control Switch "NORMAL"	No. 16 Black
33	Open	
34	*Air Conditioning Control	
	From Hi-Lo Pressure Switch "L2"	No. 16 Yellow - Blk. Cr. Tr.
	To Air Conditioning Control Relay "3" & "4"	No. 16 Black
35	Engine Overheat Alarm	
	From Driver's Control Panel Jct. 35	No. 16 Yellow
	To Engine Amphenol "C"	No. 16 Black
36	Speedometer	
	From Driver's Control Panel Jct. 49	No. 14 Maroon
	To Transmission Amphenol "E"	No. 14 Black

*Special Equipment.

ENGINE COMPARTMENT JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
37	Speedometer	
	From Transmission Amphenol "C"	No. 16 Black
	To Driver's Control Panel Jct. 37	No. 16 Black - 2 Brn. // Tr.
38	Spare From Driver's Control Panel Jct. 89	No. 16 Grn. - Blk. Tr.
39	Open	
40	Spare From Driver's Control Panel Jct. 40	No. 14 Brn. - Nat. Tr.
41	Stop Lamp Switch to Stop Lamp Relay "B"	No. 14 Black
42	Charging Circuit	
	From Driver's Control Panel Jct. 42	No. 12 Brn. - Blk. Tr.
	To Engine Comp't. Circuit Breaker No. 7	No. 14 Black
43	Open	
44	Open	
45	Open	
46	Spare From Driver's Control Panel Jct. 69	No. 14 Blue
47	Open	
48	Ground	Black

*Special Equipment

ENGINE COMPARTMENT CIRCUIT BREAKERS

Circuit breaker panel in engine compartment apparatus box (fig. 5) has spaces for eight automatic reset type circuit breakers, however, only five are used on vehicles by this manual.

Circuit breakers protect various electrical circuits as indicated in the tabulation which follows. Any condition which causes an overload on a circuit will cause the circuit breaker bimetal element to open the circuit; when the element cools, circuit breaker will again close the circuit. This off and on cycle will repeat until the switch controlling the defective circuit is turned off, or until the cause of the overload has been located and corrected. In the event a circuit breaker becomes defective (burns out or sticks closed), the defective circuit breaker must be replaced. When replacing a circuit breaker, it must be installed so the feed or battery wire connects to the "BAT" or short terminal, and the wires carrying the circuit to the electrical units connects to the "AUX." or long terminal.

Circuit breaker numbers shown on Wiring Diagrams and in the tabulation which follows do not appear on the circuit breakers or on the panel. To identify circuit breakers by number, count from top to bottom, or refer to the diagram in figure 4. The amperage rating of each circuit breaker is also shown in figure 4.

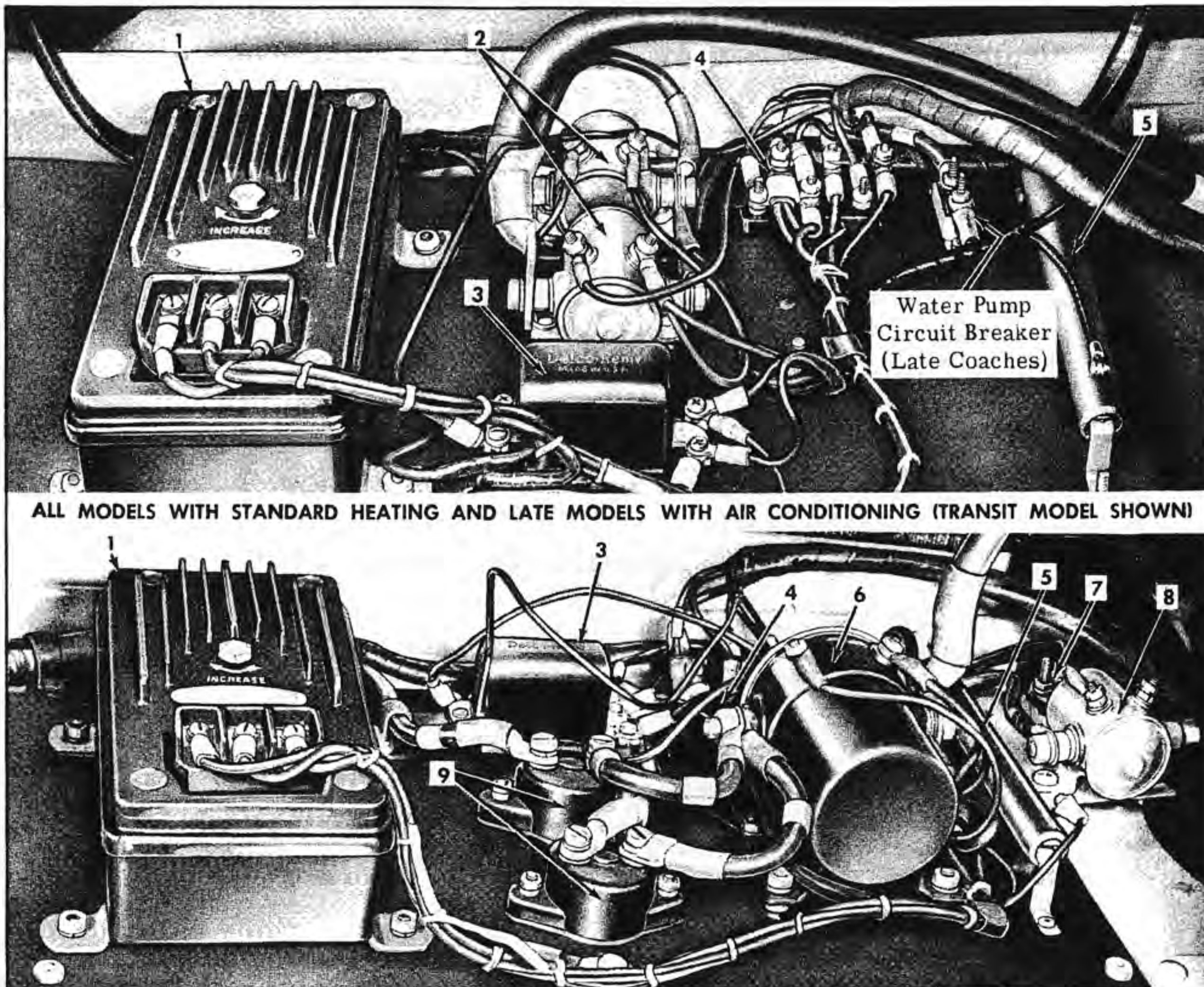
The tabulation which follows lists each circuit breaker number, the circuit it carries, and the size and color of the wire which connects to each terminal. Circuit breaker numbers 1, 2, and 3 are all fed through a bus bar directly from the engine compartment battery junction. Number 7 is fed from number 5 terminal on starter and generator control relay, and number 8 is fed from number 2 terminal on starter and generator control relay.

Circuit Breaker No.	Circuit	Wire Size & Color	Fed From
1	Engine Controls	No. 16 Black	Battery
2	Engine Comp't. Lamps & Stop Lamp Switch	No. 14 Black	Battery
3	Transmission Controls	No. 10 Black	Battery
4	Open		
5	Open		
6	Open		
7	Generator Charging Circuit	No. 14 Black	Generator
8	Starter Controls	No. 10 Black	Starter & Gen. Control Relay

REGULATOR AND BLOWER CONTROL PANEL

Voltage regulator and blower control panel (fig. 6) is mounted on forward side of rear stepwell front crossmember on Transit models, and on forward side of emergency door front bulkhead on Suburban models. Panel is protected by a shield which is hinged at rear end and secured at front end by two bolts. For access to control panel, remove the two bolts, lock washers, and flat washers and swing shield down.

On both Transit and Suburban models equipped with standard heating and ventilation system, the panel contains the voltage regulator, regulator



1 Regulator
2 Blower Control Relays
3 Regulator Sensing Control Relay
4 Junction Block
5 Sensing Control Relay Resistor
6 Blower Control Relay
7 Reading Light Circuit Breakers (All Suburban Models)
8 Reading Light Relay (All Suburban Models)
9 Blower Motor Circuit Breakers

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Figure 6—Regulator and Blower Control Panel

sensing control relay, sensing control relay resistor, two blower control relays, and a six-post junction block (4) as shown in the upper view in figure 6; Suburban models also have the reading light relay and two 20-amp reading light relay circuit breakers as shown in the lower view in figure 6.

On both early Transit and Suburban models equipped with air conditioning, the panel contains the voltage regulator, regulator sensing control relay and resistor, one blower control relay, two 90-amp blower motor circuit breakers, and a six-post junction block as shown in the lower view in figure 6; the reading light relay and two 20-amp circuit breakers shown in the lower view are presently used on Suburban models only.

Refer to "REGULATOR" section for information on the transistor-type voltage regulator. The tabulation which follows identifies wires connected to the junction block terminals. Terminal post numbers on junction block appear on wiring diagrams in the symbol ◇.

REGULATOR AND BLOWER CONTROL PANEL JUNCTIONS

Terminal No.	Circuit	Wire Size & Color
1	Battery Compt. Jct. to Water Pump C.B. and Relay "BAT"	No. 12 Black
	To "AMM" Terminal on Regulator Sensing Control Relay	No. 14 Black
2	Regulator Sensing Control Relay "C" to Spliced Jct. in No. 12 Brn. - Blk. Tr. Wire Between Driver's Control Panel Jct. 42 & Eng. Comp't. Jct. 42	No. 16 Black
3	Driver's Control Panel Jct. 14 to Blower Control Relays	No. 14 Black
4	Driver's Control Panel Jct. 24 to Blower Motors (W/Air Cond. *)	No. 14 Black
5	Regulator "FLD" Terminal to Engine Comp't. Jct. 9	No. 14 Black
6	Driver's Control Panel Jct. 50 to Reading Lamp Relay (SDH & SDM)	No. 14 Black

*Special Equipment.

ENTRANCE DOOR JUNCTIONS

Entrance door junction block is mounted in front door engine compartment above door as shown in figure 1 in "DOORS AND CONTROLS" (SEC. 3). Junction block is accessible after opening door engine compartment door. Junction block contains nine terminal posts numbered from 1 through 9. The tabulation which follows lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to each terminal. Terminal post numbers on the Wiring Diagrams appear in the symbol ▽.

Terminal No.	Circuit	Wire Size & Color
1	From Front Door Switch "COMM"	No. 16 Blue
	To Front Door Step Lamp	Red
2	Ground Through Driver's Control Panel Jct. 90	No. 14 Black
3	Feed From Driver's Control Panel Circuit Breaker No. 13	No. 14 Nat. - Blk. Tr.
	To Front Door Switch "N.C."	No. 16 Nat. - Blk. Tr.
	To Right Front Corner Marker Light	No. 16 Nat. - Blk. Tr.
	To Front Michigan Marker Lights	No. 16 Natural
	To Right Side Destination Sign *(When Used)	White
4	Spare to Driver's Control Panel Jct. 68	No. 14 Grn. - Red Ch.
5	Spare to Exit Door Jct. 16	No. 14 Yellow - 2 Blue // Tr.
6	TDH & TDM - From Driver's Control Panel Jct. 26 to Destination Sign Standby Lamps	No. 16 Brn. - Blk. Cr. Tr.
	SDH & SDM - From Driver's Control Panel Jct. 26 to Front Door Switch "N.O."	No. 16 Grn. - Blk. Cr. Tr.
7	Spare From Driver's Control Panel Jct. 48 & Exit Door Jct. 5	No. 14 Blk. - Grn. Ch.
8	Spare From Driver's Control Panel Jct. 88 & Exit Door Jct. 9	No. 14 Blue - Red Tr.
9	Driver's Control Panel Jct. 62 to Front Door Sw. "N.D." (TDH & TDM)	No. 16 Grn. - Blk. Cr. Tr.

*Special Equipment.

EXIT DOOR JUNCTIONS (TDH & TDM)

Exit door junction block is mounted in exit door engine compartment above door as shown in figure 2 in "DOORS AND CONTROLS" (SEC. 3). Junction block is accessible after opening exit door engine compartment door. Junction block contains 16 terminal posts numbered from 1 through 16. The tabulation which follows lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to each terminal. Terminal post numbers on the Wiring Diagrams appear in the symbol ◯.

Terminal No.	Circuit	Wire Size & Color
1	Open	
2	Exit Door Sw. Relay "SOL" to Driver's Control Panel Jct. 18	No. 14 Brn. - Red Tr.
	To Exit Door Unlock Lamp	No. 6 Natural
3	Open	
4	Spare to Driver's Control Panel Jct. 28	No. 14 Blue - 2 Nat. // Tr.
5	From Driver's Control Panel Jct. 48 to Exit Door Switch Relay "BAT" and to Exit Door Switch "COM."	No. 14 Blk. - Grn. Ch.
6	Open	
7	Open	
8	Ground (for Special Equipment Folding Doors)	Connected to Jct. 14 by Bus Bar

Continued on next page.

EXIT DOOR JUNCTIONS (TDH & TDM) (CONT'D.)

Terminal No.	Circuit	Wire Size & Color
9	From Driver's Control Panel Jct. 88 to Exit Door Solenoid . .	No. 14 Blue - Red Tr.
10	Spare to Driver's Control Panel Jct. 38	No. 14 Blue - Nat. Cr. Tr.
11	Spare to Driver's Control Panel Jct. 78	No. 14 Brn. - 2 Blk. // Tr.
12	From Driver's Control Panel Jct. 6	No. 16 Nat. - Blk. Tr.
	To Exit Door Step Lamp	White
13	Spare to Driver's Control Panel Jct. 60	No. 16 Brn. - 2 Nat. // Tr.
14	Exit Door Solenoid to Ground thru Driver's Control Panel Jct. 90	No. 14 Black
15	Spare to Driver's Control Panel Jct. 58	No. 14 Brn. - Grn. Tr.
16	Spare From Entrance Door Jct. 5	No. 14 Yellow - 2 Blue // Tr.

AMPHENOL CONNECTORS

Wiring harness connections are made at several points on vehicle through Amphenol multiple plug and receptacle type connectors. Terminals in receptacle and on plug are identified by letters. Locating key in receptacle housing engages a slot in plug to assure proper installation of plug. Letters on plugs and receptacles correspond to letters shown on Wiring Diagrams and in the tabulations which follow. Location of each Amphenol connector, together with the symbols and circuit tabulations, follows:

ENGINE AMPHENOL CONNECTOR

Electrical connections between the terminals, circuit breakers, and electrical units in the engine compartment apparatus box and the engine wiring harness are made through the left receptacle at the bottom of the engine compartment apparatus box.

Refer to symbol on Wiring Diagrams.

Terminal Letter	Circuit	Wire Size & Color
A	Generator "FLD" to Engine Comp't. Jct. 9	No. 14 Black
B	Generator "RELAY" to Starter & Generator Control Relay "4"	No. 14 Black
C	Engine Comp't. Jct. 35 to Engine Overheat Thermostat	No. 16 Black
D	Spare	No. 14 Black
E	Engine Comp't. Jct. 15 to Water Temperature Sending Unit	No. 16 Black
F	Spare	No. 14 Black
G	Spare	No. 14 Black
H	Emergency Stop Solenoid to Engine Comp't. Jct. 2	No. 12 Black
I	Starter Solenoid to No. 8 Engine Comp't. Circuit Breaker	No. 10 Black

TRANSMISSION AMPHENOL CONNECTOR

Electrical connections from the engine compartment apparatus box to the transmission wiring harness are made through the right receptacle at bottom of engine compartment apparatus box.

Refer to symbol on Wiring Diagram.

Terminal Letter	Circuit	Wire Size & Color
A	Speedometer Drive Unit "A" to Engine Comp't. Jct. 17	No. 16 Black
B	Speedometer Drive Unit "B" to Engine Comp't. Jct. 7	No. 16 Black
C	Speedometer Drive Unit "C" to Engine Comp't. Jct. 37	No. 16 Black
D	Speedometer Drive Unit "D" to Engine Comp't. Jct. 27	No. 16 Black
E	Speedometer Feed From Engine Compt. Jct. 36	No. 14 Black
F	Transmission Governor Switch (TDH & SDH)	No. 16 Black
	Transmission Low Oil Pressure Switch (TDM & SDM)	No. 16 Black
G	Transmission Relay "4" to Governor Switch (TDH & SDH)	No. 16 Black
H	Transmission Relay "6" to Neutral Solenoid (TDH & SDH)	No. 10 Black
	Reverse Relay "SOL" to Reverse Solenoid (TDM & SDM)	No. 10 Black
I	Transmission Relay "1" Direct Drive Solenoid (TDH & SDH)	No. 10 Black

AMPHENOL CONNECTORS (CONT'D.)

ENGINE CLOSURE DOOR AMPHENOL CONNECTOR

Engine compartment closure door wiring harness, carrying circuits to stop, directional, tail, and license lights is connected to apparatus box through an Amphenol connector at rear end of apparatus box near the top.

Refer to symbol ☒ on Wiring Diagrams.

Terminal Letter	Circuit	Wire Size & Color
A	No. 1 Engine Comp't. Jct. to Right Side Stop & Directional Light	No. 16 Black
B	No. 21 Engine Comp't. Jct. to Left Side Stop & Directional Light	No. 16 Black
C	No. 6 Engine Comp't. Jct. to License & Taillights	No. 16 Black
D	Ground	Black
E	Spare	Black

SPEEDOMETER AMPHENOL CONNECTORS

Wiring connectors at speedometer drive unit in engine compartment and at speedometer head in gauge panel are made through Amphenol connectors. Symbols on Speedometer Wiring Diagram are the same for both units.

Refer to symbol ⊠ on Wiring Diagram.

Terminal Letter	Circuit	Wire Size & Color
SPEEDOMETER DRIVE UNIT (IN ENGINE COMP'T.)		
A	To Transmission Amphenol "A"	No. 16 Black
B	To Transmission Amphenol "B"	No. 16 Black
C	To Transmission Amphenol "C"	No. 16 Black
D	To Transmission Amphenol "D"	No. 16 Black
SPEEDOMETER DASH UNIT (IN GAUGE PANEL)		
A	From No. 17 Driver's Control Panel Jct.	No. 16 Nat. - Blk. & Red // Tr.
B	From No. 27 Driver's Control Panel Jct.	No. 16 Grn. - 2 Red // Tr.
C	From No. 37 Driver's Control Panel Jct.	No. 16 Blk. - 2 Brn. // Tr.
D	From No. 7 Driver's Control Panel Jct.	No. 16 Brn. - Nat. & Blk. Cr. Tr.

DIRECTIONAL SIGNAL SWITCH AMPHENOL

Wiring harness connections from the driver's control panel junctions to the directional signal switch are made through an Amphenol connector mounted under the dash panel ahead of the steering column.

Refer to symbol ◯ on Wiring Diagram.

Terminal Letter	Circuit	Wire Size & Color
A	To Driver's Control Panel Jct. 41	No. 16 Orange - Grn. Tr.
B	To Driver's Control Panel Jct. 1	No. 16 Nat. - Red Cr. Tr.
C	To Driver's Control Panel Jct. 61	No. 16 Natural
D	To Driver's Control Panel Jct. 33	No. 16 Black - Nat. Tr.
E	To Driver's Control Panel Jct. 21	No. 16 Nat. - Blk. Cr. Tr.
F	To Driver's Control Panel Jct. 51	No. 16 Orange - Blk. Tr.
G	Feed From Driver's Control Panel Jct. 30	No. 16 Nat. - 2 Blk. // Tr.

BATTERY JUNCTIONS

Battery cable junctions are located in three places on the vehicle. Battery cables, carrying current to various parts of the vehicle for operation of the electrical units and systems, are connected at these junctions. Connections must be kept clean and tight. If corroded, disconnect cables and thoroughly clean cable ends and junction studs. Reconnect cables to junction studs and tighten stud nuts firmly. Location of battery cable junctions are as follows:

1. Two junction studs are mounted in top of battery compartment, located on left side of coach at bottom, opposite the exit door stepwell. The junction stud nearest the rear of the coach is the NEGATIVE or GROUND junction. The junction stud nearest the front of the coach is the POSITIVE junction. Battery tray must be pulled out and battery removed for access to junction studs.

2. Driver's control panel battery junction stud is between the junction panel and circuit breaker panel at left of driver (fig. 3).

3. Engine compartment battery junction is located at the bottom of the engine compartment apparatus box (fig. 5).

MISCELLANEOUS CIRCUIT BREAKERS

Heating system water pump motor is protected by a 20-amp automatic reset type circuit breaker connected between the engine compartment No. 1 junction and the "BAT" terminal of water pump relay. Views of motor, relay, and circuit breaker installed on early coaches are shown in figures 6 and 7 in "HEATING AND VENTILATION" (SEC. 3) of this manual. See figure 6 for circuit breaker location on later coaches.

On early vehicles equipped with air conditioning, a 90-amp automatic reset type circuit breaker is connected between the blower control relay (magnetic switch) and each under-floor blower motor. Circuit breakers are mounted on regulator and blower control panel (bottom view, fig. 6).

On Suburban models, a 20-amp automatic reset type circuit breaker is connected between the reading lamp relay and each bank of reading lights. Circuit breakers are mounted above the relay on the regulator and blower control panel (bottom view, fig. 6).

TELL-TALE ALARM SYSTEM

TELL-TALE LIGHTS

Ten tell-tale lights are located in gauge and tell-tale panel in front of driver (fig. 1). Tell-tale identification, shown in figure 1, is visible only when the light bulb under the lettering is illuminated. "MASTER" switch on driver's control panel must be in either "DAY" or "NITE" position to energize all tell-tale circuits. Following is a list of all tell-tale lights with a brief description of their purpose and a reference to the Wiring Diagram on which the circuit is shown.

1. "HOT ENG." Tell-tale, interconnected with the alarm buzzer, indicates that the temperature of the engine is too high for safe operation. Engine should be stopped immediately and the overheated condition corrected. Circuit is shown on "Alarm and Signal Wiring Diagram." Refer to "NOTE" following step 2 below.

2. "LOW OIL." This tell-tale, interconnected with the alarm buzzer, indicates that the engine lubricating oil pressure is below 2-3 psi. If tell-tale illuminates and buzzer sounds during operation, stop engine immediately and correct the cause of low oil pressure. Electrical circuit is shown on "Alarm and Signal Wiring Diagram." Refer to "NOTE" below.

NOTE: On vehicles equipped with special automatic engine shut-off system, the "HOT ENG." and "LOW OIL" tell-tale circuits are interconnected with a time-delay safety control relay which automatically shuts off the engine when either one of these abnormal conditions occur. There is, however, a time lag of 20 seconds (plus or minus 3 seconds) after the tell-tale comes on and buzzer sounds before the time-delay relay stops the engine. Operation of Engine Stop Time-Delay Relay System is described later in this section.

3. "LOW AIR." This tell-tale, interconnected with the alarm buzzer, indicates that air pressure is below 60-65 psi. This pressure will not efficiently operate brakes and air suspension system. If tell-tale illuminates and buzzer sounds during operation, stop the vehicle as soon as possible and correct the cause of low air pressure before proceeding. Refer to "Alarm and Signal Wiring Diagram." NOTE: On some coaches equipped with "Wig-Wag" low air pressure warning device, the circuit is disconnected from alarm buzzer (terminal No. 2).

4. "GEN." This tell-tale will light when the "MASTER" switch is placed in "DAY" or "NITE" position and the engine is not running, or when the engine is running and the generator is not charging. If "GEN" tell-tale illuminates during normal operation, the condition should be corrected immediately. Electrical circuit is shown on "Engine Control and Generator Wiring Diagram."

5. "STOP LAMP." This tell-tale illuminates when brakes are applied to indicate normal functioning of stop lights. If tell-tale does not illuminate when brakes are applied, it is an indication that one or both stop-light bulbs are burned out. Refer to "Stop and Directional Light Wiring Diagram."

6. "HI-BEAM." This tell-tale illuminates when headlight high beam is being used. Refer to "Lighting System Wiring Diagram."

7. "DIRECT SIG." This tell-tale flashes on and off when directional signals are being used to indicate normal functioning of signals. If tell-tale fails to illuminate when the directional signal switch is placed in either right or left turn position, it is an indication of a burned out directional signal bulb. Electrical circuits are shown on "Stop and Directional Light Wiring Diagram."

8. "EXIT DOOR." This tell-tale, used on Transit models only, serves to remind the driver that the exit door is unlocked. No attempt should be made to move the coach when this light is on, as the brake interlock system has the rear brakes applied. Refer to "Door Control Wiring Diagram."

9. "EMERG. DOOR." This tell-tale, interconnected with the alarm buzzer, indicates that the emergency exit door is open or partially unlatched. Coach should be stopped and emergency door securely latched for passenger safety. Refer to "Alarm and Signal Wiring Diagram."

10. "A.C. STOP." This tell-tale, used only on coaches equipped with air conditioning, will illuminate when the refrigerant Hi-Lo pressure switch contacts are open, indicating that the compressor drive clutch is disengaged. Refer to "Air Conditioning Wiring Diagram."

11. "TRANSMISSION LOW OIL." This tell-tale, used only on TDM and SDM models, indicates low oil pressure in the mechanical transmission. Electrical circuits and connections are shown on "Mechanical Transmission Wiring Diagram."

ALARM BUZZER AND RECTIFIER ASSEMBLY

Alarm buzzer and rectifier assembly is mounted on junction and apparatus panel at left of driver (item 3, fig. 3). Buzzer and rectifier is interconnected with the "HOT ENG," "LOW OIL," "LOW AIR," and "EMERG. DOOR" tell-tales and their controlling switches, and functions as previously described under "Tell-tale Lights." Refer to "Alarm and Signal Wiring Diagram" for electrical circuits. The rectifier portion of the unit permits current flow in one direction only. Since four different circuits will operate the buzzer, the rectifiers prevent backfeed of current when one abnormal condition exists from illuminating the other tell-tales.

Tell-tale and buzzer circuits can be checked for continuity, referring to the "Alarm and Signal Wiring Diagram." The "MASTER" switch must be in "DAY" or "NITE" position to energize the circuits. When checking hot engine tell-tale circuits, overheat thermostat terminal must be grounded.

Buzzer points can be cleaned, point opening can be adjusted, and the unit can be adjusted to buzz at a specified amperage. Refer to "Specifications" at end of this section.

ALARM SWITCHES

Low oil pressure switch, engine overheat thermostat, and low air pressure switch are covered in other sections of this manual as previously indicated under "Index of Electrical Units."

ENGINE STOP TIME-DELAY RELAY SYSTEM

Air-operated injector shut-off system automatically stops the engine when "MASTER" switch is turned to "OFF" position. Operation and maintenance of this system are covered in "DIESEL ENGINE" (SEC. 8).

The engine stop time-delay relay system is used as special equipment on some coaches. This system is used in conjunction with the low oil pressure and hot engine tell-tale alarm system and the air-operated injector shut-off system to automatically stop the engine when a low oil pressure or hot engine condition occurs. The time-delay relay system comprises the engine stop time-delay relay and three rectifiers. The time delay relay and one rectifier are mounted in the engine compartment apparatus box (fig. 5), and two rectifiers connected into the low oil and hot engine tell-tale circuits, are mounted at forward end of apparatus panel at left of driver (fig. 3). These units are connected into the electrical systems as shown on Engine Control and Generator Wiring Diagram with Automatic Engine Shut-off System and Alarm and Signal Wiring Diagram. The engine stop time-delay relay, with points normally closed, is fed from the "DAY" and "NITE" positions of the "MASTER" switch. Current for energizing the engine shut-off solenoid valve, which must be energized while engine is running, is fed through the normally-closed points of the time-delay relay. The time-delay relay operating coil is connected to the low oil pressure switch and to the engine overheat thermostat.

When low oil pressure switch or engine overheat thermostat contacts close, circuit is completed through the time-delay relay operating coil. With the relay operating coil energized the relay contacts open, breaking the circuit to the engine shut-off solenoid valve. With solenoid valve de-energized, air pressure is admitted to the engine shut-off air cylinder. The action of the air cylinder on the engine governor moves the injector racks to no-fuel position, stopping the engine.

Action of the time-delay relay is not immediate, as it requires 20 seconds (plus or minus 3 seconds) for the unit to open the contacts. The purpose of the rectifiers in the tell-tale circuits is to prevent backfeed of current from causing tell-tales to function when engine overheat thermostat and low oil pressure switch contacts are open.

WIRING AND MISC. ELEC.

NOTE: With engine stopped, low oil pressure switch contacts are closed. When "MASTER" switch is placed in "DAY" or "NITE" position ("DAY" position should always be used for starting engine), circuit through time delay operating coil is completed immediately through the low oil pressure switch. If the engine fails to start during the time required for the time-delay relay contacts to open (20 seconds), the system will act to move the injector racks to no-fuel position (provided air pressure is present in the system). It is then necessary to use the "STOP OVERRULE" switch as explained later.

TIME-DELAY RELAY SYSTEM TEST

Start engine and run for a few minutes to build up air pressure in system. Ground the engine overheat thermostat terminal to complete the circuit through the time-delay relay operating coil and check time lapse before the time-delay relay system acts to stop the engine. Time lapse should be 20 seconds, plus or minus 3 seconds. If engine does not stop within one minute, check operation of engine shut-off solenoid valve and air cylinder before condemning the time-delay relay. Low voltage at relay will also cause slow relay action.

Relay delay time can be adjusted by loosening lock nut and turning adjusting screw. Turn screw clockwise for faster action, or counterclockwise for slower action.

Engine "STOP OVERRULE" Switch

Coaches equipped with automatic engine shut-off system also have an overrule switch, located to rear of emergency stop switch on control panel at left of driver. Overrule switch is a momentary-on type toggle switch; switch must be held up for on position and returns to off position when released. Purpose of switch is to feed current to the engine stop solenoid valve, overruling the engine stop time-delay relay. This permits starting the engine and moving the coach to safety in case the automatic shut-off system shuts off the engine.

RELAYS

Relays are used in some instances to automatically open or close a circuit as operating conditions may require; in other cases they are used to provide a direct connection between the battery and an electrically operated device, with only a small amount of current required to energize the relay operating coil flowing through the controlling switch. The latter use eliminates the use of great lengths of heavy wire, thereby providing higher voltage to the electric device. Several of the same type relays are used on each vehicle; however, they are used in different circuits for different purposes.

Location, operation, and adjustment of various types of relays are described later under individual headings. Before attempting adjustment of relays, make sure points are clean. Clean contact points with a thin, fine-cut file if pitted or burned. Refer to applicable Wiring Diagrams for relay circuits and to identify wires which connect to terminals.

The following tabulation lists each relay used, its location on the vehicle, and its part number. After determining part number of relay, refer to instructions under that part number for operation and adjustment.

Relay	Location	Part No.
*Air Conditioning Control Relay	In Engine Compartment Apparatus Box	1116899
*Blower (Air Cond.)	On Control Panel at Left of Driver	1116852
*Blower Control (Air Cond.)	On Regulator & Blower Control Panel (early)	1119841
	(late)	1114223
Blower Control (2) (Std.)	On Regulator & Blower Control Panel (early)	2351703
	(late)	1114223
Destination Sign (TDH & TDM)	On Control Panel at Left of Driver	1116852
Dome Lamp (TDH & TDM)	On Control Panel at Left of Driver	1116852
Door Control (TDH & TDM)	On Control Panel at Left of Driver	1116852
*Engine Stop Time Delay	In Engine Compartment Apparatus Box	2395216
Exit Door Switch (TDH & TDM)	In Exit Door Engine Compartment	1116852
Horn	On Control Panel at Left of Driver	1116818
Reading Lamp Relay (SDH & SDM)	On Regulator & Blower Control Panel (early)	2351703
	(late)	1114223
Regulator Sensing Control	On Regulator & Blower Control Panel	1116797
Reverse (TDM & SDM)	In Engine Compartment Apparatus Box	1116852
Starter Control & Generator	In Engine Compartment Apparatus Box	1115822
Stop Light Tell-tale	In Engine Compartment Apparatus Box	1850547
Transmission Control (TDH & SDH)	In Engine Compartment Apparatus Box	1116899
*Transmission Governor Overrule (TDH & SDH)	In Engine Compartment Apparatus Box	1116845
Water Pump, Heating	In Air Duct at Rear of Left Rear Wheelhouse	1116852

*Special Equipment.

RELAY 1115822

Starter control and generator relay is mounted in the engine compartment apparatus box (fig. 5). Electrical circuits are shown on Engine Control and Generator Wiring Diagrams at end of manual, and on Generating System Schematic Wiring Diagram in "GENERATOR" section. This is a two-unit relay which, in conjunction with a resistor in the generator field circuit, automatically opens the starter circuit when the generator is charging.

The smaller of the two units serves as a starter control relay and the actuating current is supplied through the starter switch; this circuit is routed to ground through the generator charging circuit. Battery current is supplied to the lower contact of both relays through terminal number 6. When starter switch is closed and contacts close, battery current flows through the points and number 2 terminal, through number 8 circuit breaker to the starter solenoid, operating the starter. When the engine starts and the starter switch is opened, the operating coil of the starter control relay is de-energized and the points open, breaking the circuit to the starter solenoid.

The operating circuit of the generator relay (large unit) is fed from the "RELAY" terminal on the generator. When generator is charging, operating coil is energized. With the generator relay operating coil energized, the contacts close. Battery current then flows through the contacts and number 5 terminal to engine compartment apparatus box circuit breaker number 7 and junction 42. Junction 42 supplies current to components and circuits that are energized only when generator is charging.

If the starter switch is held closed after the engine starts, as soon as the generator starts charging the current in the charging circuit cancels the current from the starter switch. This causes the starter control relay points to open, breaking the circuit to the starter solenoid.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing voltage values.

Air Gap (Fig. 7)

Disconnect battery wire from number 6 terminal, then remove relay cover. Check and adjust each unit as follows:

1. Small Unit. Press armature down until points just close, then measure air gap between armature and center of core. Adjust, if necessary, by bending the lower contact point support.

2. Large Unit. Press armature down until points just close, then measure air gap between armature and center of core. Adjust, if necessary,

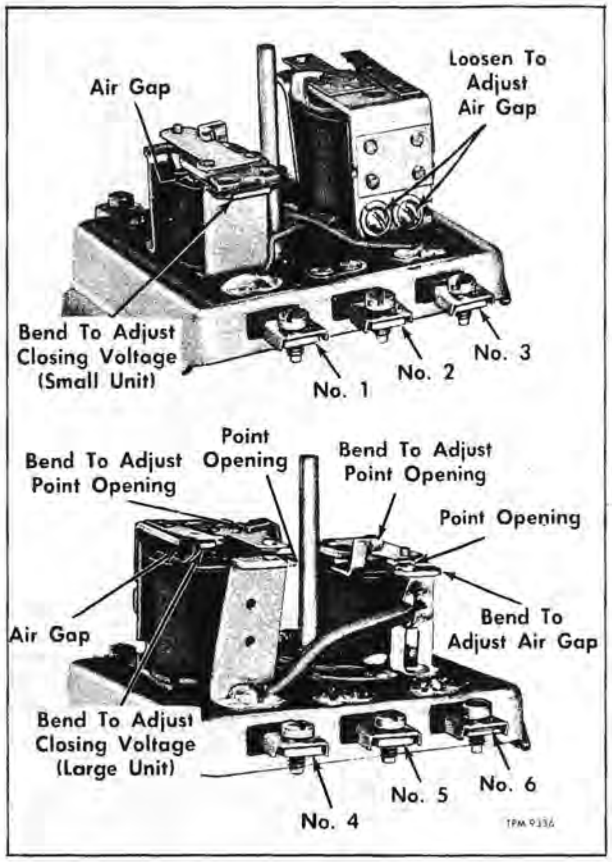


Figure 7—Relay 1115822

by loosening two armature hinge bracket attaching screws and moving armature up or down as required. Tighten screws firmly after adjustment.

Point Opening (Fig. 7)

With battery wire still disconnected from number 6 terminal, check and adjust each unit in same manner as follows:

1. Small Unit. Measure opening between contact points. Adjust, if necessary, by bending armature stop.

2. Large Unit. Measure opening between points with armature up against stop. Adjust, if necessary, by bending the armature stop.

Closing Voltage (Fig. 7)

Check each unit as follows:

1. Small Unit. Battery wire must be disconnected from number 6 terminal so starter will not operate. Connect an accurate reading voltmeter parallel with the relay operating circuit at terminal numbers 1 and 3. Connect a variable resistance unit in series with the operating circuit at number 3 terminal.

While holding engine compartment "START CONTROL" switch in "REAR START" position, slowly decrease resistance until points close and

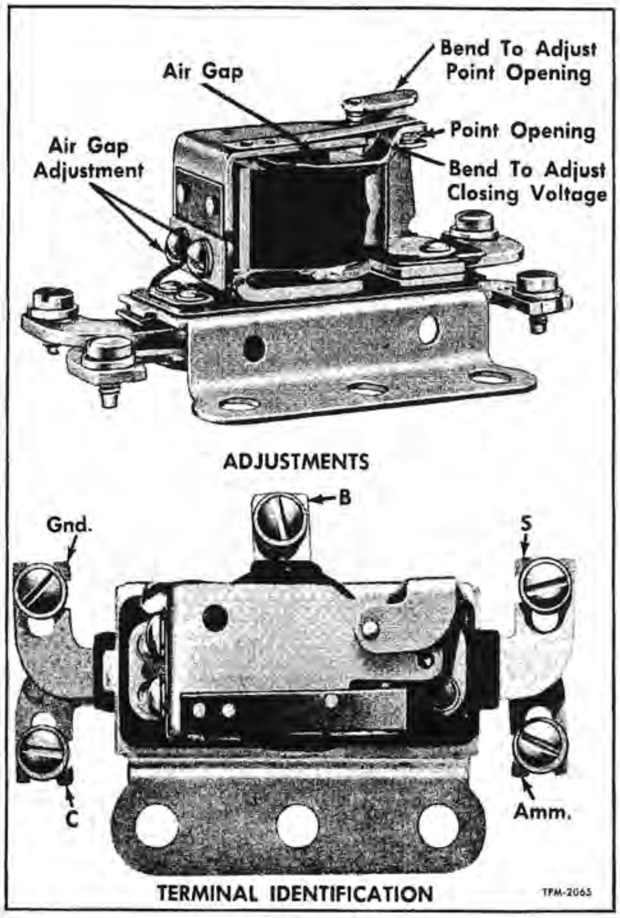


Figure 8—Relay 1116797

note the voltage reading. Adjust, if necessary, by bending the armature hinge bracket to change tension of the spring-type hinge. Increasing spring tension increases the closing voltage; decreasing spring tension lowers the closing voltage.

2. Large Unit. Connect battery wire to number 6 terminal. Connect an accurate reading voltmeter parallel with the relay operating circuit at terminals 1 and 4. Connect a variable resistance unit in series with operating circuit at number 4 terminal. Start engine and run at fast idle. Slowly decrease resistance until points close and note the voltage reading. Adjust, if necessary, by bending the armature spring stop to change tension on spring. Increase spring tension to increase closing voltage; decrease spring tension to lower closing voltage. Remove instruments and make sure wires are all connected and securely tightened after completing adjustment.

RELAY 1116797

Regulator sensing control relay is mounted on the regulator and blower control panel (fig. 6). Electrical circuits and connections are shown on Engine Control and Generator Wiring Diagrams in back of manual, and on Generating System Schematic Wiring Diagram in "GENERATOR" section.

Upper contacts of relay (closed when generator is not charging) are used to carry current for operation of No-Charge tell-tale and excitation current for generator through the regulator. This action takes place when "MASTER" switch is placed in "DAY" or "NITE" position.

When generator is charging, current is supplied from relay terminal of generator through the starter control and generator relay to operating coil of regulator sensing control relay. This action closes the lower contacts and opens the upper contacts, thereby turning off the No-Charge tell-tale light. With lower contacts close, full line current is supplied to "POS" terminal of regulator to provide maximum regulated generator output.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing voltage.

Air Gap (Fig. 8)

Remove cover from relay. Press armature down until lower points just close and measure air gap between armature and core. Adjust air gap, if necessary, by loosening two screws and moving armature up or down as necessary. If necessary, bend the lower contact support so the air gap will be uniform across top of core.

Point Opening (Fig. 8)

Measure opening between lower points with upper points closed. Adjust point opening, if necessary, by bending the upper contact support.

Closing Voltage (Fig. 8)

Connect an accurate reading voltmeter parallel with the coil winding from "C" terminal to ground. Connect a variable resistance in series with the coil winding at the "C" terminal. Start engine and run at fast idle (generator charging). Slowly decrease resistance until lower contacts close and note the reading on voltmeter. If not within range listed in "Specifications," adjust by bending the armature spring post to increase or decrease spring tension. Increasing spring tension increases the closing voltage, and decreasing spring tension decreases the closing voltage.

RELAY 1116818

This relay, used only in the horn circuit, is mounted on control panel at left of driver (2, fig. 3). Relay circuits and connections are shown on "Alarm and Signal Wiring Diagram" in back of manual. Coil windings of relay are connected in series with the horn button. When horn button is pressed, circuit through relay winding is completed and armature is attracted to core. This completes the circuit from the "B" terminal through the closed points and "D" terminal to the horn.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing voltage.

Air Gap (Fig. 9)

Disconnect wire from "B" terminal and remove relay cover. Press armature down until points just touch and measure air gap between armature and core. Adjust air gap, if necessary, by loosening two screws and moving armature up or down as required. If necessary, align the support carrying the lower contact so the air gap will be uniform between the coil and the armature.

Point Opening (Fig. 9)

With wire still disconnected from "B" terminal, measure contact point opening with armature up against stop. Adjust opening, if necessary, by bending the armature stop.

Closing Voltage (Fig. 9)

Connect an accurate reading voltmeter parallel with the operating circuit at the "B" and "S" terminals. Connect a variable resistance unit of 10 ohms in series with the operating circuit at the "B" terminal. With horn button pressed, slowly decrease resistance until points close and note the voltmeter reading. Adjust, if necessary, by bending the armature spring post to change tension of armature spring. Increasing spring tension increases the closing voltage, and decreasing spring tension decreases the closing voltage.

RELAY 1116845

This relay, used as a transmission governor overrule relay on TDH and SDH models (special equipment) is mounted in the engine compartment apparatus box (3, fig. 5). Relay circuits and connections are shown on "Hydraulic Transmission Wiring Diagram With Overrule" in back of this manual.

Feed circuit from the "DAY" position of "MASTER" switch is routed to the normally open contacts of transmission overrule switch. Switch is located either separately on floor or directly under the accelerator pedal. When switch contacts are closed, calling for transmission not to upshift into direct drive, the overrule relay operating coil is energized, completing the circuit from transmission governor switch to energize transmission

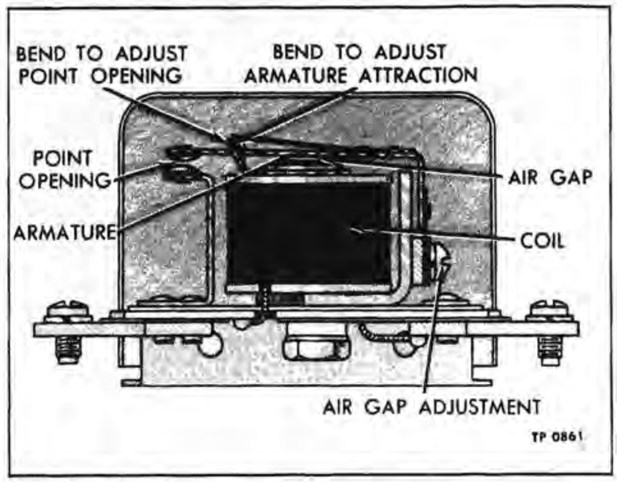


Figure 9—Relay 1116818

operating coil through No. 4 terminal of relay. With coil energized, relay contacts close to complete battery circuit to the transmission direct drive solenoid, which acts to prevent transmission from shifting into direct drive.

Transmission Governor Overrule Switch

Transmission governor overrule switch may be of floor-mounted foot-operated type or of micro-type located under and activated by the accelerator pedal.

Switch of type mounted under accelerator pedal is adjustable up or down by means of slotted bolt holes in switch mounting bracket.

Switch is properly positioned when contacts of switch are closed and the accelerator pedal is held down on pedal stop. To reposition switch, loosen two bolts which attach switch mounting bracket to floor riser, then move switch bracket up or down as required. Tighten mounting bolts firmly after making adjustment.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for opening and closing voltage.

Air Gap (Fig. 10)

With "MASTER" switch in "OFF" position, remove cover from relay. Depress armature against lower stop and measure air gap between armature and core. Adjust air gap, if necessary, by loosening two screws and moving armature up or down as required. If necessary, bend lower armature stop to obtain uniform air gap between armature and core.

Point Opening (Fig. 10)

Measure point opening with armature depressed against lower stop. Adjust point opening, if necessary, by bending the upper contact point support.

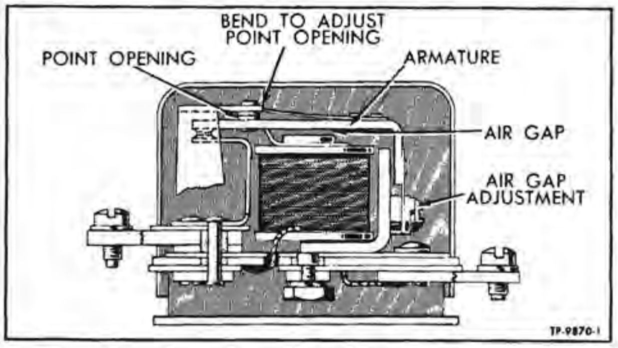


Figure 10—Relay 1116845

Opening Voltage (Fig. 10)

Connect an accurate reading voltmeter parallel with the operating coil circuit from "S" terminal to ground. Connect a variable resistance unit in series with the operating coil circuit at the "S" terminal. Connect a jumper lead across transmission control relay terminals "4" and "5" to energize the modulating relay operating coil circuit.

Slowly decrease the resistance and note reading on voltmeter when relay contacts open. Slowly increase resistance and note voltage at which points close. If not within limits listed in "Specifications," adjust by bending armature spring stop to change armature spring tension. Increasing spring tension increases opening voltage, and decreasing spring tension decreases opening voltage. After completing adjustment, remove jumper lead from transmission control relay terminals, remove instruments, and reconnect wire to relay "S" terminal.

RELAY 1116852

Several of these relays are used on each vehicle as indicated in the "Relays" tabulation previously. Location and function of each relay are described under individual headings. Adjustment instructions apply to all units. Relay adjustment points are illustrated in figure 9.

DESTINATION SIGN RELAY (TDH & TDM)

Relay is mounted on control panel at left of driver (12, fig. 3). Circuits and connections are shown on "Lighting System Wiring Diagram - TDH & TDM" in back of manual.

Relay "BAT" terminal is fed directly from the control panel battery junction through number 1 circuit breaker. Relay operating coil is energized from the "NITE" position of the "MASTER" switch through number 9 circuit breaker. When "MASTER" switch is turned to "NITE" position, relay coil is energized, armature is attracted to core, and relay points close. Current from the "BAT" terminal then flows through the closed points and "SOL" terminal to the dome lamp relay operating coil through the "OFF" side of the "STANDBY SIGN" switch and the "OFF" side of the "DOME" switch; both of these switches are on recessed switch panel at left of driver. When "STANDBY SIGN" switch is turned to "STANDBY SIGN" position, current from the destination sign relay "SOL" terminal energizes the incandescent stand-by lights in the destination sign compartment.

DOME LAMP RELAY (TDH & TDM)

Dome lamp relay is mounted on control panel at left of driver (4, fig. 3). Electrical circuits and connections are shown on "Lighting System Wiring Diagram - TDH & TDM" in back of manual.

Relay "BAT" terminal is fed from the control panel battery junction through number 11 circuit breaker. Relay operating coil is energized from the "NITE" position of the "MASTER" switch through the destination sign relay and "OFF" side of "STANDBY SIGN" lamp switch and "DOME" lamp switch on recessed switch panel as explained above. Relay operating coil can also be energized through the on side of the "DOME" lamp switch, regardless of the position of the "MASTER" switch.

When relay coil is energized, points close and battery current flows through the points and "SOL" terminal to the positive (+) terminal of the fluorescent lighting power supply unit. With power supply unit energized, fluorescent lamps in coach ceiling and destination sign compartment are illuminated.

DOOR CONTROL RELAY (TDH & TDM)

Door control relay is mounted on control panel at left of driver (1, fig. 3). Electrical circuits and connections are shown on "Door Control Wiring Diagram" in back of manual.

Relay "BAT" terminal is fed from the "DAY" and "NITE" positions of the "MASTER" switch through number 8 circuit breaker. Relay operating coil is connected to the switch on the air-electric door control valve. Feed circuit to door control valve switch is energized only when the "DOOR MASTER" switch is in closed position. Relay operating coil is energized when door control lever is in any "rear door unlock" position. When relay coil is energized, points close. Current from "BAT" terminal then flows through points and "SOL" terminal to the exit door solenoid. With solenoid energized, action of solenoid unlocks exit doors, permitting passenger to push doors open.

EXIT DOOR SWITCH RELAY (TDH & TDM)

Exit door switch relay is mounted in exit door engine compartment as shown in figure 2 (item 9), in "DOORS AND CONTROLS" (SEC. 3). Electrical circuits and connections are shown on "Door Control Wiring Diagram" in back of manual.

Relay "BAT" terminal is fed from the "DAY" and "NITE" positions of "MASTER" switch through number 8 circuit breaker and "DOOR MASTER" switch on recessed switch panel. Relay operating coil is connected to the "N.C." terminal of the exit door switch in the door engine compartment. When exit door is unlocked by action of the door control relay and exit door solenoid as explained above, movement of door lock cam lever closed the exit door switch contacts. With exit door switch contacts closed, relay operating coil is energized and points close. Current then flows from the relay "BAT" terminal through the points and "SOL" terminal to the "EXIT DOOR UNLOCKED" lamp above exit door, "EXIT DOOR" tell-tale, and brake interlock magnet valve.

WATER PUMP RELAY

Water pump relay is mounted in air duct at rear of left rear wheelhouse on Transit models, or under the seat riser at left rear side on Suburban models. Views of relay installed are shown in figures 6 and 7 in "HEATING AND VENTILATION" (SEC. 3) of this manual. Electrical circuits and connections are shown on "Heating and Ventilation Wiring Diagram" in back of manual.

Relay "BAT" terminal is fed hot from the battery compartment battery junction. Water pump relay operating coil is connected to the "COM" terminal on the heating system modulating valve switch. Relay operating coil is energized whenever "DEFROST" switch is in either "HI" or "LO" position (with "MASTER" switch in "DAY" or "NITE" position), or whenever the thermostat is calling for heat (with generator charging).

When operating coil is energized, relay points close. Current then flows from the relay "BAT" terminal through the points and "SOL" terminal to the heating system water pump motor. Circuit from relay to pump motor is protected by a 20-amp circuit breaker, mounted at side of relay.

AIR CONDITIONING BLOWER RELAY

Blower relay, used on coaches equipped with air conditioning, is mounted on control panel at left of driver (13, fig. 3). Refer to applicable "Air Conditioning Wiring Diagram" in back of manual for electrical circuits and connections.

"BAT" terminal is fed from the charging circuit and is energized only when the generator is charging. Relay operating coil is connected to the "N.C." terminal of the modulating valve switch and is energized only when the thermostat is calling for heat and generator is charging. When operating coil is energized, points close. Current then flows from "BAT" terminal through the points and "SOL" terminal, and to the blower control relay operating coil. The blower control relay then causes the underfloor blower motors to operate at high speed.

REVERSE RELAY (TDM AND SDM)

Reverse relay, used only on coaches equipped with mechanical transmission, is mounted in engine compartment apparatus box (3, fig. 5). Purpose of relay is to complete circuit from battery to reverse solenoid on transmission when "REV" switch (7, fig. 2) is pressed to permit shifting transmission into reverse gear. Relay circuits and connections are shown on "Mechanical Transmission Wiring Diagram" in back of manual.

Relay "BAT" terminal is fed from battery through number 3 engine compartment circuit breaker. Relay operating coil is connected to "REV" switch on driver's control panel and is fed from number 20 driver's control panel circuit breaker when "MASTER" switch is in "DAY" or "NITE" position. When operating coil circuit is completed at the "REV" switch, relay points close, completing the circuit from battery to reverse solenoid.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing values.

Air Gap (Fig. 11)

Disconnect lead from relay "BAT" terminal and remove relay cover. With contact points held closed, measure air gap between armature and center of coil. Adjust air gap, if necessary, by loosening two screws and moving armature up or down as required. If necessary, align the support carrying the lower contact so the air gap will be uniform between the coil and the armature.

Point Opening (Fig. 11)

With lead still disconnected from the "BAT" terminal, measure contact point opening with armature up against stop. Adjust opening, if necessary, by bending the armature stop.

Closing Voltage (Fig. 11)

With all leads connected to the relay as shown on the applicable wiring diagram, connect an accurate reading voltmeter in parallel with the relay operating circuit at the "VAC" and "GEN" terminals. Insert a variable resistance unit in series with the operating circuit at the "VAC" terminal. To check closing voltage, close the relay operating switch, then slowly decrease resistance until points close and note the voltage reading. (In some cases, generator must be charging to energize the relay operating circuits.) Adjust, if necessary, by bending armature spring post. Increasing spring tension increases the closing voltage, and decreasing spring tension decreases closing voltage.

WIRING AND MISC. ELEC.

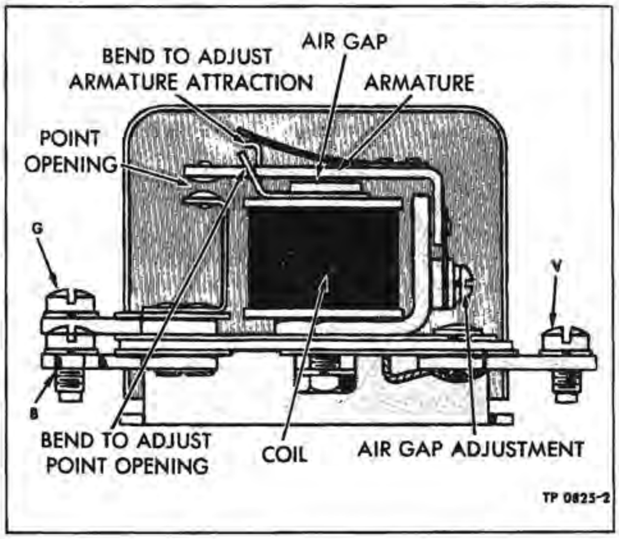


Figure 11—Relay 1116852

RELAY 1116899

Two of these relays may be used, depending upon the coach model and equipment. Location and function of each relay are described under individual headings.

HYDRAULIC TRANSMISSION CONTROL RELAY (TDH & SDH)

This relay, used in the hydraulic drive transmission control system, is mounted in engine compartment apparatus box (8, fig. 5). Electrical circuits and connections are shown on "Hydraulic Transmission Wiring Diagram" in back of manual. Operation and adjustment of relay are covered in "Hydraulic Drive - Model VH" operation and maintenance manual.

AIR CONDITIONING CONTROL RELAY

This relay is used on all models when equipped with air conditioning. Relay is mounted in engine compartment apparatus box (9, fig. 5). Electrical circuits and connections are shown on applicable "Air Conditioning Wiring Diagram" in back of manual, and on "Simplified Schematic Wiring Diagram" in AIR CONDITIONING (SEC. 26). Relay operation and adjustment are described in AIR CONDITIONING (SEC. 26).

RELAY 1119841 (MAGNETIC SWITCH)

This single relay (magnetic switch) is used as a blower control relay on early models equipped with air conditioning. Relay is mounted on regulator and blower control panel (fig. 6). Electrical circuits and connections are shown on "Air Conditioning Wiring Diagram - Early Models" in back of manual. Relay controls only the blower high speed circuit; low speed circuit is routed directly from the Air Conditioning Control Switch to the blower motors.

Relay battery terminal is fed from the battery junction in battery compartment. Relay operating coil is connected to number 1 terminal on Air Conditioning Control Switch and to "SOL" terminal on blower relay. Operating coil is energized whenever switch is in "BLOWER HI" or "AIR CONDITION" position, or when blower relay points are closed by the action of the modulating valve switch. In either case, the circuit is energized only when the generator is charging. With operating coil energized, relay contacts close, completing circuit to high speed circuit of blower motors.

The relay winding assembly is not removable from the case, however, the contact disc, plunger, and plunger return spring can be removed after removal of the cover. Gaskets on both sides of the moulded terminal ring seal the contact compartment. When assembling, make sure gaskets are in good condition and properly seated.

RELAY 1850547

This relay, used as a stop light tell-tale relay, is mounted in bottom of engine compartment apparatus box (6, fig. 5). Relay electrical circuits and connections are shown on "Stop and Directional Light Wiring Diagrams" in back of manual. Relay is similar in appearance to the horn relay (relay 1116818, fig. 9) and the adjustment points are identical.

Relay is connected into the stop light and stop light switch circuit in such a manner that when brakes are applied and stop light switch contacts close, current to stop lights passes through the relay coil winding. With coil winding energized, armature is attracted to core and relay points close, completing the circuit to the "STOP LAMP" tell-tale in gauge and tell-tale panel, indicating that the stop lights are illuminated.

Stop light tell-tale relay is sensitive to amperage, requiring the current draw of both stop light bulbs to close the points. If one bulb is burned out, current draw will not be sufficient to close the relay points, and "STOP LAMP" tell-tale will not illuminate when brakes are applied. When the directional signal lights are being used and brakes are applied, one bulb is intermittently taken out of the circuit to produce the directional signal. To prevent the relay points from opening under these conditions, a resistor, installed on control panel at left of driver (14, fig. 3), is connected into the flasher circuit in such a manner that the resistor is placed into the circuit when the stop light bulb is taken out by the flasher. This provides constant current draw sufficient to keep the relay points closed.

ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing amperage.

Air Gap (Fig. 9)

Remove relay cover. Press armature down until points just close and measure air gap between armature and core. Adjust, if necessary, by loosening two screws and moving armature up or down as required. If necessary, align the support carrying the lower contact so the air gap will be uniform between the coil and the armature.

Point Opening (Fig. 9)

Measure contact point opening with armature up against stop. Adjust opening, if necessary, by bending the armature stop.

Closing Current (Fig. 9)

Connect an accurate ammeter and a variable resistance unit in series with the relay operating circuit at the "S" terminal. Turn "MASTER" switch to "DAY" position. Apply the brakes, or connect a jumper lead across the stop light switch terminals to complete the circuit. Slowly decrease resistance until points close and note reading on ammeter. Increase resistance until the points open and note reading on ammeter. If closing and opening amperage is not within limits listed in "Specifications," adjust by bending armature spring post to increase or decrease spring tension. Increasing spring tension increases closing amperage, and decreasing spring tension decreases closing amperage.

If relay does not function properly during normal operation in vehicle, candlepower of stop light bulbs should be checked. Stop light bulbs of proper size must be used.

RELAY 1114223 AND RELAY 2351703

NOTE: Relay number 2351703 is used on early coaches and number 1114223 is used on later coaches. Part number is stamped on relay.

Two magnetic switch type relays, controlling circuits to heating system and A/C blower motors, are mounted on regulator and blower control panel (fig. 6). Electrical circuits and connections are shown on applicable Wiring Diagram." Relays are fed battery current direct from battery compartment battery junction. Relay operating circuits can be energized only when the generator is charging. With generator charging, relay operating coils can be energized by placing "BLOWER" switch on recessed switch panel in "NORMAL" position; operating coils are automatically energized by the water modulation valve switch whenever the thermostat is calling for heat, regardless of the position of the "BLOWER" switch. When coil windings are energized, the switch contacts close and complete the battery circuit to the blower motor windings.

NOTE: Another relay is used on SDH and SDM coaches for controlling the reading lights. Refer to "Lighting System Wiring Diagram - SDH and SDM" in back of manual for relay and light circuits.

Relays are sealed units and are not adjustable or reparable. If either switch fails to function properly, the defective unit must be replaced.

IMPORTANT: When operating blowers from under vehicle by means of a jumper lead to check blower operation or alignment of blower wheels, the instructions under "Procedure for Operating Blower Motors From Below Coach" in BODY (SEC. 3), must be followed to aboid burning out the circuit breakers built into the motors.

RELAY 2395216

This is a time-delay relay used in the automatic engine shut-off system. Operation and test of this relay is covered under "Engine Stop Time-Delay Relay System" earlier in this section.

ELECTRIC HORN

Horn (fig. 12) operates on magnetic principle to produce a warning signal. Current from battery flows through windings within horn when circuit is completed by action of a relay when horn button is pressed. Horn circuit is protected by No. 1 circuit breaker on panel at left of driver. Refer to "Alarm and Signal Wiring Diagram" in back of manual for horn circuit.

HORN TESTS

If horn produces a weak signal, voltage at horn should be checked by connecting a voltmeter across horn terminals. The voltage reading should not be less than 11 volts. A lower reading indicates either a low battery or high resistance in horn circuit.

Loose or corroded connections in horn circuit should be corrected. Check for defective wiring by connecting test leads from horn to battery.

A loose connection or poor contact at horn push button may cause horn to operate intermittently. Shunt around the horn button to determine whether there is poor contact at push button. Whenever wiring is replaced in horn circuit, use correct size as shown on wiring diagram.

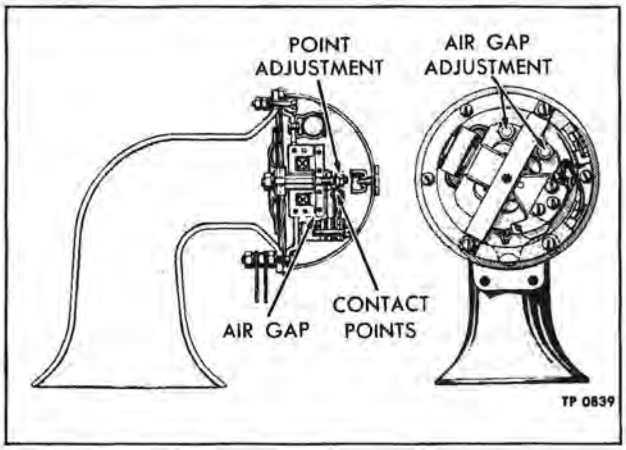


Figure 12—Electric Horn

Horns usually have a rasping sound when vital parts are broken or loose. A loose back shell may affect tone. Tighten collar screws, mounting nuts, and studs. Replace all damaged parts.

The horn will not function properly if field windings within horn are open circuited or grounded. Connect an ammeter in circuit at horn terminal. If there is no indication of current flowing when contact points are closed, windings are open circuited. The ammeter will indicate an excessive flow of current if windings are short circuited or grounded.

Windings may also be checked for grounded circuit with test lamp having its own source of current. Disconnect horn leads and touch one test point to one of the horn terminals and the other point to the horn base. If lamp lights, field windings are grounded.

Excessive arcing at contact points may be caused by improper current adjustment. An open circuit in condenser will cause excessive arcing and, in some cases, contacts will be held together.

HORN ADJUSTMENTS

If tone is not satisfactory after checking preceding conditions, adjust horn in following manner:

1. Remove shell from horn.

2. Connect ammeter in circuit at horn and adjust current consumption by varying position of adjusting nut. Refer to "Specifications" at end of this section for current consumption.

3. Loosen adjusting lock nut and turn adjusting nut to left or right to increase or decrease current.

4. Too much current will cause horn to have a spluttering sound. This adjustment is very sensitive. Move nut 1/10 turn at a time and lock in position each time before trying. If ammeter is not available, adjust according to sound.

5. Correct air gap between armature and core is important for proper tone. The gap must be uniform across entire surface of armature. Width of gap may be determined by using a feeler. Adjustments are made by use of air gap adjusting nuts. Refer to "Specifications" at end of this section for correct adjustment dimensions.

ELECTRIC SPEEDOMETER

The electric speedometer drive unit is mounted in engine compartment, and is driven by a short flexible cable from the transmission speedometer drive gear. A four-wire connector cable plugged into drive unit is connected to an electric motor unit mounted on back of mechanical speedometer head in gauge and tell-tale panel. Electric motor drives speedometer when actuated by electrical impulses from the drive unit. Drive unit uses 12-volt current from the battery. Speedometer circuit is protected by No. 16 circuit breaker on panel at left of driver, and by a 6-amp line fuse installed in the feed line at the drive unit. Refer to "Speedometer Wiring Diagram" in back of manual for electrical circuits.

Current is divided in drive unit by a mechanically driven rotor with two brushes which run against a resistor ring. Varying currents are transmitted to motor on speedometer head through a four wire cable.

Electrical currents from drive unit energize two pairs of coils in motor unit, causing magnetic rotor to rotate at exactly same speed as mechanically driven unit. Since motor is coupled to speedometer head, rotation is transformed to a reading on face of calibrated speedometer head.

TESTING

For testing speedometer electrical units (using battery of 12 volts), plus or minus one volt variation is permissible. The maximum current consumption should not exceed two amperes.

Jam nut, located at point where four wire conduit fastens to connector plugs, should always be kept tight. The connector plug body grips cable insulation and prevents conduit coming loose from connector plugs due to rough handling which would cause loose connections.

A test light (1568147) should be used to test electric speedometer. If speedometer ceases to function, proceed as follows:

1. Check test light bulbs with battery to be sure they are not burned out.

2. Pull four-contact plug out of top of drive unit and insert plug on end of light cable in its place.

3. Turn "MASTER" switch to "DAY" position to energize drive unit.

4. Disconnect flexible drive shaft at transmission. Turn drive shaft slowly by hand. If lights alternately grow bright and dim, the drive unit is functioning properly.

5. Remove test light cable plug from drive unit and reconnect cable to drive unit.

6. Disconnect cable plug from speedometer head motor and connect to test light cable, using double end male adapter chained to end of cable.

7. Again turn drive shaft slowly by hand. If lights alternately go bright and dim, wiring between drive unit and head is good and trouble should be in head unit.

8. Always be sure that plugs make good contact when connected.

9. If lights fail to check when connected to unit, check feed and ground connections at drive unit for tightness; also for broken drive shaft.

10. If lights check when connected to drive unit but not when connected to front of cable, careful check should be made of electrical cable for broken wire or loose connections where the wires attach to sockets.

With above procedure, it will be easy to determine whether trouble lies in drive unit, in connector plug and wiring, between drive unit and motor unit, or in motor unit and speedometer head assembly.

NOTE: If speedometer test fixture with master head is available, the speedometer can be tested with master speedometer reading 60 miles per hour. If speedometer calibration is not satisfactory when speedometer is driven mechanically, the head may be recalibrated by an authorized United Motors Service Station. Speedometer calibration discrepancies have no connection with the electric drive unit, providing the speedometer head and motor unit are not binding, which is easily discovered by excessive pointer fluctuations.

SPECIFICATIONS

CIRCUIT BREAKERS

DRIVER'S COMP'T. & ENGINE COMP'T. PANELS

Make	FASCO Industries, Inc.
Type	Automatic Reset
Amperage Rating	Refer to Figure 4

READING LIGHT (SUBURBAN MODELS) AND WATER PUMP (HEATING SYSTEM)

Make	FASCO Industries, Inc.
Type	Automatic Reset
Amperage Rating	20 amp.

BLOWER MOTOR (AIR COND.) (EARLY MODELS)

Make	Spencer Thermostat Co.
Type	Automatic Reset
Amperage Rating	90 amp.

FUSE

Speedometer Drive Unit Line Fuse	6 amp.

RESISTORS

Stop Lamp	25 watt, 8 ohm
Regulator Sensing Control Relay	100 watt, 3 ohm
Generator Tell-tale	20 watt, 20 ohm

ALARM BUZZER AND RECTIFIER

Make	Delco-Remy
Model	1116981
Point Opening	0.015"
Adjust to Buzz at	0.030-0.035 amps at 13.5-14.5 volts

RELAYS

(Refer to Table on Page 220 for Relay Usage)

1115822

Make	Delco-Remy

Small Unit (Starter Relay)

Air Gap (points closed)	0.011" Min.
Point Opening	0.025"
Closing Voltage Range	6.3-8.2
Opening Voltage	2.0 Min.
Sealing Voltage	8.7 Max.

Large Unit (Generator Relay)

Air Gap (points closed)	0.011"-0.016"
Point Opening	0.023"
Closing Voltage Range	3.3-4.2
Sealing Voltage	0 to 0.9 above closing

SPECIFICATIONS (CONT.)

1116797
Make .... Delco-Remy
Air Gap (points closed) .... 0.012″
Point Opening .... 0.020″
Closing Voltage Range 7.0-9.0

1116818
Make .... Delco-Remy
Air Gap (points closed) .... 0.022″
Point Opening .... 0.030″
Closing Voltage Range 6.0-8.0
Sealing Voltage .... 11.0 Max.

1116845
Make .... Delco-Remy
Air Gap (armature down) .... 0.012″
Point Operating (armature down) .... 0.020″
Closing Voltage .... 6.0 Min.
Opening Voltage Range 9.0-10.6

1116852
Make .... Delco-Remy
Air Gap (points closed) .... 0.022″
Point Opening .... 0.030″
Closing Voltage .... 7.0 Min.
Sealing Voltage .... 9.0 Max.

1116899
Make .... Delco-Remy
Air Gap (points closed) .... 0.014″
Point Opening .... 0.028″
Closing Voltage Range 8.5-10.5
Opening Voltage .... 4.3 Min.

1850547
Make .... Delco-Remy
Model 268-H
Air Gap (points closed) .... 0.015″
Point Opening .... 0.020″
Closing Current (amps.) .... 2.35 Max.
Opening Current (amps.) .... 1.5 Min.

1119841 (Magnetic Switch)
Make .... Delco-Remy
Current Consumption .... 1.05-1.17 @ 12 volts

2351703 (Magnetic Switch)
Make .... R-B-M Div., Essex Wire Corp.
Type .... 70-111224 Continuous Duty
Voltage 12

1114223 (Magnetic Switch)
Make .... Delco-Remy
Voltage 12
Current Consumption .... 0.7-0.8 amps.

2395216 (Engine Stop Time Delay Relay)
Make .... Eagle Signal Co.
Type .... Single-pole, Double-throw
Voltage 12
Time Delay (Adjustable)
Factory Setting (except when otherwise specified) .... 20 seconds, plus or minus 3 sec.

ELECTRIC HORN

Make .... Delco-Remy
Model 1999700
Voltage 12
Air Gap .... 0.030″-0.034″
Current .... 3.5-5.5 amps.
Frequency 300-320

SPEEDOMETER

DRIVE UNIT
Make .... AC Spark Plug Div.
Model 1580697

SPEEDOMETER HEAD
Make .... AC Spark Plug Div.
Model 1587607

Batteries

Battery compartment is located at left side of coach ahead of left rear wheelhouse. To open compartment door, unlock door latch at each upper corner of door, using compartment door key provided, and swing door down. View of batteries installed with compartment door open is shown in figure 1.

Two 12-volt batteries, connected parallel, are clamped in a pull-out tray. Tray is secured in position by a pivot-mounted retainer bolt which engages a slotted bracket at bottom of tray. Battery tray rides in two support channels. A roller is mounted on an eccentric pin and lever assembly in outer end of each support channel. When the levers are pulled out and downward, the eccentric pins cause rollers to rise and support battery tray. An angle stop, bolted to rear of battery tray and extending downward, contacts a stop plate which prevents tray from being accidentally pulled out of support channels.

To pull tray out for servicing batteries, loosen nut on retainer bolt and disengage from bracket. Pull out and downward on roller levers to place tray on rollers, then pull outward. Before pushing tray back into compartment, make sure cable connections are clean and tight, and that batteries are securely clamped in tray. After pushing tray into place, swing roller levers up, engage retainer bolt in slot in retainer bracket, and tighten nut firmly.

IMPORTANT: Observe decal on inside of battery compartment door which reads: CAUTION - NEGATIVE GROUND. It must be emphasized that if the batteries are not connected NEGATIVE GROUND, severe damage to the generator, regulator, batteries, and battery cables will result.

The battery has three major functions to perform on the vehicle.

1. It provides a source of current for starting the engine.

2. It acts as a stabilizer to the voltage in the electrical system.

3. It can for a limited time furnish current when the electrical demands of the electrical equipment exceed the output of the generator.

BATTERY MAINTENANCE

Electrolyte level in the batteries should be checked at least every 1,000 miles or once every two weeks. If the electrolyte level is found to be low, water should be added to each cell until the level rises to the bottom of the vent well. DO NOT OVERFILL! Distilled water or water passed through a "demineralizer" should be used to eliminate the possibility of harmful impurities being added to the electrolyte. Many common impurities will greatly shorten battery life. DO NOT ADD ANY SUBSTANCE TO THE ELECTROLYTE EXCEPT WATER.

The external condition of the batteries and the battery cables should be checked periodically. The top of the batteries should be kept clean and the battery hold-down bolts should be kept properly tightened. For best results when cleaning battery, wash first with a dilute solution of ammonia or soda to neutralize any acid present, then flush off with clean water. Care must be used to keep vent plugs tight so that the neutralizing solution does not enter the cells. The hold-down bolts should be kept tight enough to prevent the batteries from shaking around in their holders, but they should not be tightened sufficiently to place a strain on the battery cases.

To insure good contact, the battery cable clamps should be tight on the battery posts. If the posts or cable clamps are corroded, the cables should be disconnected and the posts and clamps cleaned separately with a soda solution and a wire brush. Install clamps on battery posts and tighten firmly, then coat posts and clamps with petroleum jelly to help retard corrosion.

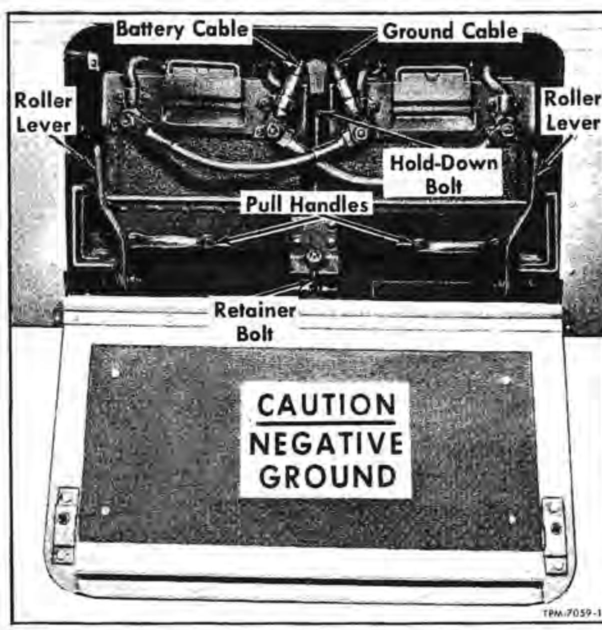


Figure 1—Batteries Installed

BATTERIES

ON VEHICLE TESTS

Three battery checks are described below to determine in a minimum amount of time the condition of the battery.

1. State of Charge (hydrometer test).
2. Battery Capacity Test.
3. Three Minute Battery Test.

If a battery failure is encountered, the cause may lie outside the battery itself. DO NOT BE SATISFIED TO MERELY RECHARGE OR REPLACE IT. FIND THE CAUSE OF FAILURE AND PREVENT RECURRENCE OF TROUBLE.

STATE OF CHARGE (Hydrometer Test)

The hydrometer test is merely a means of determining the state of charge of the battery. This test will not necessarily indicate whether the battery is able to perform its normal functions, such as starting.

1. Measure specific gravity of electrolyte in each battery cell. The hydrometer tube must be held vertically. Do not draw too much electrolyte into the hydrometer. The float must be freely suspended in the electrolyte and the reading taken at eye level. If water has been recently added to the cells, or battery fast charged, the hydrometer reading will be false.

2. Correct hydrometer reading for temperature. When electrolyte temperature is above 80 degrees F., add 4 points (.004) to reading for each 10 degrees above 80. If electrolyte temperature is below 80 degrees F., subtract 4 points for each 10 degrees below 80.

3. Analyze the readings as follows:

a. If the specific gravity readings are 1.215-1.270 at 80 degrees F., and variation between cells is less than 25 gravity points (.025), the battery presumably is at least 3/4 charged and in good condition for further use.

b. If the specific gravity readings are below 1.215 and the variation between cells is less than 25 gravity points, the battery presumably is in sound condition, but its state of charge is too low for further use or testing electrical circuits.

c. If the specific gravity readings show a variation between cells of more than 25 gravity points, an unsatisfactory battery condition is indicated which may be caused by shorted cells, acid loss, or a worn out battery.

To determine whether a battery is a good battery, regardless of its state of charge, proceed with the "Battery Capacity Test" below:

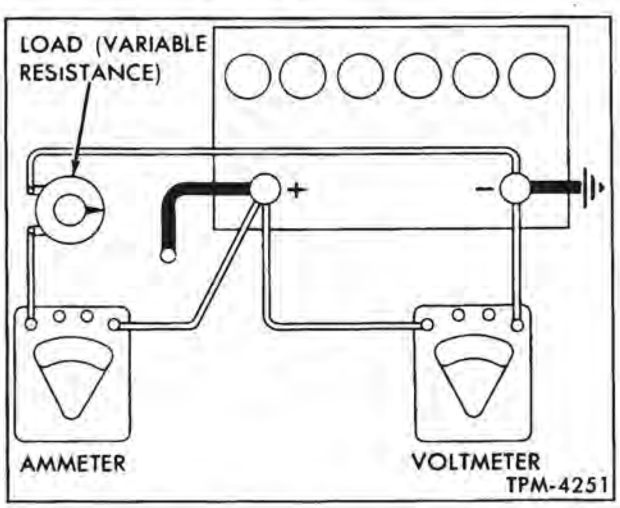


Figure 2—Typical Test Hook-Up For Battery Capacity Test

BATTERY CAPACITY TEST

This test is one means of determining whether a battery is functioning efficiently to the degree where it can be relied upon to perform all of its duties properly in the vehicle.

A 12-volt battery that will maintain 8.4 volts or better during a battery capacity test should be considered a good battery. To make this test, use equipment that will take a heavy electrical load to the battery such as a carbon pile or other suitable means. If test equipment is not available for loading battery, the starter may be used as a load.

1. Connect positive voltmeter and ammeter leads to battery positive post, and connect negative voltmeter and ammeter leads to battery negative post (fig. 2). NOTE: Ammeter cable clips must contact battery posts; voltmeter cable clips must contact battery post or cable clamp, not the ammeter cable clips.

2. Apply a load to the battery of three times the ampere-hour rating of the battery for 15 seconds. Refer to "Specifications" at end of this section for ampere-hour rating of battery used in vehicles covered by this manual.

3. With ammeter reading specified load, read voltage which should not be less than 8.4 volts at 80°F. (and above) electrolyte temperature.

a. If voltmeter shows 8.4 volts or more, battery has good output capacity and will readily accept a normal charge.

(1) If specific gravity is 1.215 or more, no service is required.

(2) If specific gravity is below 1.215, check charging circuit to determine the cause and correct as required. The battery should be slow-charged for city driving. With highway driving and a good charging system, the battery should charge satisfactorily.

b. If voltmeter shows less than 8.4 volts, proceed with the "Three-Minute Battery Test" described following:

THREE-MINUTE BATTERY TEST

In cases where a voltage of less than 8.4 volts is obtained in the "Battery Capacity Test" described above, an accurate test using a voltmeter and a fast charger will quickly establish in three to four minutes whether a battery is good or bad even when the battery is in a discharged condition.

This procedure determines the condition of charged or discharged batteries by following the principles that:

a. A charged battery may be tested by taking current out of it.

b. A discharged battery may be tested by passing current through it.

THIS TEST SHOULD NOT BE USED IF BATTERY TEMPERATURE IS BELOW 60 DEGREES F.

If battery temperature is above 60 degrees F., add battery water, if necessary, and proceed with the three-minute battery test. CAUTION: Do not make this test, which is recommended for discharged batteries, if voltage obtained in "Battery Capacity Test" is 8.4 or more. A charged battery will not accept 40 amperes without an excessively high voltage.

Test Procedure

If voltage obtained in "Battery Capacity Test" was less than 8.4 volts, fast charge battery at 40 amperes for 3 minutes. Then, with charger still operating, test individual cell voltages of battery.

NOTE: Since cell connectors are not exposed, it is necessary to pierce the cover to contact the connector straps to obtain individual cell voltages. Where pierced, the connectors should be resealed. A hot soldering iron may be used to reseal the connectors. DO NOT USE AN OPEN FLAME NEAR THE BATTERY.

a. If cell voltages are uneven by more than 0.1 volt, replace the battery.

b. If cell voltages are even within 0.1 volt, test total battery voltage with charger still operating on fast charge.

(1) If total voltage is over 15.5 volts, battery is unsatisfactory and is probably sulfated. Battery may be serviceable after continued slow charge, then test capacity. If above 8.4 volts, place back in service. If below 8.4 volts, replace the battery.

(2) If total voltage is under 15.5 volts, test specific gravity and charge battery.

OFF VEHICLE SERVICE

COMMON CAUSES OF BATTERY FAILURE

When a battery fails, the cause of failure may lie outside the battery itself. For this reason, when a battery failure is encountered, do not be satisfied to merely recharge or replace it. Find the cause of the failure and prevent recurrence of the trouble. Listed below are some of the common causes of battery failure.

1. Defect in generating system such as high resistance or faulty generator or regulator.

2. Overloads caused by defective starter or excessive use of accessories.

3. Dirt and electrolyte on top of battery causing a constant drain.

4. Hardened battery plates, commonly called "sulfation," due to battery being in a low state of charge over a long period of time.

5. Physical defects such as shorted cells, loss of active material from plates, etc.

6. Driving conditions or requirements under which the vehicle is used only for short drives.

CHARGING

Batteries removed from the vehicle for charging should be charged continuously at a low rate until fully charged. Batteries may be safely slow-charged at a rate in amperes equal to 7% of the battery's ampere-hour capacity. (Refer to "Specifications" at end of this section for ampere-hour rating of battery used.) This is called the "normal" charge rate. The battery is fully charged when specific gravity readings taken at hourly intervals show no increase during three consecutive readings.

A very low rate -- not more than one-half the normal charging rate -- should be used for charging a sulfated battery. In the case of badly sulfated batteries, as much as 100 hours of charging time may be required before the battery becomes fully charged. Badly sulfated batteries may require a continuous slow charge for 48 hours or more before a rise in gravity reading occurs. If the specific gravity reading of any cell fails to reach 1.250 (corrected to 80^{o}F.) or if there is a variation of more than 25 gravity points between cells after thorough slow charging, replace the battery.

Although the slow-charge method is recommended for charging all batteries, discharged batteries in otherwise good condition (refer to "Battery Capacity Test") may be given a boost with a quick charger if time does not permit complete slow charging. When using a quick charger, it must be remembered that the battery is only receiving a partial charge and that the battery electrolyte temperature must not be allowed to exceed 130^{o}F. If the battery heats up excessively, quick charging must be discontinued.

BATTERY CABLES

Check all cable leads and connections to determine if they are in good condition. Excessive resistance, generally caused by poor connections, produces abnormal voltage drop which may lower voltage at starting motor to such a low value that normal operation of starting motor will not be obtained. Abnormal voltage drop can be detected with a low-reading voltmeter as follows:

NOTE: To prevent engine starting while operating starter, block stop lever on top of engine governor in no-fuel position. Place engine compartment control panel "ENGINE CONTROL" switch in "REAR RUN" position to energize the starter control circuit just before making each check. On vehicles equipped with automatic engine shut-off system, the engine stop time delay relay will open the starter circuit 20 seconds after the control switch is turned on. If this occurs, turn "ENGINE CONTROL" switch to "OFF" position to permit the engine stop time delay relay to re-set.

1. Check voltage drop between grounded (negative) battery terminal and vehicle frame. Place one prod of voltmeter on battery terminal and other on vehicle frame. With starting motor cranking engine at normal room temperature (70°F.), voltage reading should be less than 0.3 volt. If more than this, there is excessive resistance in this circuit.

2. Check voltage drop between ungrounded (positive) battery terminal and starting motor terminal stud while motor is operated. If reading is more than 2.5 volts, there is excessive resistance in circuit. NOTE: If necessary to extend wire from the meter for this test, use No. 16 or larger wire.

3. Check voltage drop between starting motor housing and vehicle frame. This must be less than 0.2 volt.

SPECIFICATIONS

Manufacturer	The Electric Storage Battery Co.
Quantity	2, Connected Parallel
Type	
With 6V-71 Engine	Ultra-Start LX-B4
With 8V-71 Engine	Hycap 8D
Plates Per Cell	
With 6V-71 Engine	17
With 8V-71 Engine	25
Amp. Hour Capacity @ 20 Hour Rate (Each Battery)	
With 6V-71 Engine	175
With 8V-71 Engine	200

Starting System

GENERAL

The starting system includes batteries, starter, starter solenoid, starter relay (incorporated in starter control and generator relay), starter switches, circuit breakers, and interconnecting wiring and cables. Starting system control circuits are shown on "Engine Control and Generator Diagrams" in back of manual. Refer to "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section for information on all relays.

CONTROL SYSTEM OPERATION

Starter control system is inoperative with "START CONTROL" and "ENGINE CONTROL" switches on engine compartment control panel in "OFF" position; these switches must be in "NORMAL" position to operate starter from driver's compartment. On models with hydraulic transmissions, transmission shift lever must be in neutral to operate starter from either control panel.

The "MASTER" switch must be in "DAY" position (when starting at front) or engine compartment control panel "ENGINE CONTROL" switch (fig. 1) must be in "REAR RUN" position (when starting at rear) to energize the engine stop solenoid valve and to complete the circuit to starter switch. When starter switch is closed, circuit is completed through operating coil of starter relay portion of starter and generator control relay, causing the contacts of the relay to close. Battery current then flows from number 6 terminal through the closed contacts of the starter relay to the operating coil of the starter solenoid. With solenoid operating coil energized, circuit is completed direct from battery to starter.

On coaches equipped with automatic engine shut-off system, circuit from "MASTER" or "ENGINE CONTROL" switch to engine stop solenoid valve is routed through the normally closed contacts of the engine stop time delay relay. If engine fails to start within 20 seconds after circuit is energized, the time delay relay contacts will open; "MASTER" or "ENGINE CONTROL" switch must then be momentarily returned to "OFF" position to permit the time-delay relay to reset itself and close the contacts.

On coaches equipped with parking lot heater connections, circuit to starter relay operating coil is routed through the "STARTER CUT-OUT" switch, located in radiator filler door (fig. 2). This switch must be in "NORMAL" position for starter to operate.

Figure 1—Engine Compartment Control Panel

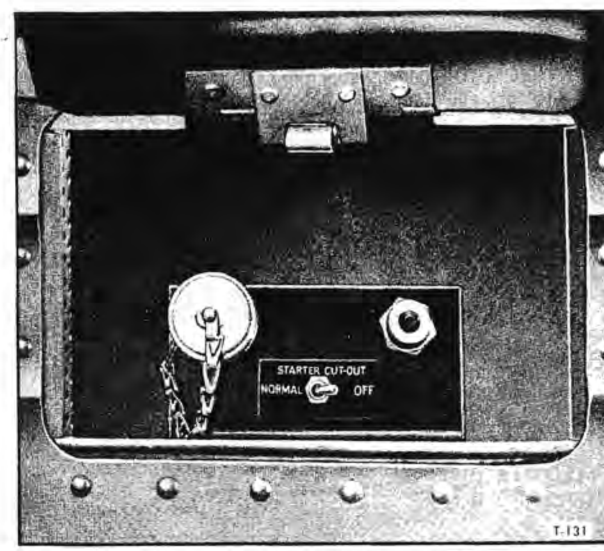


Figure 2—Starter Cut-out Switch

STARTER

DESCRIPTION

Starter (fig. 6) is a heavy duty unit, solenoid operated through an enclosed shift lever. Starter is equipped with a heavy duty sprag type overrunning clutch. A removable plug is provided in shift lever housing to permit adjustment of pinion clearance.

Armature shaft is supported in bronze bushings at three points -- in commutator end frame, in shift lever housing, and in nose housing. Positive lubrication is provided at each bushing by an oil saturated wick that projects through the bushing and contacts the armature shaft. A waste-filled oil reservoir for each wick provides a large oil supply.

O-ring seals are used between commutator end frame and field frame, and between shift lever housing and field frame. A spring-loaded lip type oil seal together with an O-ring seal in shift lever housing and a boot over the solenoid plunger prevents entry of transmission oil into the armature, field coils, and solenoid case.

Two brushes are carried in each of four holders mounted on plates which are attached to, but insulated from the commutator end frame. As shown on internal wiring diagram (fig. 3), two sets of brushes are connected to the ground terminal stud on commutator end frame; these connections are made through the brush holder mounting plate. The other two sets of brushes, which are insulated from mounting plate, connect to field coil leads.

STARTER DRIVE OPERATION

When starter circuit is energized, shift lever operated by solenoid slides the pinion into mesh with flywheel ring gear teeth. The rotary motion between pinion and ring gear, provided by the spiral splines on clutch shaft, normally relieves tooth abutment on the first attempt. A protective sleeve located on spiral spline acts as a stop for the pinion when extreme tooth abutment occurs. This limits the clutch travel, preventing the switch contacts in solenoid from closing. Therefore, armature cannot rotate before pinion is engaged properly, preventing damage to pinion and ring gear. A second attempt to engage rotates pinion enough to assure proper engagement.

MAINTENANCE

Other than periodic lubrication as directed in LUBRICATION (SEC. 13) and keeping cable connections clean and tight, the starter should require no periodic maintenance. The brushes can be inspected and replaced without disassembling the starting motor; however, it must be removed from the engine. Starter is accessible through access opening in crossmember underneath the vehicle.

BRUSH REMOVAL

1. Remove starting motor from engine.
2. Loosen two screws holding cover band on commutator end of field frame, then remove cover band.
3. Remove screws and washers attaching brush leads and field coil leads to brush holders.
4. Using a screwdriver as shown in figure 4, bend brush holder spring back and remove brush from holder.

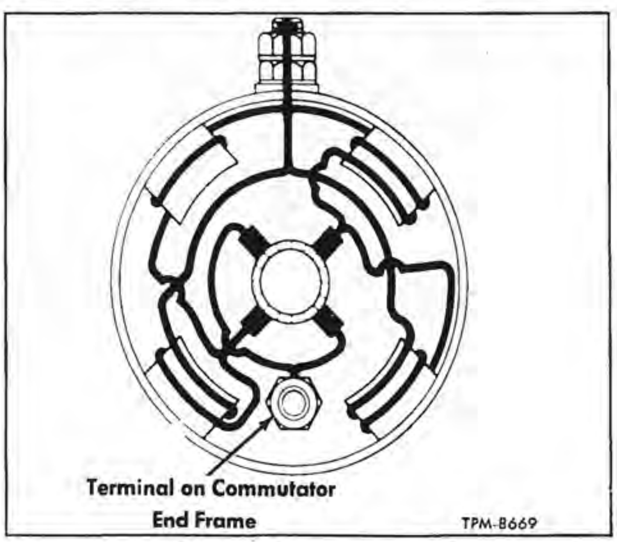


Figure 3—Starter Internal Wiring Diagram

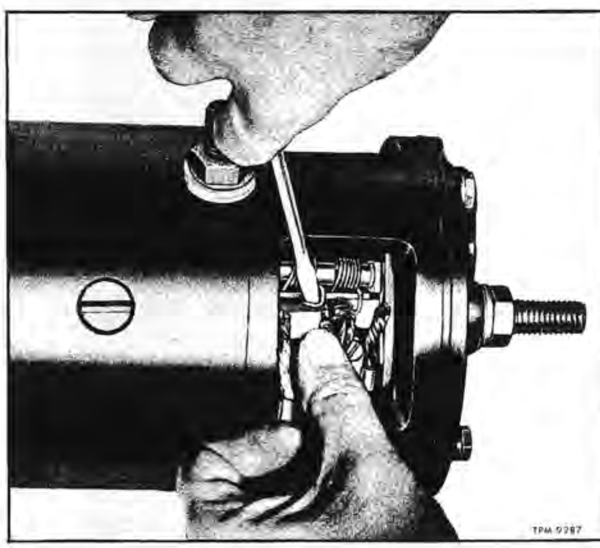


Figure 4—Removing or Installing Brushes

BRUSH INSPECTION

1. When brushes are worn down to less than one-half their original length, they must be replaced (original length is 3/4").

2. Be sure leads are secure in brushes and that clips are properly soldered to leads.

BRUSH INSTALLATION

1. Using screwdriver to bend brush holder spring as shown in figure 4, and with groove in brush aligned with ridge in holder, insert brushes in holders.

2. Position brush leads and field coil leads to brush holders and attach with one screw and washer in each brush. Tighten screws firmly.

3. Position cover band over commutator end of field frame, and tighten cover band screws firmly.

4. Install starting motor on engine.

STARTER FREE SPEED CHECK

Before disassembling starter, the following check of starter operation can be made to determine conditions which may require special attention during overhaul.

To make this check, connect an ammeter in series with the positive (+) terminal of a 12-volt battery and the "BAT" terminal of the starter solenoid (fig. 5). For the return circuit, connect a lead from the starter frame to the battery negative (-) terminal. Connect a voltmeter from solenoid "BAT" terminal to ground on starter frame.

Use a tachometer at end of armature shaft (fig. 5) to determine armature rpm. Energize the solenoid by connecting a jumper lead from the solenoid "BAT" terminal to the solenoid switch terminal. Observe the armature rpm, voltage, and current draw. Failure of starter to operate according to values listed in "Specifications" at end of this section may be due to tight or dry bearings, or to high resistance connections.

STARTER DISASSEMBLY

(Refer to Figure 6)

1. Using a prick punch or small chisel, mark relative positions of commutator end frame and shift lever housing to field frame, and position of nose housing to shift lever housing so they can be reassembled in same positions.

2. Remove nut and lock washer attaching solenoid "MOTOR" terminal connector strap to terminal stud on field frame. Also disconnect solenoid ground lead from terminal stud on commutator end frame.

3. Remove plug and gasket from shift lever housing. Remove nut from end of solenoid plunger rod, then remove solenoid assembly from field frame and shift lever housing.

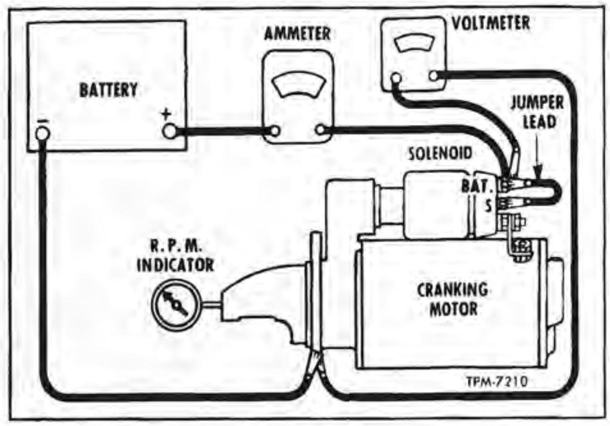


Figure 5—Test Hook-up For Checking Starter Free-Speed

4. Remove six socket-head screws attaching nose housing to shift lever housing. Remove nose housing from lever housing and armature shaft.

5. Remove cover band assembly from commutator and field frame assembly. Disconnect field coil leads from brush holders.

6. Remove bolts and lock washers attaching commutator end frame to field frame. Remove commutator end frame assembly from field frame and armature shaft. Remove thrust washer from armature shaft.

7. Remove bolts and lock washers attaching shift lever housing to field frame. Separate field frame from shift lever housing and remove field frame from armature.

8. Withdraw armature from shift lever housing, removing drive clutch assembly from armature shaft as armature is removed. Remove brake washer from armature shaft, and remove collar and O-ring from counterbore in shift lever housing.

9. It is not necessary to further disassemble starter unless parts require replacement as directed later under "Inspection, Tests, and Repair."

INSPECTION, TESTS, AND REPAIR

(Refer to Figure 6)

The overrunning clutch assembly, armature, and field frame and coil assembly should not be cleaned in a degreasing tank or with grease dissolving solvents, since these would dissolve the lubricant in the clutch mechanism and damage the insulation in the armature and field coils. All parts except the clutch should be cleaned with oleum spirits and a brush. The clutch should be wiped with a clean cloth. Commutator can be cleaned with No. 00 sandpaper. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR.

ARMATURE

If the armature commutator is worn, dirty, out-of-round, or has high insulation, the armature

STARTING SYSTEM

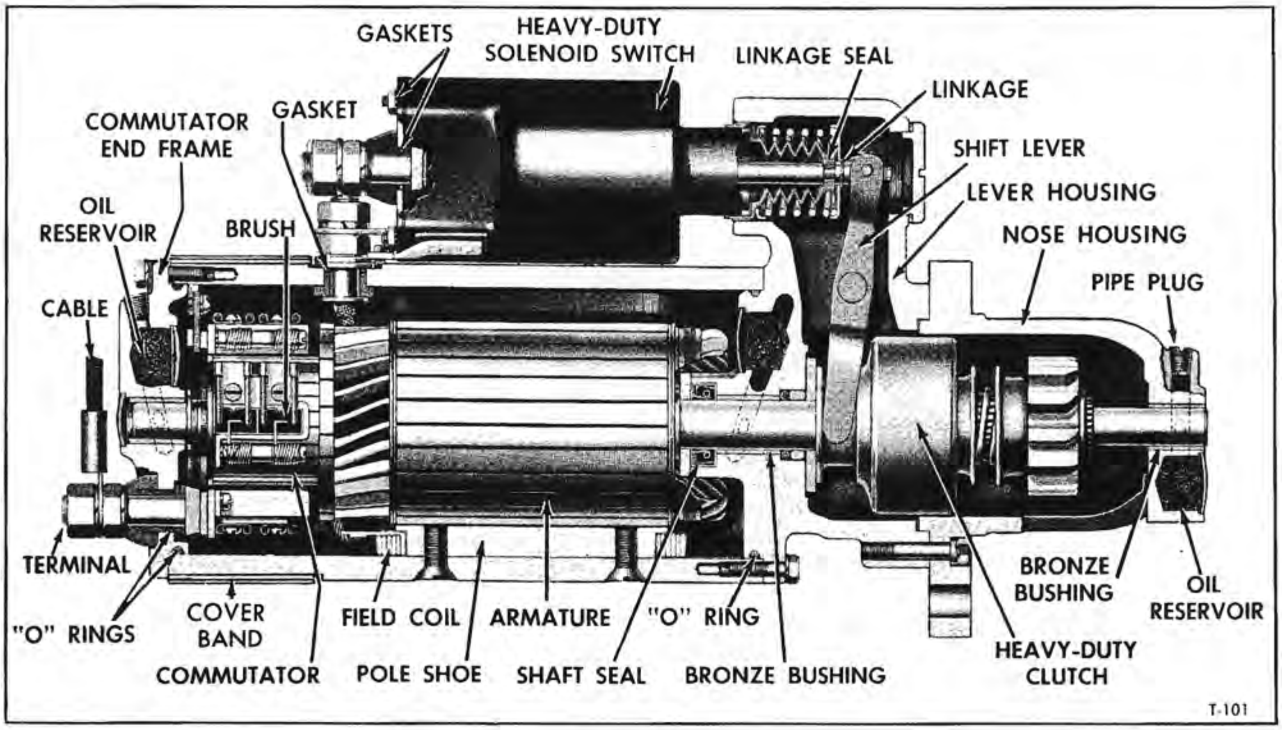


Figure 6—Starter and Solenoid Assembly

should be placed in a lathe and the commutator turned down. Do not cut deeper than necessary to remove rough spots or out-of-round condition. DO NOT UNDERCUT THE INSULATION BETWEEN THE COMMUTATOR SEGMENTS AFTER TURNING DOWN THE COMMUTATOR AS HAS BEEN THE PRACTICE IN THE PAST.

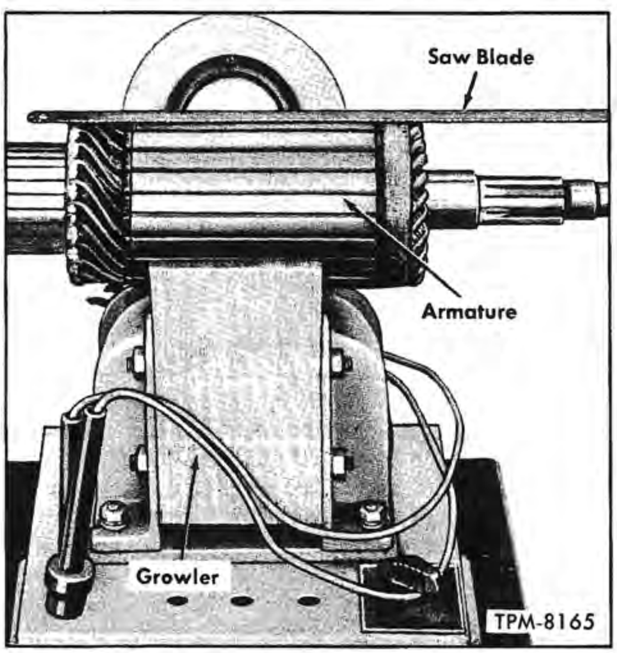


Figure 7—Checking Armature For Short Circuits

The armature should be checked for open circuit, short circuit, and grounds as follows:

Open Circuit Test

Open circuits are usually caused by excessively long cranking periods. The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of commutator bars. If bars are not too badly burned, repairs can sometimes be made by resoldering the leads in the riser bars, using rosin flux solder. After soldering, turn down commutator and undercut the insulation.

Short Circuit Test

Short circuits in the armature are located by the use of a growler. When armature is rotated in the growler with a still strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuits is located (fig. 7). The possibility of shorts between the bars is eliminated because of insulation type and high copper content brushes.

Ground Test

Grounds in the armature can be detected with a 110-volt test lamp and test points. If the lamp lights with one test point on commutator and the other on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure, which is often brought about by overheating due to excessively long cranking periods, or by accumulation of brush dust between the commutator bars and the steel commutator ring.

FIELD COILS

Internal wiring circuits are shown in figure 3. Connect one test lamp lead to the field frame and the other to the terminal stud on the field frame. If lamp lights, at least one of the field coils is grounded and it must be repaired or replaced.

Connect one test lamp lead to the terminal stud on field frame and the other, in turn, to each of the field coil leads which connect to the brush holders; lamp should light. If lamp fails to light in either case, the field coils are open.

Field Coil Replacement

Field coils can be removed from the field frame by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding the field coils as the pole shoes are tightened into place. Each pole shoe has a long lip on one side and short lip on the other; they should be installed with the long lip pointing in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

COMMUTATOR END FRAME

Remove all brushes. Place one test lamp lead on end frame, and the other, in turn, on each of the brush holders and on terminal stud. If lamp lights it is an indication of defective brush holder insulation or terminal insulators. Replace defective insulators under brush holder mounting plates or at terminal stud.

If brushes are worn down to less than one-half their original length, they must be replaced (original length is 3/4"). Be sure leads are secure in brushes and that clips are properly soldered to leads.

Check brush spring tension. If not within limits listed in "Specifications" at end of this section, replace with new springs. Examine brush holders and hinge pins for bent or damaged condition. Any condition which might prohibit free brush action must be corrected.

Examine bushing in end frame for excessive wear or out-of-round condition. Original diameter of bushing is listed in "Specifications" at end of this section. Replace bushing, if necessary, as directed following.

Bushing Replacement

1. Remove expansion plug from armature shaft bore.

2. Remove expansion plug from oil reservoir and remove pipe plug from oil wick passage. Remove packing and oil wick from reservoir.

3. Press old bushing from end frame and press new bushing into place.

4. Using a drill same size as oil wick passage, run drill through passage to cut through edge of bushing. Remove burrs from bushing caused by drilling operation.

5. Install new oil wick and fill oil reservoir with fine wool packing material. Saturate reservoir packing and oil wick with engine oil, then install new expansion plug with gasket in oil reservoir opening.

6. Install new expansion plug with gasket in armature shaft bore in end frame.

SHIFT LEVER HOUSING

Inspect oil seal and bushing in shift lever housing for evidence of damage or excessive wear. Original diameter of bushing is listed in "Specifications" at end of this section. Replace bushing, if necessary, as directed in "Bushing Replacement" under "Commutator End Frame," omitting steps 1 and 6. When installing new oil seal, lip must point inward.

If shift lever appears excessively loose on lever shaft, worn parts can be replaced by removing retaining ring from exposed small end of lever shaft, then driving shaft out of housing. When installing lever and shaft, use new O-rings in grooves in shaft.

NOSE HOUSING

Inspect bushing in nose housing for wear, referring to "Specifications" for original bushing diameter. Replace bushing, if necessary, as directed in "Bushing Replacement" under "Commutator End Frame," omitting steps 1 and 6.

OVERRUNNING CLUTCH ASSEMBLY

Drive pinion must rotate freely in overrunning direction and must not slip in cranking direction. The overrunning clutch can be serviced as follows, referring to figure 8.

Disassembly

1. Using suitable tools, remove the pinion stop cup and split washers from sleeve.

NOTE: In removing the pinion stop cup, cup will be damaged. Use new cup at assembly.

2. Remove pinion, spring retainer outer cup, spring, and spring retainer inner cup.

Inspection and Repair

1. Inspect spring and spring retainer cups. If not in good usable condition, replace with new parts.

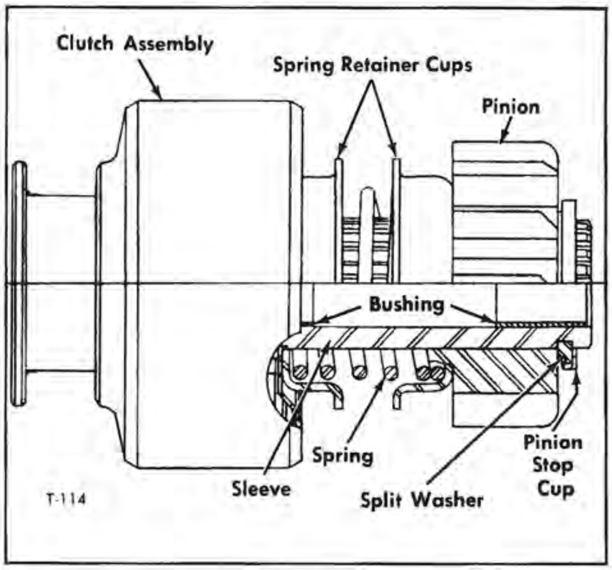


Figure 8—Drive Clutch Assembly

2. Inspect pinion. If teeth are chipped or cracked, replace pinion.

3. Inspect sleeve bushings. If bushings do not meet specifications listed at end of this section, press old bushings out of sleeve and press new bushings into place. Ream bushings to specifications listed at end of this section.

Assembly

1. Install spring retainer inner cup, spring, and spring retainer outer cup on sleeve.

2. Install pinion and pinion stop cup on clutch sleeve.

Figure 9—Installing Commutator End Frame

3. Install split-type washers in groove at end of clutch sleeve.

4. Position clutch sleeve assembly in a vise; then with pinion seated firmly against the pinion stop cup, and using suitable tools, bend pinion stop cup lip over split washers, locking pinion stop and split washers together.

STARTER ASSEMBLY

(Refer to Figure 6)

1. Lubricate splines of armature shaft with engine oil, then insert drive end of armature shaft through shift lever housing until shaft just extends through housing. Place O-ring and collar over armature shaft and position in counterbore in housing. Place brake washer over end of shaft.

2. Position drive clutch assembly in lever housing with lugs on lever yoke engaging groove in drive clutch shift collar, then push armature shaft through housing and drive clutch.

3. Place gasket in counterbore in shift lever housing, then install nose housing over armature shaft and position at lever housing, with marks made prior to disassembly aligned. Attach nose housing to lever housing with six socket head screws; tighten screws to 13-17 foot-pounds torque.

4. Install new O-ring in groove in field frame side of shift lever housing. Install field frame over armature and position against shift lever housing, with marks made prior to disassembly aligned. Attach lever housing to field frame with five cap screws and lock washers. Tighten cap screws firmly.

5. Position solenoid with plunger assembly on field frame, inserting plunger rod end of solenoid into shift lever housing. Through opening in opposite side of lever housing, make sure plunger rod passes through plunger rod guide in shift lever. Thread adjusting nut a few turns onto plunger rod. Attach solenoid to field frame with four cap screws and lock washers. Install connector strap on solenoid "MOTOR" terminal and field frame terminal stud.

6. Place thrust washer over commutator end of armature shaft. Place new O-ring in groove around commutator end frame. With marks made prior to disassembly aligned, install end frame to field frame as shown in figure 9. Attach end frame to field frame with four cap screws and lock washers; tighten firmly. Through openings in field frame, install brushes and connect field coil leads to brush holders as previously directed in "Brush Installation" under "Maintenance."

7. Install cover band over commutator end of field frame and tighten two screws firmly. Connect solenoid ground lead to terminal stud on commutator end frame.

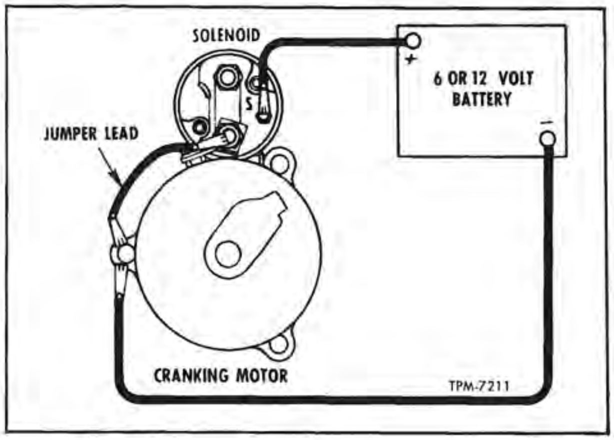


Figure 10—Test Hook-up For Checking Pinion Clearance

NOTE: In order to prevent early starter failure by the entrance of water, oil, or cleaning spray, care should be taken, to prevent crimping cover band during installation.

8. Adjust pinion clearance as directed below.

PINION CLEARANCE ADJUSTMENT

1. To check the pinion clearance, connect a 6-volt battery from solenoid switch terminal to starter frame (fig. 10). If solenoid does not operate, use a 12-volt battery. To prevent starter from motoring, connect a heavy jumper from solenoid "MOTOR" terminal to starter frame (fig. 10).

2. With solenoid energized and drive clutch shifted toward the nose housing, push the pinion back toward armature to take up slack, then check clearance between the pinion and nose housing (fig. 11). Adjust nut on solenoid plunger rod as necessary to obtain the proper clearance of 23/64 inch. After correct adjustment is obtained, install access plug and gasket in shift lever housing.

STARTER SOLENOID

Starter solenoid is used to shift the starter drive pinion into engagement with flywheel teeth and to complete the circuit from battery to starter.

Solenoid has two windings, the pull-in winding and the hold-in winding. When starter switch is closed, both windings are energized, producing a magnetic field which pulls the plunger in. Inward movement of plunger shifts starter pinion into engagement with flywheel ring gear teeth, and closes the main contacts in the solenoid switch to complete the circuit from battery to starter.

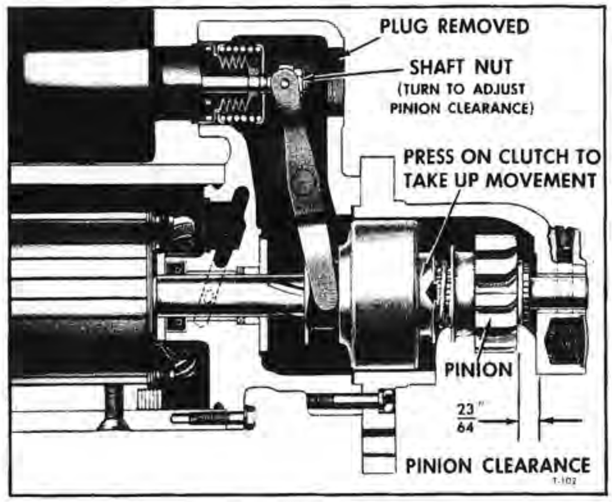


Figure 11—Pinion Clearance Check and Adjustment

The pull-in winding draws comparatively heavy current for a short interval. This is required to shift the pinion into engagement. The hold-in winding also aids the pull-in winding. As soon as plunger closes the main switch contacts, pull-in winding is de-energized and only the hold-in winding draws current for the balance of the starting cycle.

SOLENOID MAINTENANCE

Solenoid requires no periodic maintenance other than keeping the terminals clean and tight. Always check action of solenoid if it has been removed. If unit fails to function, first check wiring before condemning the solenoid. Solenoid windings can be checked for current draw, open circuit, or shorts. Refer to "Specifications" at end of this section for current values. Solenoid coil, terminals, and switch plunger can be replaced if burned or otherwise damaged. Whenever solenoid is replaced, pinion clearance must be checked and adjusted, if necessary, as previously directed in starter assembly procedures.

Refer to next page for "Specifications."

SPECIFICATIONS

Make	Delco-Remy
Starter Model	1114100
Rotation (Viewing Drive End)	Counterclockwise
Minimum Brush Spring Tension	35 oz.
No-Load Test	
Volts	11
Maximum Amps.	170
Minimum Rpm	6300
Lock Test	
Volts	1.5
Maximum Amps.	700
Minimum Torque (Ft. Lbs.)	15
Bushing Diameters (I.D.)	
Commutator End Frame	0.540"-0.544"
Shift Lever Housing	0.810"-0.813"
Nose Housing	0.625"-0.627"
Drive Clutch Sleeve*	0.6245"-0.6260"
Starter Solenoid Model	1119895
Current Consumption @ 80° F.	
Both Windings	
Amperes	65.3-73.3
Volts	10
Hold-in Winding	
Amperes	12.7-14.3
Volts	10

*Burnish after installing

Generator

The generating system consists of an engine-driven, oil-cooled brushless generator, a transistorized voltage regulator, and a starter control and generator relay. Information concerning the transistorized voltage regulator is covered in "REGULATOR" section later in this group. The starter control and generator relay is covered under "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section.

IMPORTANT

The electrical system on these coaches is NEGATIVE GROUND. It must be emphasized that if the batteries are not connected for a NEGATIVE GROUND system, severe damage to the generator, regulator, batteries, and battery cables will result.

GENERAL

The oil-cooled generator is a self-rectifying AC generator in which all current carrying members, windings, built-in diodes, and field coils are stationary. It is a totally enclosed unit, cooled and lubricated by engine oil. The oil inlet is on the diode end cover and the oil drains back into the engine crankcase through the drive end frame and gear train cover as shown in figure 1. The generator should never be operated with the oil line disconnected.

Power output is DC with a maximum rating of 220 amperes. It will produce 120 amperes at normal engine idle speed.

The generator has three terminals (fig. 2); the DC power output terminal, a field terminal, and a relay terminal. The relay terminal provides voltage only for the starter control and generator relay. Generating system wiring diagram is schem-

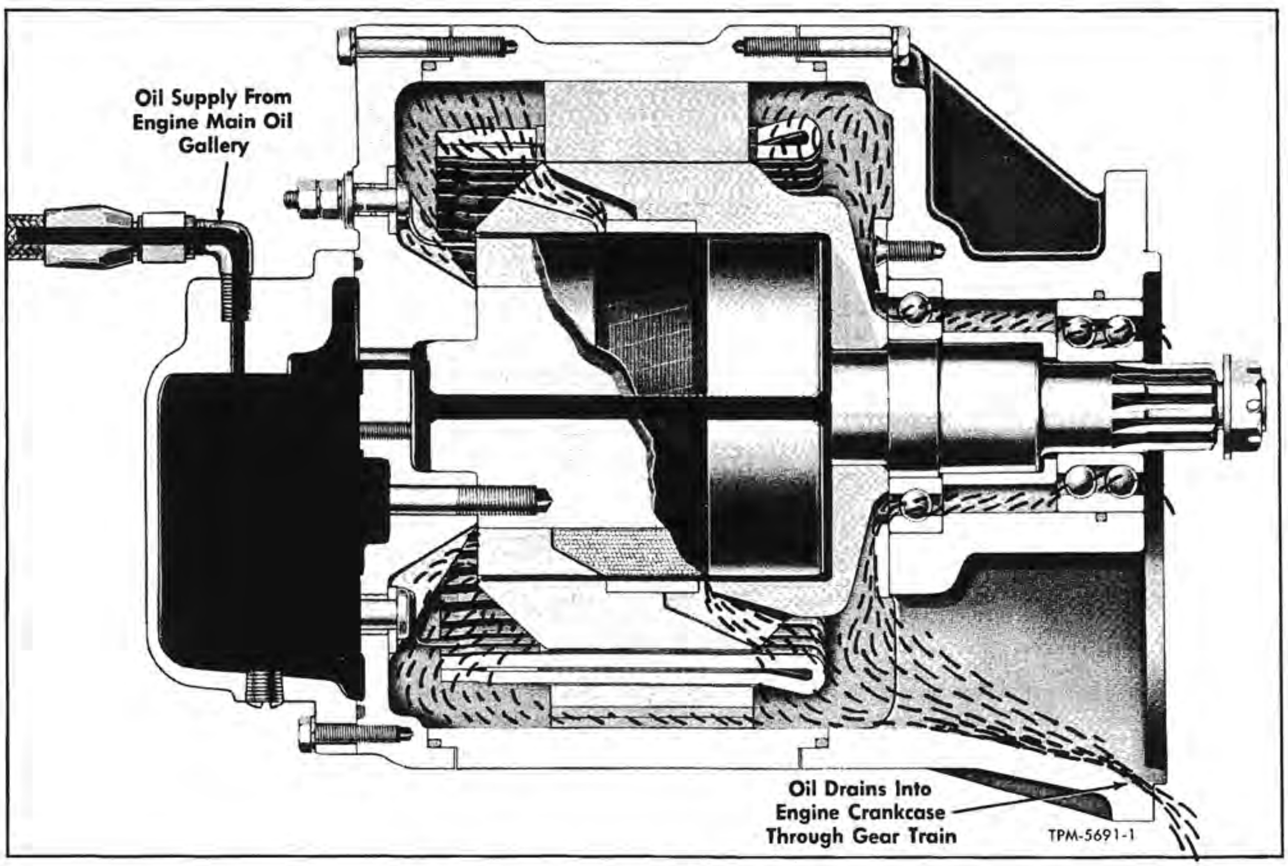


Figure 1—Oil Circulation Through Generator

GENERATOR

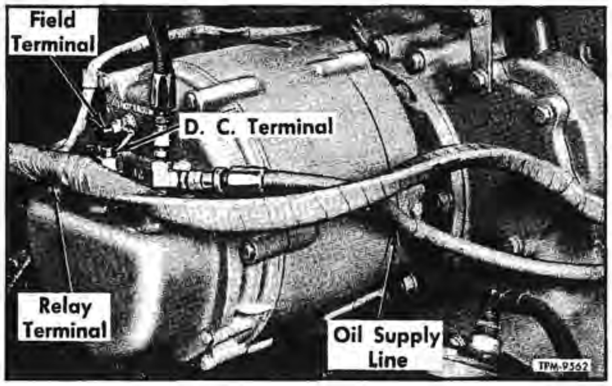


Figure 2—Oil-Cooled Generator Installed

atically illustrated in figure 3. Refer to "Engine Control and Generator Wiring Diagrams" in back of this manual for complete electrical circuit diagram.

The generator has inherent current regulation so that an external current regulator is not needed. The use of silicon diodes eliminates the need for a cut-out relay, since current cannot flow in reverse direction through the diodes.

PRECAUTIONS

1. Electrical system is NEGATIVE GROUND. Connecting the batteries with positive ground will result in severe damage to the generator, regulator, batteries, and battery cables.

2. The common trouble-shooting practice of momentarily grounding the generator field terminal to determine presence or absence of field power MUST BE AVOIDED. Grounding the generator field terminal will instantly overload and destroy the transistors within the regulator.

3. The generator output terminal is energized whenever the batteries are connected. If work is to be done near the generator, the batteries should be disconnected to prevent accidental grounding at the generator power output terminal.

MAINTENANCE

Because of the absence of brushes, commutator, and rubbing seals, the generator requires no periodic maintenance.

ON-VEHICLE CHECKS

Abnormal operation of the generating system is indicated by a tell-tale in the instrument panel in front of driver. Normally, the tell-tale will light up when "MASTER" switch is placed in either "DAY" or "NITE" position, and will remain on until engine is started and generator is charging. If tell-tale comes on during operation, or if it fails to light when "MASTER" switch is turned on, trouble in the generating system is indicated. The following quick checks will determine if the trouble is in the generator, or starter control and generator relay. If trouble is found not to be in one of these units, refer to "REGULATOR" section later in this group for further checks. Any unit which is found to be defective must be replaced. Internal

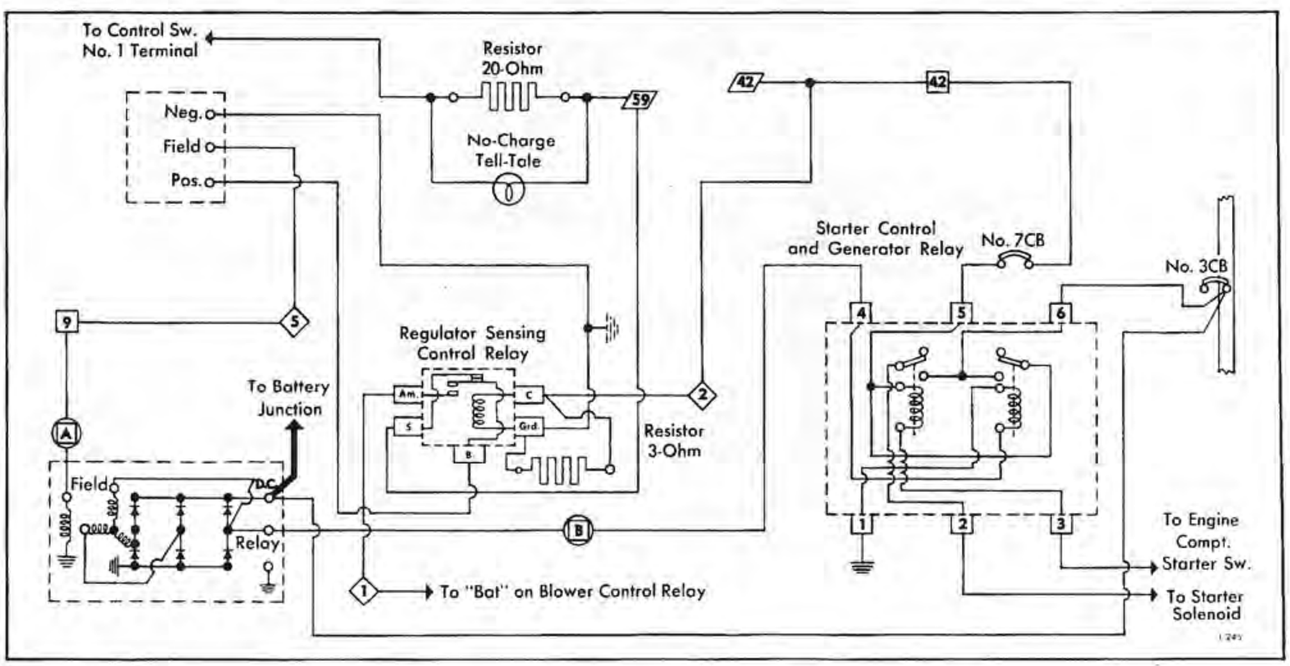


Figure 3—Generating System Schematic Wiring Diagram

checks of the generator components can be made as directed later under "Generator Repair."

PRELIMINARY CHECKS

First check the entire generating system for loose connections and broken wires. If generator no-charge tell-tale fails to light when "MASTER" switch is turned on (before engine is started), make sure tell-tale bulb is not burned out.

GENERATOR

Generator Output Check (Fig. 4)

1. Disconnect battery cable at battery.

2. Disconnect all leads from regulator and disconnect lead from generator field terminal.

CAUTION: Do not allow leads to touch ground.

3. Connect a voltmeter and ammeter in circuit as shown in figure 4.

4. Connect a jumper lead from generator "DC" terminal to generator field terminal as shown.

5. Connect a carbon pile load across battery as shown.

NOTE: Make sure carbon pile is turned off.

6. Reconnect battery cable at battery.

7. Start engine and operate at approximately 1500 rpm (3100 generator rpm).

8. Turn on all vehicle accessories and adjust carbon pile load until a 220 ampere current draw is shown on ammeter.

9. Check voltmeter; a minimum voltage reading of 13.7 volts should be obtained.

10. If generator fails to perform as explained in steps 8 and 9, generator is defective. Check component parts of generator as explained under "Troubleshooting."

Shorted Diodes

A shorted diode in the output side of the rectifying bridge of the generator will operate the starter control and generator relay. This will be evidenced by:

1. Starter will not operate.

2. The no-charge tell-tale lamp will not light when engine is not running and "MASTER" switch is in "DAY" position.

When the above conditions exist, check diodes and replace defective units as directed later under "Generator Repair."

STARTER CONTROL AND GENERATOR RELAY

This unit has a dual function - One relay energizes the starter solenoid; the other relay is powered from the relay terminal of the generator and closes when the generator is charging. The two relays are interconnected so that when the generator is charging the starter relay will not operate if the starter switch is closed.

1. Connect voltmeter leads to generator "Relay" terminal and to vehicle ground.

2. Start engine. A reading of 6 to 7 volts is normal and indicates proper feed to relay.

3. Connect voltmeter leads to No. 5 terminal of relay and to vehicle ground. Voltmeter should read battery voltage when generator is charging. No voltage indicates a defective relay.

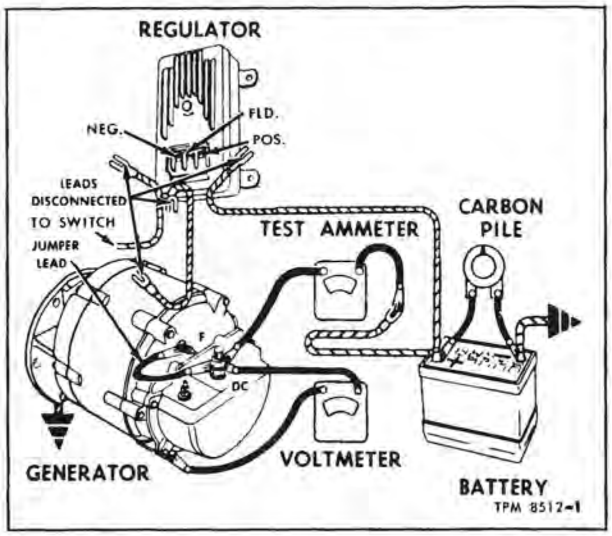


Figure 4—Checking Generator Output

GENERATOR REPLACEMENT

REMOVAL

Refer to figure 5.

1. Remove drain plug from bottom of diode end cover and drain oil into a container. Reinstall drain plug after draining.

2. Disconnect wires from "F" and "RELAY" terminals and disconnect battery cables from "DC" terminal on diode end cover. Tape ends of battery cables to prevent short circuit, and tag wires removed from other terminals for identification at time of installation.

3. Disconnect flexible oil supply line from elbow on diode end cover. Remove clip securing flexible oil line to bracket on generator drive end frame.

4. Remove nuts and lock washers from six mounting studs. Pull generator straight back off mounting studs to complete removal.

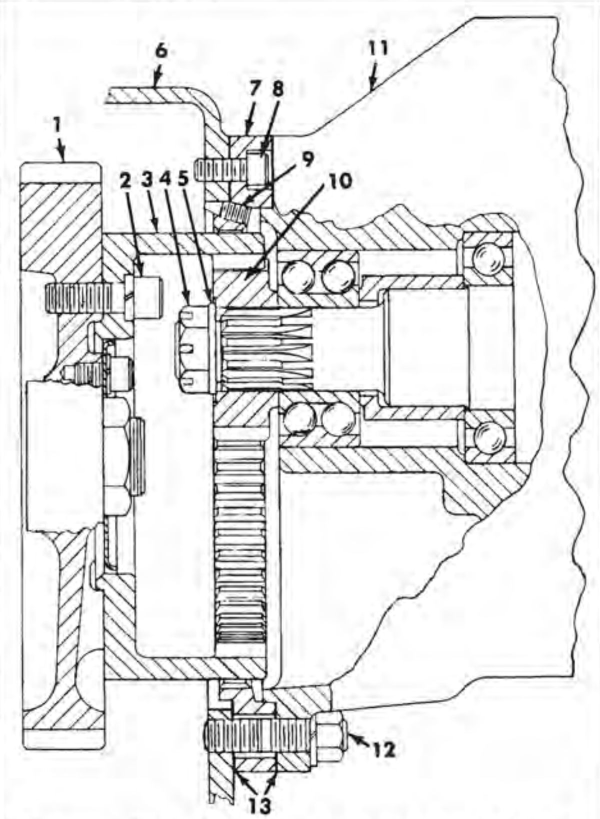
5. If a new or rebuilt generator is to be installed, remove driven gear for installation on replacement unit.

INSTALLATION

Key numbers in text refer to figure 5.

1. Before installing generator, inspect drive gear (3) for worn or damaged teeth. If wear or damage is evident, drive gear must be replaced as follows:

GENERATOR



1 Balance Shaft Gear	8 Socket-Head Screw
2 Socket-Head Screw	9 Socket Head Screw
3 Drive Gear	10 Driven Gear
4 Gear Retaining Nut	11 Generator End Frame
5 Flat Washer	12 Mounting Stud
6 Gear Train Cover	13 Gaskets
7 Spacer Ring	

TPM-5692

Figure 5—Generator Drive

a. Remove six socket-head set screws (2) and lock washers attaching internal-toothed drive gear (3) to engine balance shaft gear (1). Remove gear.

b. Position new drive gear (3) on balance shaft gear (1), with pilot on drive gear entering pilot bore in balance shaft gear. Install six socket-head set screws (2) with lock washers and tighten firmly.

c. Clamp a dial indicator to drive gear (3) in such a manner that indicator pin will contact the generator end frame pilot bore in the spacer ring (7). Turn engine over with starter while observing reading on dial indicator. Run-out of pilot bore with axis of shaft should not exceed 0.002" total indicator reading. If necessary, loosen two socket-head set screws (8) and adjust tapered set screws (9) to locate spacer ring within limits. After the proper concentricity is obtained, tighten spacer ring attaching set screws (8) to 8-12 inch-pounds torque.

2. Install drive gear (10) on generator rotor shaft and secure with flat washer (5) and nut (4). Tighten nut to 180 foot-pounds torque and secure with cotter pin.

3. Place gasket (13) over generator mounting studs. Position generator assembly on engine, with holes in end frame flange over mounting studs (12) and with teeth of driven gear engaging teeth in drive gear. Install lock washers and nuts on mounting studs and tighten firmly.

4. Connect flexible oil line to elbow on diode end cover. Secure oil line in clip on bracket attached to generator drive end frame.

IMPORTANT

Foreign material may clog the oil inlet orifice in the diode end cover. When replacing or connecting oil line, use extreme care to prevent foreign material getting into the oil line or fitting.

5. Connect wires to "F" and "RELAY" terminals and connect battery cables to "DC" terminal. Tighten terminal nuts firmly.

6. Make sure drain plug is installed and securely tightened in diode end cover.

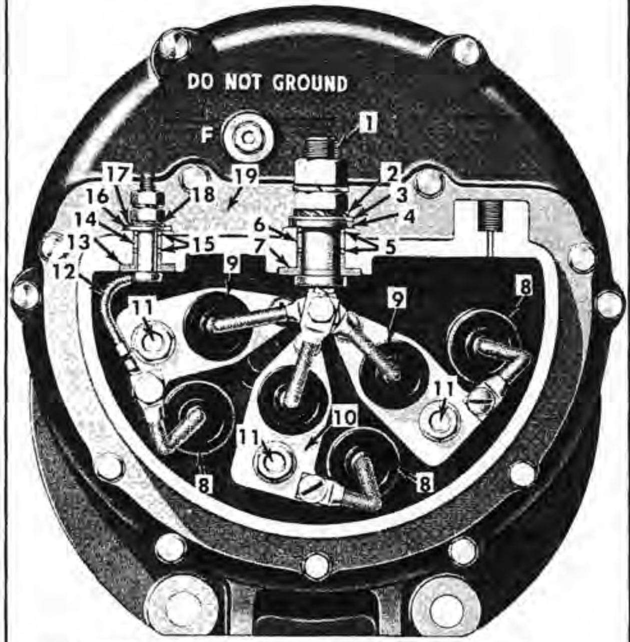
7. NOTE: When oil was drained from the diode end cover, this removed approximately one quart of oil from the engine oil supply. After running engine to fill the diode end cover, check engine oil level and replenish as necessary as directed in LUBRICATION (SEC. 13).

TROUBLESHOOTING

GENERAL

It is not necessary to completely disassemble the generator to make electrical checks. All electrical checks are made at the diode end of the assembly without disassembling the rotor, drive end frame, and bearing. If electrical components are not defective, but bearing replacement is necessary, this is accomplished at the drive end without disassembling the diode end of the unit as explained under "Generator Repair."

These procedures are based on the assumption that "On-Vehicle Checks" have indicated that the generator is malfunctioning and that the generator has been removed from the engine as previously directed under "Generator Replacement."



1 Output Terminal Stud	11 Stator Terminal Studs
2 Toothed Lock Washer	12 Relay Terminal Stud & Lead Assy.
3 Flat Washer	13 Insulating Bushing
4 Insulating Washer	14 Insulating Sleeve
5 O-rings	15 O-rings
6 Insulating Sleeve	16 Insulating Washer
7 Insulating Bushing	17 Flat Washer
8 Diode (in end frame)	18 Toothed Lock Washer
9 Diode & Support Assy. (R.H. & L.H.)	19 Diode End Cover
10 Diode & Support Assy. (Center)	

TPM 9396

Figure 6—Cutaway View Through Diode End Cover

DIODE END COVER REMOVAL

In order to remove the diode end cover, it is necessary to remove the output terminal stud and relay terminal stud attaching nuts so the studs can be withdrawn from the end cover as the cover is removed from the diode end frame.

1. Remove all nuts, lock washers, flat washers, and insulating washers from the output and relay terminal studs (fig. 6). Tap studs lightly to loosen, then push studs down into diode end cover.

2. Remove seven cap screws and lock washers attaching diode end cover to end frame. Remove end cover from end frame, at the same time completing removal of terminal studs from end cover. Remove O-ring seal from end frame, and remove terminal stud insulating sleeves, O-rings, and insulating bushings from end cover.

3. Disconnect all diode flexible leads, three from output terminal stud and three from diode supports (fig. 7).

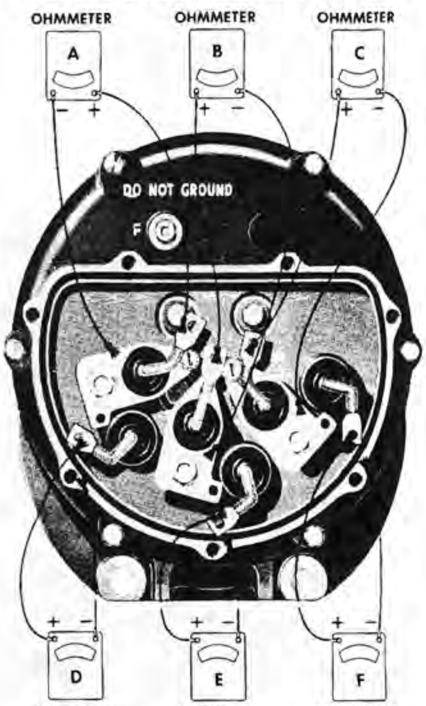


Figure 7—Checking Diodes For Shorts

DIODE CHECKS

NOTE: When checking diodes for shorts and opens, use an ohmmeter with a 1-1/2 volt cell. Select a scale on which the 300 ohm value lies within the middle third of the scale.

CHECKING DIODES FOR SHORTS

If a reading of 300 ohms or less is obtained in either of the checks below, most likely the diode being tested is defective. Diode should be replaced as explained under "Generator Repair" later in this section.

Diodes Mounted in Supports

To check diodes mounted in supports, connect the positive lead of ohmmeter to each diode lead and the negative lead to each support as shown in parts A, B, and C of figure 7. If reading of 300 ohms or less is obtained, replace diode.

Diodes Mounted in End Frame

To check diodes mounted in end frame, connect the positive lead of ohmmeter to each diode lead and negative lead to end frame as shown in parts D, E, and F of figure 7. If a reading of 300 ohms or less is obtained, replace diode.

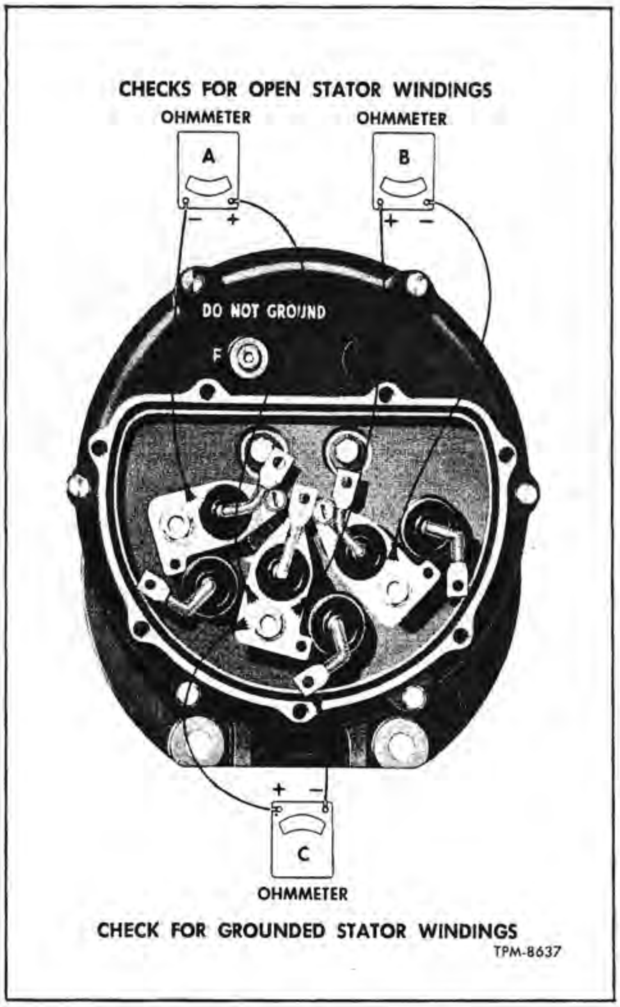


Figure 8—Checking Stator Windings

CHECKING DIODES FOR OPENS

To check diodes for opens, reverse leads of ohmmeter and accomplish procedures given under "Diodes Mounted in Supports" and "Diodes Mounted in End Frame." An infinite resistance reading indicates an open diode.

FIELD WINDING CHECKS

The preferred method for checking generator field windings for opens, grounds, and shorts is to check the amperage draw of the field windings:

Make check as follows:

1. Disconnect diode leads.
2. Connect an ammeter with a 12 volt battery in series with the generator field ("F") terminal and ground (on diode end frame).
3. Generator field should pass 7.8 to 8.6 amperes with 12 volts applied.
4. Amperage readings other than the above indicate an open, grounded, or shorted field winding.

STATOR WINDING CHECKS

OPENS

To check stator windings for open, connect ohmmeter leads to two pairs of diode supports as shown in parts A and B of figure 8. The ohmmeter should show a low resistance. If an infinite or high resistance is obtained in either one or both of the checks, the stator windings are open.

GROUNDS

To check stator windings for grounds, connect an ohmmeter to diode support and diode end frame as shown in part C of figure 8. The ohmmeter should show an infinite or very high resistance. If a zero or very low resistance reading is obtained, the windings are grounded.

SHORTS

The stator windings are difficult to check for shorts without laboratory test equipment due to the very low resistance of the windings. However, if all other generator checks are satisfactory, yet the generator fails to perform according to specifications, shorted stator windings are indicated.

GENERATOR REPAIR

REPLACEMENT OF ELECTRICAL COMPONENTS

NOTE: The replacement procedures which follow are based on the assumption that the diode end cover is still removed and diode leads disconnected as required during the preceding tests.

DIODE REPLACEMENT

IMPORTANT: When replacing a diode, make sure it is designed for a negative ground system. Diode can be identified by the symbol stamped on diode case. The arrow must point toward the diode flexible lead.

The three diodes which are mounted in sup-

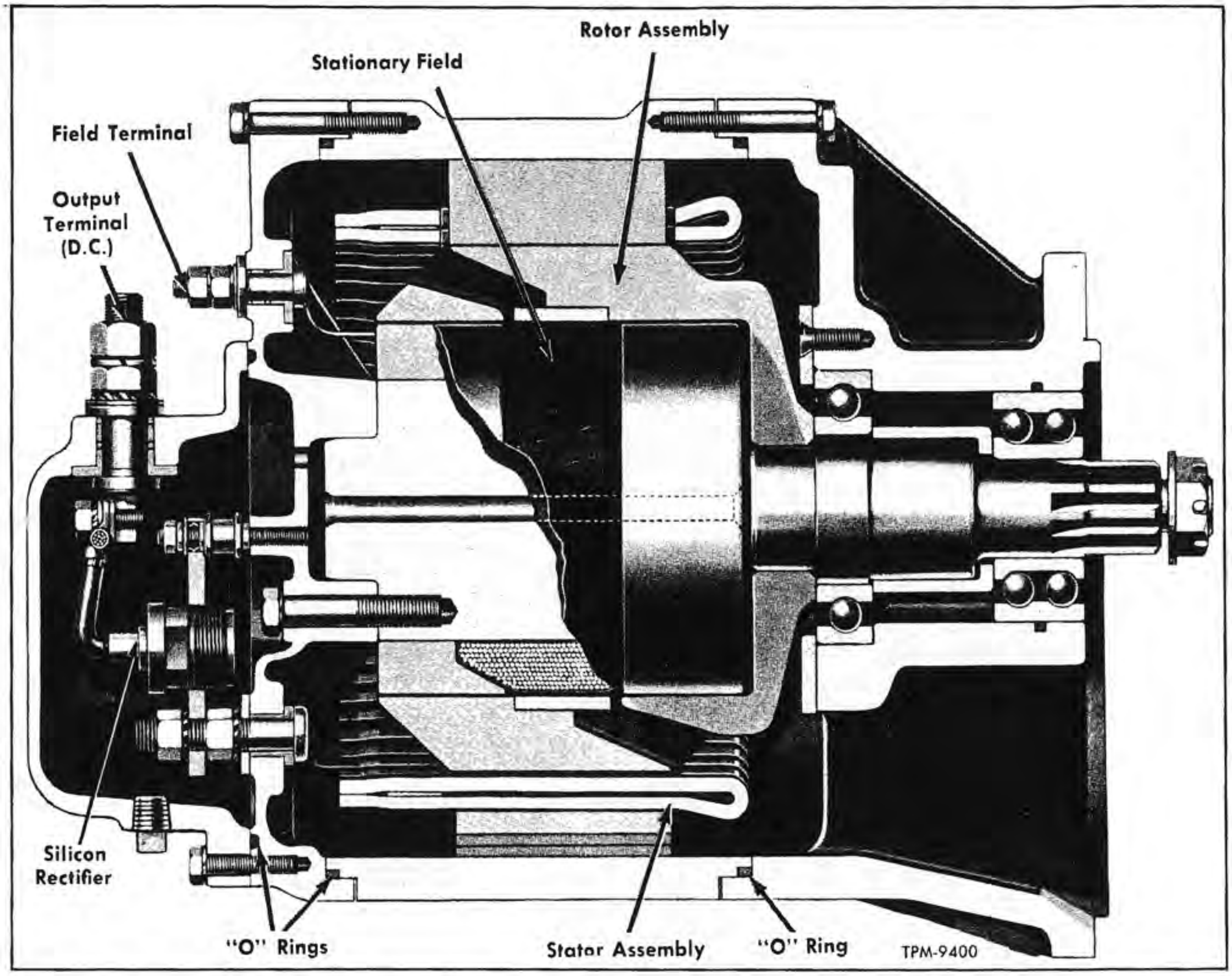


Figure 9—Oil-Cooled Generator Assembly

ports attached to stator lead studs (fig. 6) are serviced only as diode and support assemblies. The two outer diode and support assemblies are identical and can be installed at either side; the center unit has a different support, with 2 inches between mounting hole centers (outer supports have 2-1/4 inch hole centers).

Diode and Support Replacement

Refer to figures 6 and 9 for assembled views.

1. Remove nut w/lock washer attaching diode support to stator lead stud.

2. Remove nut, lock washer, and flat washer attaching support to end frame.

3. Remove diode and support assembly, then remove insert from small hole in support or from small stud in end frame. Also remove insulating sleeve from diode flexible lead.

4. Install insulating sleeve over flexible lead of new diode and support assembly.

5. Place diode and support assembly over stator lead stud and small mounting stud. Place insert over small stud inside the hole in support. Install flat washer, lock washer, and nut on small stud and tighten to 22-25 inch-pounds torque. Install nut w/lock washer on stator lead stud and tighten firmly.

Diode (In End Frame) Replacement

Refer to figures 6 and 9 for assembled views.

The three diodes which are threaded into the end frame are identical. To remove diode, use a thin 1-inch open end wrench on flats of diode case to unscrew diode from end frame. Coat threads of new diode with silicone grease, thread into end frame and tighten to 15-18 foot-pounds torque.

If no other parts are to be replaced, refer to "Diode End Cover Installation" later to complete the assembly.

FIELD REPLACEMENT

Refer to figure 9 for assembled view.

Removal

1. Remove three diode and support assemblies from end frame to provide access to the two lower field to end frame bolts.

2. Remove nut w/lock washer and flat washer from three stator lead studs.

3. Remove six bolts and lock washers attaching diode end frame to stator frame.

4. Separate end frame from stator frame and withdraw end frame and field assembly from rotor, at the same time pushing stator lead studs out of end frame.

5. Remove nut, lock washer, flat washer, and insulating washer securing field lead terminal stud in end frame. Push stud out of end frame.

6. Remove four bolts and lock washers attaching field to end frame.

7. To separate field from end frame, install four 3/8-24 x 3" bolts in place of the 3/8-24 x 2" attaching bolts removed in step 6. Thread bolts in to equal heights. Support end frame in arbor press, and using a suitable press plate to exert force on all four bolt heads, press field out of end frame.

Installation

1. Position field assembly at end frame, insert four 3/8-24 x 3" bolts through end frame, and thread into field to keep holes aligned.

2. Support end frame on arbor press bed in such a manner that the diodes will not be damaged and press field into end frame. Press in until shoulder on field core bottoms against end frame.

3. Remove the four guide bolts. Install four 3/8-24 x 2" bolts, using new lock washers, attaching field to end frame and tighten securely.

4. Place insulating bushing in inner side of field terminal stud hole in end frame and insert stud through bushing. Place an O-ring, insulating sleeve, and another O-ring over field terminal stud and push these parts into end frame. Install insulating washer, flat washer, toothed lock washer, and nut on terminal stud and tighten firmly.

5. Install each of three stator lead studs in end frame as follows: Place insulating washer over stud and insert stud through end frame. Place insulating bushing over stud and position in hole in end frame. Install flat washer and nut w/lock washer on stud and tighten firmly.

6. Install three diode and support assemblies on end frame as previously directed under "Diode Replacement."

7. Install new O-ring seal in notch around end of stator frame. Insert field into rotor and position end frame against stator frame. Attach end frame to stator frame with six bolts and lock washers. Tighten bolts firmly.

8. If no other parts require replacement, refer to "Diode End Cover Installation" later to complete the assembly.

STATOR REPLACEMENT

Refer to figure 9 for assembled view.

If tests indicated an open circuit or short in the stator, the stator and frame assembly must be replaced.

Removal

1. Remove diode end frame and field assembly as previously directed in steps 1 thru 4 under "Removal" in "Field Replacement" procedure.

2. Remove six bolts and lock washers attaching stator frame to drive end frame.

3. Separate stator frame from drive end frame and remove from end frame and rotor.

Installation

1. Position new O-ring seal (5) in notch around drive end of stator frame.

2. Position stator and frame assembly over rotor against drive end frame. Attach stator frame to drive end frame with six bolts and lock washers. Tighten bolts firmly.

3. Install diode end frame and field assembly as directed in steps 5, 6, and 7 under "Installation" in "Field Replacement" procedure.

4. Install rectifier end cover as directed later.

DIODE END COVER INSTALLATION

Refer to Figures 6 and 9 for assembled views.

1. Make sure all diodes are properly installed and securely tightened. Leads from diodes threaded into end frame must be securely attached to diode supports. Relay terminal lead must also be attached to left diode support as shown in figure 6.

2. Connect leads from three diodes mounted in supports to output terminal stud as shown in figure 6. Tighten attaching screw firmly. Place insulating bushing over output terminal stud and place insulating bushing over relay terminal stud.

3. Place new O-ring seal in groove in diode end frame.

4. As diode cover is positioned at end frame, the output terminal stud and relay terminal stud must be inserted through holes in top of end cover. Wrapping soft wire around stud threads and inserting wires through the holes will facilitate pulling studs through holes. Make sure insulating bushings are on terminal studs.

5. With end cover in place against end frame, install seven attaching cap screws and lock washers. Tighten cap screws to 5 - 5.4 ft.-lbs. torque.

6. Referring to figure 6, install insulating sleeves and O-rings over output terminal stud and relay terminal stud, and push these parts down into

cover. Make sure insulating bushings are in place in counterbores on underside of cover. Secure each terminal stud in place with insulating washer, flat washer, toothed lock washer, and nut. Tighten nuts firmly.

7. Make sure drain plug is installed and securely tightened in bottom of end cover. Plug oil inlet opening in top of cover to keep out dirt until generator is installed.

BEARING OR ROTOR REPLACEMENT

Whenever rotor and drive end frame are disassembled for any reason, the single row ball bearing must be replaced with a new one due to the probability of its being damaged during disassembly.

REMOVAL AND DISASSEMBLY

Refer to figure 9 for assembled view.

1. If driven gear was not removed from rotor shaft at time of generator removal, remove nut and flat washer from shaft and pull gear off shaft.

2. Remove six bolts and lock washers attaching drive end frame to stator frame. Separate drive end frame from stator frame and remove drive end frame and rotor assembly.

3. Support drive end frame in arbor press in such a manner that the rotor can be pressed down out of end frame. Using a suitable adapter against end of rotor shaft which will pass through the inner race of the double-row ball bearing, press rotor down out of end frame and bearings. (Since the single-row bearing outer race is retained in the end frame by the retainer plate, and the inner race is a press fit on the rotor shaft, the bearing is likely to be damaged when the shaft is pressed out and must be replaced with a new part.)

4. Remove six screws attaching bearing retainer plate to drive end frame. Remove retainer plate, single-row bearing, and bearing spacer from end frame.

5. Support drive end frame in arbor press, with double-row bearing down, in such a manner that the bearing can be pressed down out of end frame. Using a suitable driver which will exert force on the bearing outer race, press bearing out of end frame.

6. Remove rubber bearing clamp from groove in end frame.

ASSEMBLY AND INSTALLATION

Refer to figure 9 for assembled view.

1. Install new single-row ball bearing into inner side of drive end frame. Install bearing retainer plate and attach with six screws. Stake screws in place after tightening.

2. Position rubber bearing clamp in groove in bearing bore in drive end frame. Lubricate clamp to permit bearing to be pressed in without dislodging or damaging the clamp.

3. Position rotor in arbor press with shaft end up. Install drive end frame and single-row bearing assembly over rotor shaft. Using a driver over rotor shaft which will exert force on the bearing inner race, press bearing onto shaft until it bottoms against the rotor.

4. Install bearing spacer over rotor shaft. Position double-row bearing over rotor shaft at end frame bore. Using an adapter which will exert force on both the inner and outer races of the bearing, press bearing onto shaft and into end frame until inner race bottoms against bearing spacer.

5. Place new O-ring seal in notch around drive end of stator frame.

6. Insert the rotor between the stator and field, and position drive end frame against stator frame. Attach end frame to stator frame with six bolts and lock washers. Tighten bolts to 5 - 5.4 ft.-lbs. torque.

GENERATOR SPECIFICATIONS

Make	Delco-Remy
Model Number	1117670
Rotation	Either
Field Current @ 80° F.	
Amperes	7.8-8.6
Volts	12
Hot Output	
Amperes	235
Volts	14
Approximate rpm	3100
Generator Drive Ratio	2.29 to 1

Regulator

GENERAL

The transistor regulator used on all vehicles covered by this manual is an assembly composed principally of diodes, condensers, resistors, and transistors. These components are mounted on a printed circuit panel board to form a completely static unit containing no moving parts. Regulator terminal connections are marked "NEG," "FLD," and "POS."

The regulator components work together to limit the generator voltage to a pre-set value by controlling the generator field current. This is the only function the regulator performs in the charging circuit.

The voltage at which the generator operates is determined by the regulator adjustment. Once adjusted, the regulator voltage remains constant, since the regulator is unaffected by length of service, changes in temperature, or changes in generator output and speed.

The primary controlling device for the regulator is the Zener diode (D2). The Zener diode is used as a reference source to sense increasing voltage and to turn on the driver transistor (TR2) which in turn shuts off the power transistors (TR1).

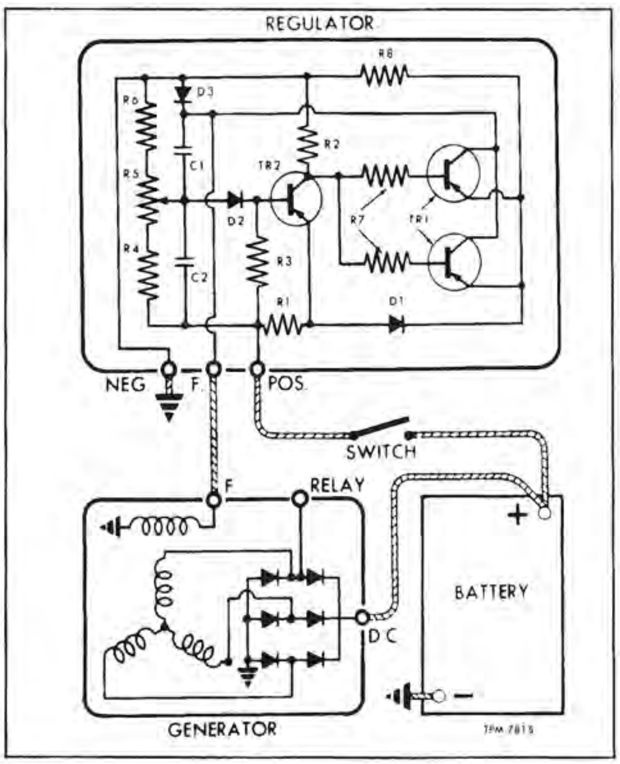
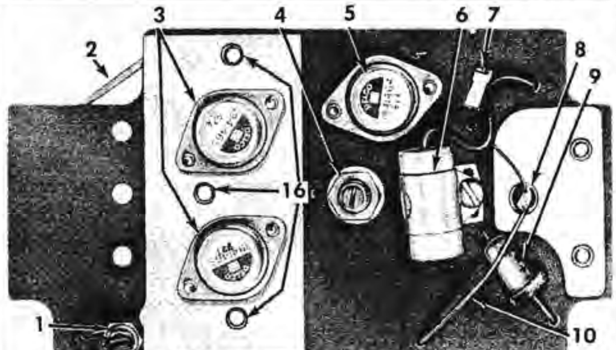


Figure 1—Regulator Circuitry Diagram

With power transistors (TR1) shut off, field current drops until system voltage drops sufficiently to cause the Zener diode (D2) to again allow full field application by the transistors. This action occurs at a varying frequency, depending on generator speed and load.

CAUTION: When performing maintenance on generator or regulator, NEVER ALLOW REGULATOR LEADS TO BECOME GROUNDED.

Figure 1 shows regulator circuitry with each major component identified. Figure 2 shows corresponding items in actual location on panel board in respect to circuitry diagram (fig. 1).



1 Field Discharge Diode (D3)
2 Wire Wound Resistor (R2)
3 Power(Output) Transistors (TR1)
4 Potentiometer (R5)
5 Driver Transistor (TR2)
6 Feed-Back Condenser (C1)
7 Zener Diode (D2)
8 Back-Bias Diode (D1)
9 Filter Condenser (C2)
10 Feed Back Resistor (R1)
11 Wire Wound Resistor (R4)
12 Wire Wound Resistor (R3)
13 Wire Wound Resistor (R8)
14 Wire Wound Resistor (R7)
15 Wire Wound Resistor (R6)
16 Insulators

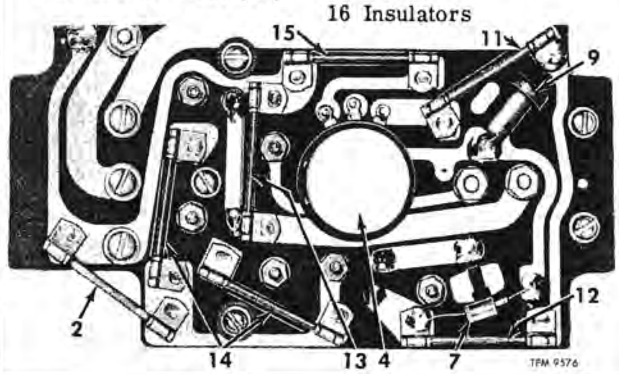


Figure 2—Regulator Components

Regulator is mounted on regulator and blower control panel as shown in figure 6 in "WIRING AND MISCELLANEOUS ELECTRICAL" section. Accessibility to regulator is also described in the same section.

ON VEHICLE ADJUSTMENT

Trouble in the electrical system will usually be indicated by one of two conditions - an undercharged or an overcharged battery. Either condition can result from an improper regulator setting.

The ideal voltage setting is the one which will maintain the batteries in a fully charged condition with a minimum use of water. This setting must be determined by the operator according to the particular type of service under which the coach operates. Check and adjust voltage regulator setting as follows: (See fig. 3 for voltmeter connections.)

1. Connect a voltmeter from regulator "POS" terminal to ground.
2. Start engine and operate at approximately 1000 rpm (about 2300 generator rpm).
3. Turn on vehicle blower motors.
4. Observe voltmeter; a steady reading of 13.7 volts should appear. If this reading is not present, remove plug from regulator and adjust potentiometer (fig. 4) until reading is obtained.

NOTE: In some cases, when maximum special electrical equipment is used and an undercharged battery condition results over a period of time, it may be necessary to adjust regulator to 14 volts. If this is the case, operate vehicle a minimum service period of 48 hours and check for an improved battery condition. The same procedure applies for an overcharged battery, except adjust voltage to 13.4 volts.

5. If voltage cannot be adjusted by turning potentiometer, and it is evident that trouble exists in generating system, check generator as directed in "GENERATOR" section of this manual. If generator is found to be satisfactory, check regulator as directed under "Troubleshooting" below.

TROUBLESHOOTING

Various electrical checks can be made to locate defective components. Components to be checked are identified in figure 2.

The ohmmeter used in the following checks must be accurate, and must be one which uses a 1-1/2 volt dry cell. The milliammeter and voltmeter used in figure 5 are as follows: Milliammeter - use the milliammeter ranges of a Simpson Model 260 Multimeter, or any reliable 0-100 milliampere D.C. meter; voltmeter - use the voltmeter range of a Simpson Model 260 Multimeter, or any 0-15 voltmeter with 10,000 ohms/volt or higher movement. The spare potentiometer used in figure 5 is a 30-ohm, 10-watt unit (part number 1941477).

When making checks, note carefully in the illustrations how the ohmmeter is connected with regards to polarity, and select a scale applicable to check being made.

POLARITY OF OHMMETER MUST BE DETERMINED BEFORE FOLLOWING CHECKS ARE MADE.

To determine polarity of ohmmeter, connect one lead to a known positive (+) lead of a voltmeter and other lead to negative (-) lead of voltmeter. If voltmeter reads up-scale, ohmmeter positive (+) lead is connected to voltmeter positive (+) lead and ohmmeter negative (-) lead is connected to voltmeter negative (-) lead.

It is important that the following checks be made in the order listed. If a defective part is found, replace it before proceeding with the remaining checks. Be sure to make all the checks as

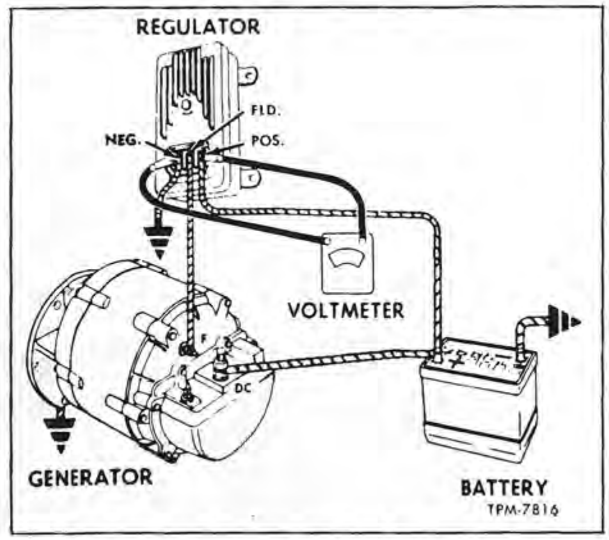


Figure 3—Checking Regulator Voltage Setting

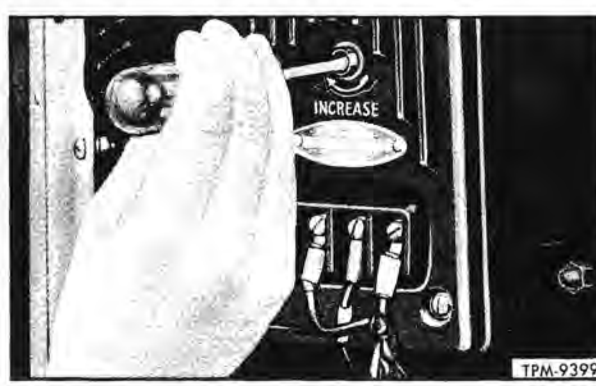


Figure 4—Adjusting Voltage Regulator

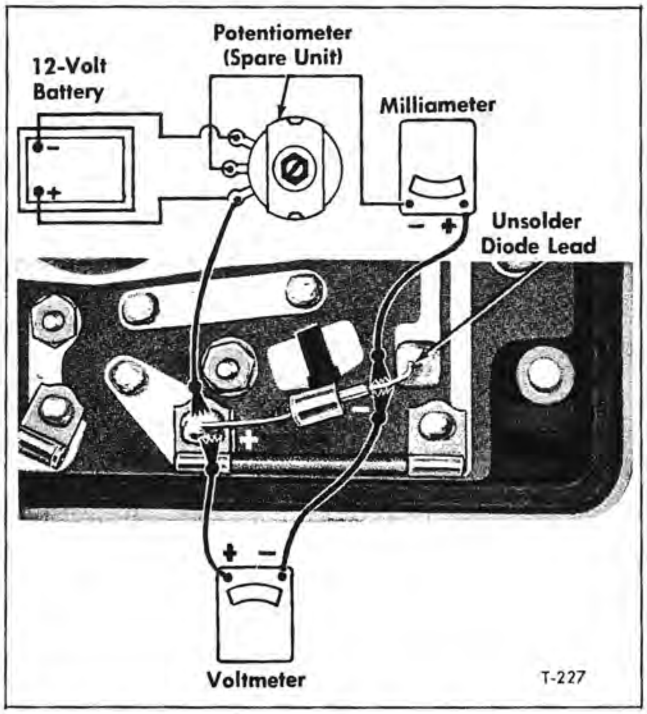


Figure 5—Meter Connections For Checking Zener Diode

more than one component may be defective.

A defective part may be replaced by removing any attaching screws involved and/or unsoldering the connections. To replace the parts identified in figure 2, separate the printed circuit board from the cover by removing eight attaching screws. When resoldering, limit solder time to a minimum, as excessive heat may damage the printed circuit and component parts. However, good soldered connections are essential for satisfactory operation. Any good grade of radio-type rosin core solder is recommended. Use soldering iron having sufficient heating capacity to solder or unsolder connection quickly.

ZENER DIODE

To check the Zener diode (7, fig. 2), unsolder the diode lead and lift up just enough to separate from the printed circuit; bending lead too far may cause it to break off inside the diode. Connect instruments as shown in figure 5, then check as follows: Do not attempt to use potentiometer in regulator. Use spare unit.

1. Start with potentiometer at extreme clockwise position.

2. With ammeter set at appropriate scale, rotate potentiometer until milliammeter reads 2

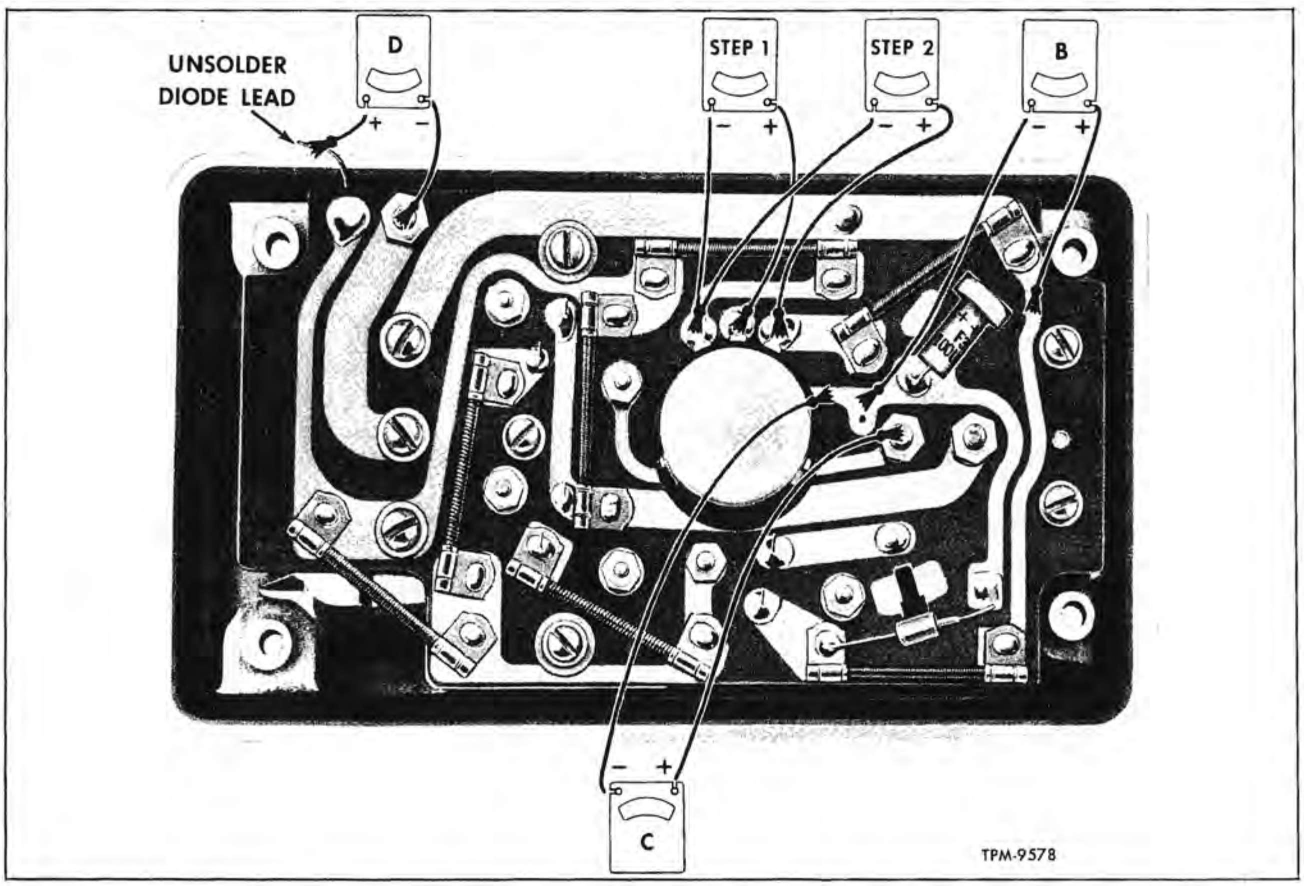


Figure 6—Regulator Component Checks

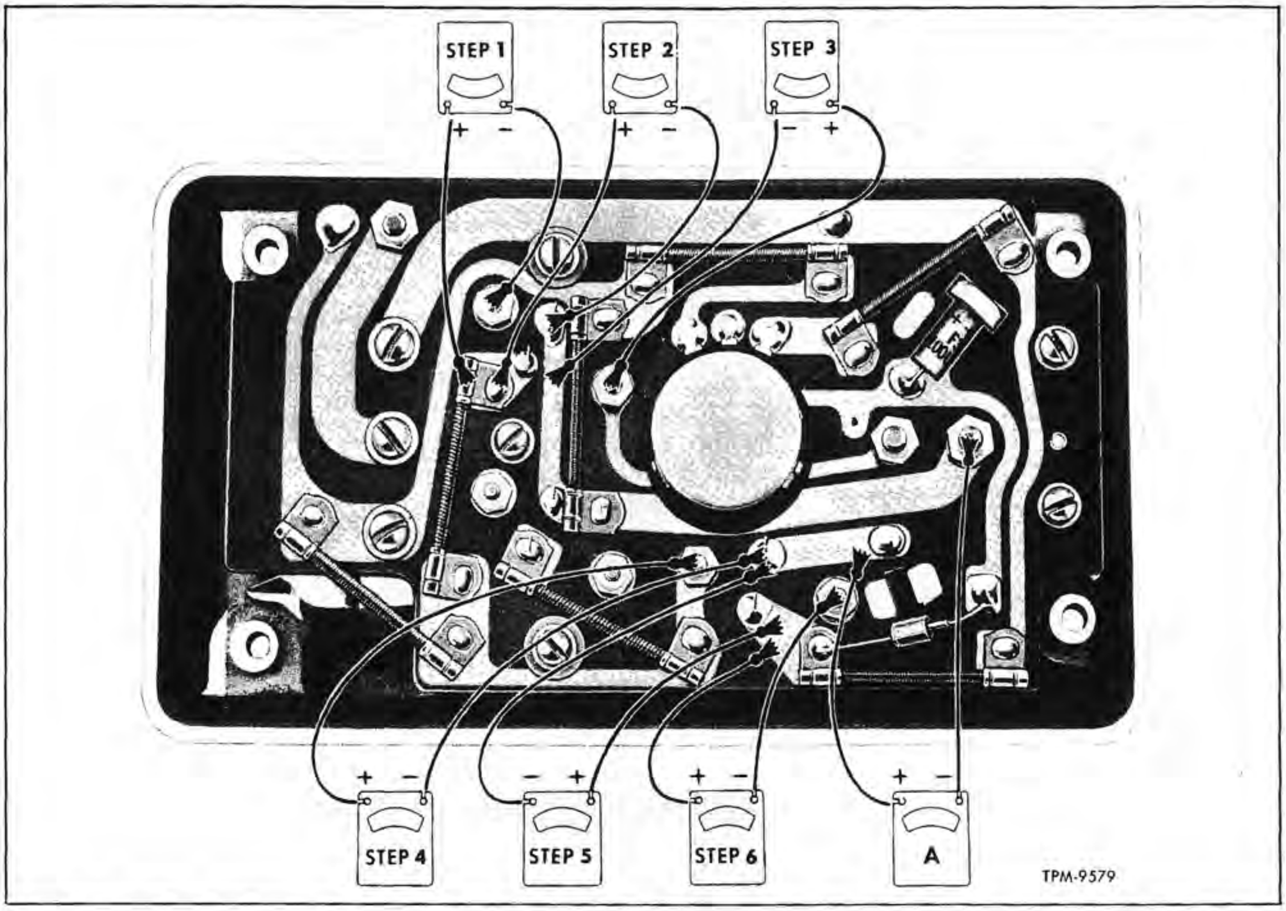


Figure 7—Regulator Component Checks

milliamperes. Read voltmeter - limits are 7.4 volts minimum, 10.0 volts maximum.

3. Rotate potentiometer until milliammeter reads 50 milliamperes. Voltmeter reading must not increase more than 0.5 volt above reading in step 2.

POTENTIOMETER

To check the potentiometer (4, fig. 2), connect ohmmeter leads as shown in Steps 1 and 2 of figure 6. If either reading is 100 ohms or above, potentiometer is open.

FILTER CONDENSER

To check the filter condenser (9, fig. 2), connect ohmmeter leads as shown in Part "B" of figure 6. A zero ohm reading indicates a shorted filter condenser. To check for opens, inspect the two soldered connections for breaks.

FEED-BACK CONDENSER

To check the feed-back condenser (10, fig. 2), connect ohmmeter leads as shown in Part "C" of figure 6. If a zero ohm reading is obtained, condenser is shorted. To check for opens, inspect the soldered connection.

FIELD DISCHARGE DIODE

To check the field discharge diode (1, fig. 2), unsolder lead and connect ohmmeter leads as shown in Part "D" of figure 6. If a zero ohm reading is obtained, diode is shorted. If a very high (infinite) reading is obtained, diode is open.

NOTE: Before proceeding with other check, resolder diode lead.

BACK BIAS DIODE

To check the back bias diode (8, fig. 2), connect ohmmeter leads as shown in Part "A" of figure 7. A zero ohm reading indicates a shorted diode, and a reading over 100 ohms indicates an open diode.

POWER TRANSISTORS

Shorted Transistor

Check the power transistors (3, fig. 2), by connecting the ohmmeter the three ways shown in Steps 1, 2, and 3 of figure 7. If any reading is zero ohms, one of the power transistors is shorted. To determine which power transistor is shorted, or if both transistors are shorted, remove the upper transistor (3, fig. 2) and repeat the check as

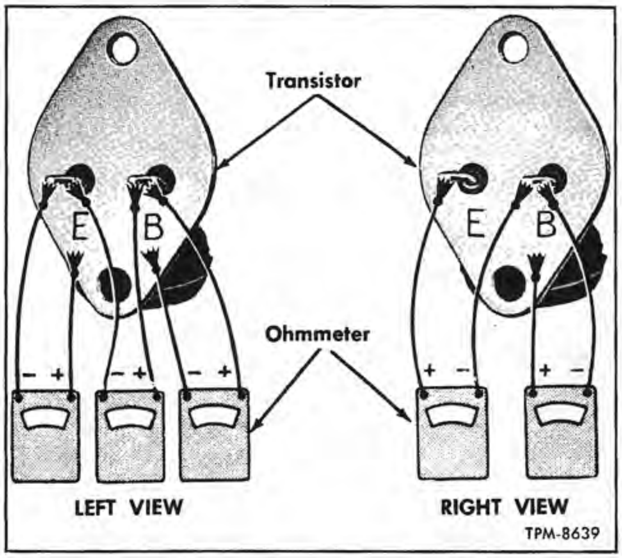


Figure 8—Checking Transistors Removed From Panel Board

shown in figure 7 on the transistor which is still mounted on the printed circuit board. If any of the three readings is zero, the transistor is shorted. Also check the transistor which has been removed by connecting the ohmmeter the three ways shown in left view of figure 8. A zero reading in any one of the three checks indicates a shorted transistor.

Open Transistor

Check power transistors for opens by removing transistor from panel board and connecting ohmmeter to each transistor as shown in right view of figure 8. A very high (infinite) reading in either check indicates an open transistor.

DRIVER TRANSISTOR

Shorted Transistor

Check the driver transistor (5, fig. 2) by connecting ohmmeter as shown in steps 4, 5, and 6 of figure 7. The transistor being checked is shorted if a zero ohm reading is obtained.

Open Transistor

Check the driver transistors for opens as explained under "Power Transistors."

REGULATOR SPECIFICATIONS

Make	Delco-Remy
Type	Transistorized
Model Number	9000551
Polarity	Negative Ground
Quantity of Transistors	
Power (output)	2
Driver	1
Voltage Setting	13.7 (see text)

Lighting System

All interior and exterior lights and their controlling switches, relays, and circuit breakers except tell-tale lights, stop and directional lights, and other miscellaneous lights are shown on "Lighting System Wiring Diagrams" in back of manual.

IMPORTANT: All lights should be checked daily and necessary replacements made. Bulb sizes are listed in "Specifications" at end of this section.

SWITCHES AND CIRCUIT BREAKERS

All interior and exterior lights required for normal operation of the vehicle are controlled by the "MASTER" switch on control panel at left of driver. Light circuits which are energized when "MASTER" switch is in "DAY," "NITE," or "PARK" position are listed below under "Master Switch." The destination sign standby lights and dome lights are controlled by secondary switches, interconnected into the master switch circuits; these switches are located on recessed switch panel at left of driver. Engine compartment lights are controlled by a switch on the engine compartment control panel.

All lighting circuits are protected by automatic reset type circuit breakers. Location and rating of all circuit breakers are covered in "WIRING AND MISCELLANEOUS ELECTRICAL" section at beginning of this group.

"MASTER" SWITCH

Master switch circuit positions are marked "OFF," "DAY," "NITE," and "PARK." Selected circuits become energized when circuit caption on switch is rotated into alignment with position indicator button on control panel. Only the lighting circuits controlled by the various switch positions are listed below. Refer to "Master Switch Operation" in "WIRING AND MISCELLANEOUS ELECTRICAL" for listing of all circuits controlled by the master switch.

"DAY" POSITION

1. Directional Light Controls
2. Tell-tale Light Circuits

"NITE" POSITION

1. Directional Light Controls
2. Tell-tale Light Circuits
3. Marker Lights
4. License Plate Light
5. Rear Step Lights (Transit)
6. Entrance Door Step Lights (Operated by Door Switch)
7. Fluorescent Dome and Destination Sign Lights (Transit)
8. Headlights
9. Taillights
10. Destination Sign (Suburban)
11. Dome Lights (Suburban)
12. Reading Lights (Suburban)

"PARK" POSITION

1. Marker Lights
2. Taillights
3. License Plate Light
4. Front Step Lights
5. Rear Step Lights (Transit)
6. Destination Sign Standby Lights (Transit) (Operated by Stand-by Sign Switch)
7. Dome Lights (Suburban)
8. Reading Lights (Suburban)
9. Destination Sign (Suburban)

EXTERIOR LIGHTING EQUIPMENT

HEADLIGHTS

Each headlight consists of two 5-3/4-inch Type T-3 sealed-beam lamp units. Outer lights are double-filament units, having upper and lower beams. Inner lights are single-filament units, and are used only in conjunction with the upper beam of the outer units. The inner units are identified as Type 1 and have the numeral "1" molded in top of lens; the outer units are type 2, with the numeral "2" molded in top of lens.

Type T-3 sealed-beam unit lens incorporate three projecting guide points which are optically ground to provide flat surfaces at right-angles to the light beam (fig. 1). This design permits adjustment of the light beams in daylight without the use of an aiming screen and without requiring a large work area. Aiming is accomplished with a "T-3 Safety Aimer, Type B" (J-6663). Instructions for using the T-3 aimers are supplied by the instrument manufacturer. Headlights can also be adjusted without the use of the mechanical aimer as follows:

AIMING PROCEDURE

<u>Inner (High-Beam) Lights (Fig. 2)</u>

1. Position vehicle on level floor with headlights 25 feet from a smooth vertical surface. Surface should be provided with paper or a panel

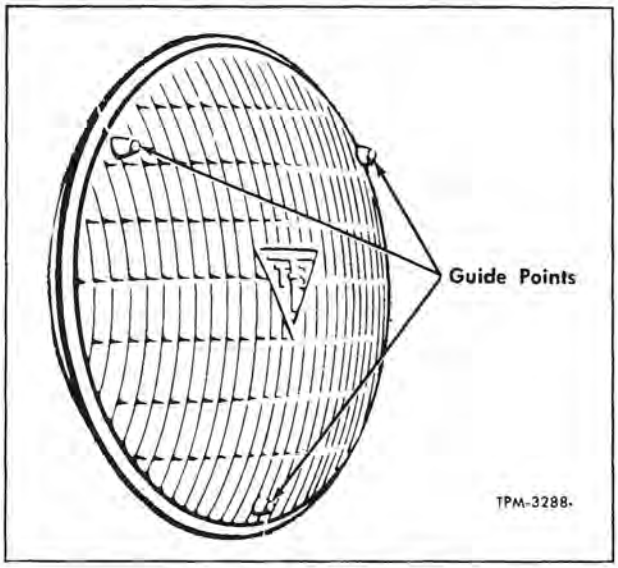


Figure 1—T-3 Headlight Lens

which can be removed to permit drawing two sets of aiming lines. Centerline of vehicle must be at right-angle to the vertical surface.

2. Measure height of headlight centers from floor and mark this height on vertical surface. Draw a horizontal line A-A on vertical surface at this height. Draw a second horizontal line B-B parallel with and 2 inches below line A-A.

3. Locate point at which projected centerline of vehicle intersects these lines and draw a vertical line C-C.

4. Measure distance between centers of inner lights, then divide this distance equally on both sides of centerline C-C. Draw a vertical line (D-D and E-E) through each of these points.

5. Remove headlight bezel for access to adjusting screws. Turn "MASTER" switch to "NITE" position and select high beam with dimmer switch. Cover all lights except one inner light.

6. The high intensity zone of the beam pattern should center at the point where vertical line (D-D or E-E) intersects horizontal line B-B. Turn vertical adjusting screw (fig. 3) to raise or lower the beam pattern, and turn horizontal adjusting screw to move it to right or left.

7. After completing adjustment on one inner light, cover that light, uncover the other inner light, and adjust the other inner light in the same manner.

8. Remove paper or panel from vertical surface to permit drawing aiming lines for outer lights. NOTE: Lines A-A and C-C in figure 2 are in same location for figure 4 and can be located on vertical surface in same place by taking measurements from the removed paper or panel.

Outer (Low Beam) Lights (Fig. 4)

1. Locate projected centerline of vehicle and height of headlight centers (if not marked from previous chart in step 8 above) in same manner

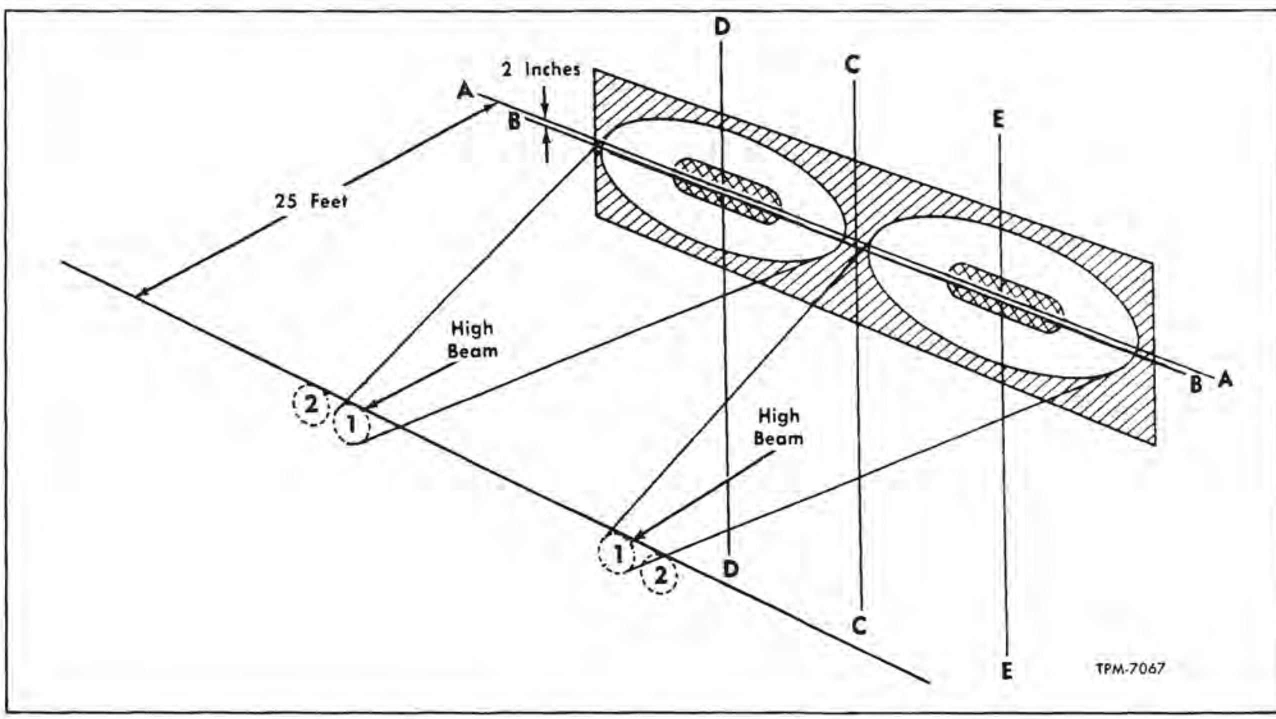


Figure 2—Inner Light (High Beam) Aiming Chart

as in steps 2 and 3 above, except that horizontal line B-B is omitted.

2. Measure distance between centers of outer lights and divide this distance equally on both sides of centerline C-C. Draw a vertical line (D-D and E-E) through each of these points.

3. Turn "MASTER" switch to "NITE" position and select low beam with dimmer switch (inner lights will not be illuminated). Cover one light while adjusting the other. The edge of the intensity zone of the beam pattern must be just below the horizontal centerline (A-A) and to the right of the vertical centerline (D-D or E-E). Turn vertical or horizontal adjusting screws as necessary to obtain this condition.

4. After all lights are properly adjusted, install headlight bezels.

SEALED-BEAM UNIT REPLACEMENT

Removal

1. Remove four screws attaching headlight bezel to front trim panel and remove bezel.

2. Remove two screws attaching sealed-beam unit retaining ring to mounting ring.

3. Unhook spring from retaining ring and remove retaining ring.

4. Remove sealed-beam unit and pull wiring connector plug off back of unit.

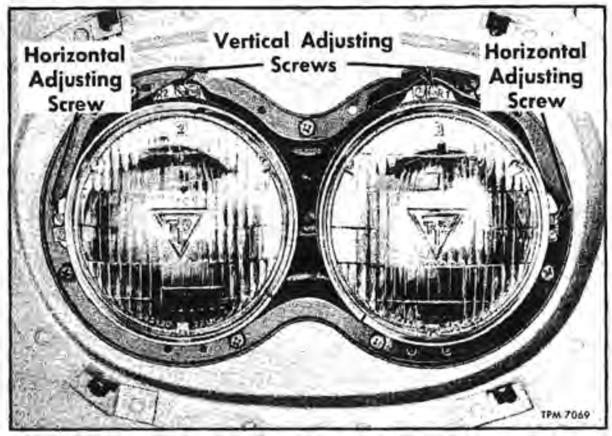


Figure 3—Headlight Adjusting Screws

Installation

NOTE: Sealed-beam unit with number "1" molded in top of lens must be used at inside lights. Unit with number "2" on lens must be used at outside lights.

1. Install wiring connector plug on back of sealed-beam unit. Position unit in mounting ring with lugs on back of unit engaging holes in mounting ring. Molded number on lens must be at top.

2. Position retaining ring over lens and secure to mounting ring with two screws.

3. Hook spring into hole in retaining ring.

4. Adjust headlight beam, either by means of

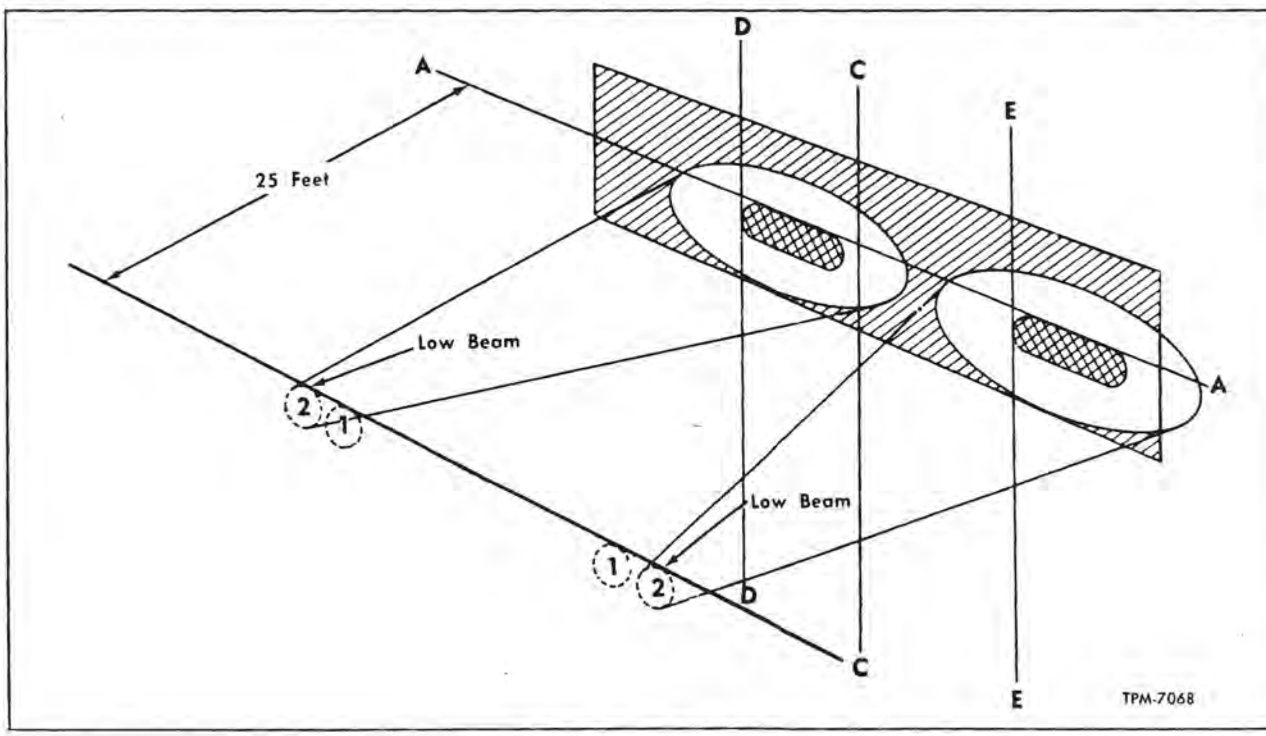


Figure 4—Outer Light (Low Beam) Aiming Chart

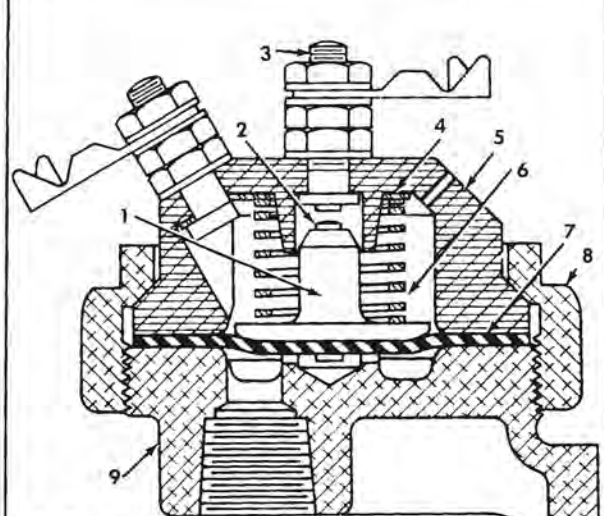


Figure 5—Stop Light Switch

a mechanical aimer, or as previously directed under "Aiming Procedure."

5. After completing installation and adjustment, install headlight bezel.

HEADLIGHT DIMMER SWITCH

Foot-operated switch, located on floor of driver's compartment at extreme left side, is used to select headlight high and low beams. Circuit is operative only with "MASTER" switch in "NITE" position. Tell-tale marked "HI BEAM" is illuminated when high beam is being used.

Dimmer switch requires no maintenance other than keeping wiring connections tight. If switch becomes defective it must be replaced. Switch is mounted to underside of floorboard, with switch button extending up through floor into driver's compartment.

IMPORTANT: When replacing switch, the black wire must be connected to the switch terminal marked "BAT." Connect the other two wires to remaining terminals; position of these with respect to terminals is not important.

STOP AND DIRECTIONAL LIGHTS

The stop and directional light systems use the same lights. Directional lights are located on front and rear of coach on both left and right sides. Flasher unit for the directional signal system is protected by number 6 circuit breaker on control panel at left of driver. Stop light system is protected by number 2 circuit breaker in engine compartment apparatus box.

STOP LIGHT SYSTEM

Stop light system consists of two lights, an air-operated switch mounted on top of rear brake relay valve, stop light tell-tale relay mounted in engine compartment apparatus box, and stop light tell-tale light located on driver's gauge and tell-tale panel. Stop light circuit is shown on "Stop and Directional Light Wiring Diagram - Standard" at back of this manual.

OPERATION

When brakes are applied and stop lamp switch is closed, current is supplied to left and right stop lights through stop light tell-tale relay and directional signal switch. When stop light tell-tale relay is energized, current is supplied to illuminate stop light tell-tale light. Tell-tale light is illuminated at all times when brakes are applied and stop light switch is closed. When directional signal switch is placed in left or right turn position, stop lights for that particular side flashes on and off.

BULB REPLACEMENT (AT REAR OF COACH)

Remove slotted nuts from four studs which attach the lens to the light body. Remove lens, then replace bulb. Before installing lens, examine lens gasket for collapsed or deteriorated condition and replace, if necessary. Tighten lens retaining nuts evenly and firmly.

STOP LIGHT SWITCH (Fig. 5)

Air-operated stop light switch is mounted on top of rear brake relay valve, on crossmember just ahead of rear axle. Switch is actuated by the same air pressure delivered to the top of the relay valve from the brake application valve. When brakes are applied, contacts within switch are closed by air pressure, completing circuit through the stop light relay to stop lights and stop light tell-tale. Shield over switch must be removed for access to switch terminals.

Switch Removal

Remove shield from top of switch. Disconnect wires from switch terminals, then unscrew switch from pipe nipple in top of relay valve.

Switch Repair (Fig. 5)

Disassemble switch and examine diaphragm and contact points. Replace diaphragm if cracked or damaged. If contact points are only slightly burned or pitted, they may be reconditioned using a contact point file. If points are badly damaged, terminal screw and contact plunger with new points should be installed. Replace spring if weakened by rust or corrosion. Make sure small bent hole in cover is open.

Switch Installation

Thread switch onto pipe nipple in top of relay valve and tighten firmly. Connect wires to switch terminals, then install shield over switch. With air pressure in system, apply brakes and check operation of stop lights.

STOP LIGHT TELL-TALE RELAY

Operation, maintenance, and adjustment of stop light tell-tale relay are described under "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section at beginning of this group.

DIRECTIONAL SIGNAL SYSTEM

Directional signal system consists of the two stop lights, located on engine compartment door at rear of coach, two lights on front of coach, and on some coaches, two front side lights. Directional signal system on standard vehicles is controlled by directional signal switch located on steering column. On some vehicles, directional signal lights are controlled by separate foot-operated switches (special equipment). Switches are located on angle panel on floor in driver's compartment, just to the left of steering column. A flasher unit is located on control panel at left of driver. Directional signal circuits are shown on "Stop and Directional Light Wiring Diagrams" at back of this manual.

DIRECTIONAL SIGNAL LIGHTS (STANDARD)

Directional signal lights are controlled by a self-cancellling switch mounted on steering column below steering wheel. Pushing switch lever up (forward) turns on right front and rear directional signals, and pulling lever down (rearward) turns on left front and rear directional signals. When turn is completed, switch lever automatically returns to off position. Electrical connections from control panel junction to switch are made through an amphenol connection mounted below the gauge and tell-tale panel.

DIRECTIONAL SIGNAL LIGHTS (SPECIAL) FOOT OPERATED

Directional signal lights are controlled by separate foot-operated switches. Switches are located on angle panel on floor in driver's compartment, just to the left of steering column. The left switch operates left turn directional signals and the right switch operates the right turn directional signals. Switches are of the momentary-on type and switch button must be held down for full time of desired operation. Switch returns to open position when button is released. Tell-tale marked "DIRECT. SIG." on gauge and tell-tale panel flashes on and off when directional signals are operating, indicating normal operation of the directional signal lights. Directional signal light circuit is protected by number 6 circuit breaker on control panel at left of driver. Electrical circuits are shown on "Stop and Directional Light Wiring Diagram" at back of this manual. Rear directional signal lights are interposed in the stop lights mounted in engine compartment door. When directional signal circuit to stop light is energized, flasher in circuit flashes on and off causing stop light to react likewise. Front directional signal lights are separate units, mounted in each front corner of coach near the headlights. A special side directional signal light (when used) is mounted at top front side of each front wheelhouse.

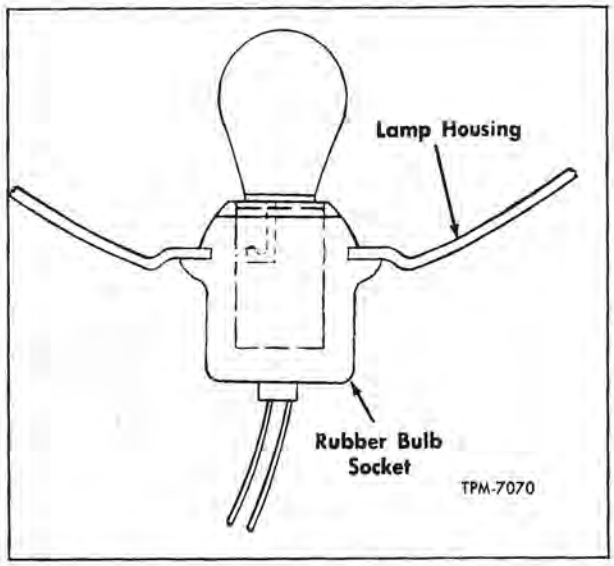


Figure 6—Front Directional Light Bulb Socket

BULB REPLACEMENT (AT FRONT OF COACH)

Rear directional light bulbs are the same bulbs used as stop lights; replacement is previously described under "Stop Lights." Front directional light bulbs are replaced in the following manner: NOTE: Front light bulbs are readily accessible from inside the coach. Access to right front light is through the dash compartment door. Bulb socket is molded into a rubber base which fits into the lamp housing in same manner as a rubber grommet (fig. 6). Grasp bulb socket base and pull out the lamp housing. DO NOT PULL ON WIRES. Remove bulb from socket and install new bulb. Install bulb socket base in lamp housing, pushing base into opening with a twisting motion until inner lip of base slides over the inner edge of the opening. It may be necessary to use a silicone lubricant on inner lip to facilitate installation. Side directional light bulbs

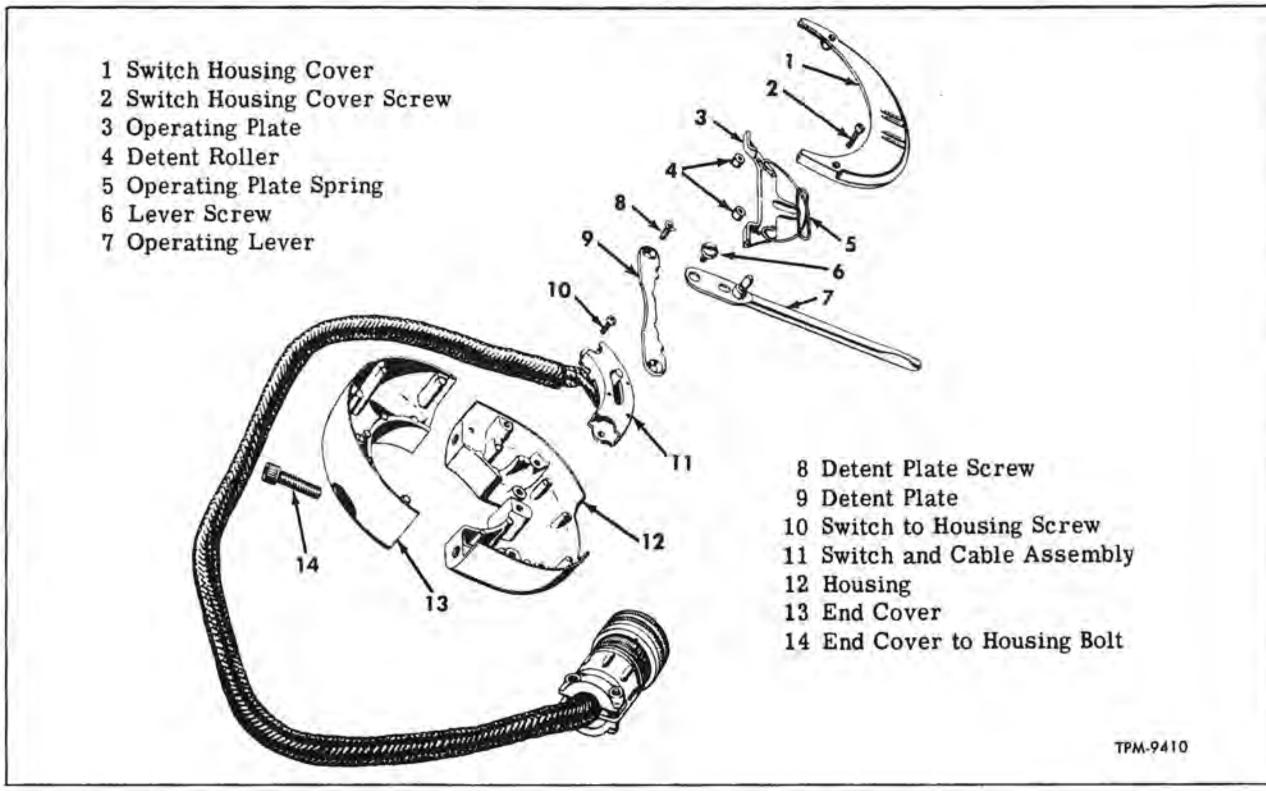


Figure 7—Standard Directional Signal Switch Components

(above front wheel housing) are accessible after removing two screws attaching lens to lamp and removing lens.

DIRECTIONAL LIGHT SWITCH (STANDARD)

Operation of directional light switch is previously described under "Directional Signal Lights." Switch is of a repairable type.

NOTE: Refer to "Steering Wheel Removal" in STEERING (SEC. 16) of this manual for removal of directional signal cancelling plate.

Removal

1. Disconnect amphenol connector mounted below the gauge and tell-tale panel.
2. Remove three screws attaching cable and guard to steering column.
3. Remove two Allen screws attaching end cover and signal housing assembly to steering column. Remove end cover and signal housing assembly from steering column.
4. Remove cable guard from cable.

Disassembly

Key numbers in text refer to figure 7.

1. Remove two screws (2) attaching cover (1) to housing assembly, then remove cover.
2. Remove two screws (8) attaching operating plate (3) and detent plate (9) to housing (12), then remove operating plate and detent plate.
3. Remove operating plate spring (5) and detent rollers (4) from operating plate (3).
4. Remove lever screw (6), then remove lever (7) from housing.
5. Remove two screws (10) attaching switch and cable assembly (11) to housing, then remove switch and cable assembly from housing.

Inspection

1. Inspect switch and cable assembly. If cable is worn, or switch defective, replace.

NOTE: Switch and cable must be purchased as an assembly.

2. Inspect operating plate spring and detent rollers. If worn, replace.
3. Inspect operating plate and detent plate, if worn, replace.
4. Inspect directional switch lever. If worn or broken, replace.
5. Inspect housing, end cover, and housing cover for cracks or worn condition. If cracked or worn, replace.

Assembly

Key numbers in text refer to figure 7.

1. Position switch and cable assembly (11) in housing, attach switch to housing with two screws (10), and tighten screws firmly.

2. Position operating lever (7) over switch and attach lever (7) to housing (12) with one screw. Tighten screw firmly.

3. Install detent rollers (4) and spring (5) in operating plate.

4. Position detent plate (9) in housing (12) and attach with two screws. Tighten screws firmly.

5. Position operating plate (3) on detent plate (9), with spring (5) over lug on operating lever.

6. Install cover (1) on housing (12) and attach with two screws (2). Tighten screws firmly.

Installation

1. Position housing assembly and end cover on steering column and attach with two Allen screws. Tighten screws firmly.

2. Install cable guard on cable.

3. Position cable and guard on steering column and attach with three screws. Tighten screws firmly.

4. Connect amphenol connector below the gauge and tell-tale panel.

FOOT-OPERATED DIRECTIONAL LIGHT SWITCHES (SPECIAL)

Operation of directional light switches is previously described under "Directional Signal Lights." Switches require no maintenance other than keeping connections tight. Switches are non-reparable; if either switch becomes defective it must be replaced.

When connecting wires to switch terminals, it is imperative that certain wires be connected to the correct terminals and to the correct switch (right or left). Terminal numbers are marked on switch housing. Position of terminals on switch do not correspond to position of terminals shown on "Foot-Operated Directional Light Wiring Diagram" at back of this manual. When connecting wires, match wire color to terminal number shown on Wiring Diagram, not to terminal position shown on wiring diagram.

At left switch, the orange wire with black tracer must connect to number 5 terminal; the natural wire with black cross tracer must be connected to number 1 terminal. At right switch the orange wire with green tracer must connect to number 5 terminal; the natural wire with red cross tracer must connect to number 1 terminal. The other wires, where identical wires connect to both switches, can be connected to either switch, but they must be connected to the correct terminal.

EMERGENCY FLASHER SYSTEM (SPECIAL EQUIPMENT)

Emergency flasher system (when used) utilizes the two stop lights at rear of coach, two directional signal lights at front of coach, and on some coaches, two side directional signal lights. System is operated by emergency flasher switch located on dash panel and flashing cycle is controlled by flasher units mounted on control panel at left of driver. Emergency flasher system circuit is shown on applicable "Stop and Directional Light Wiring Diagram With Emergency Flashing System" at back of this manual.

OPERATION

When emergency flasher switch is placed in "Emerg. Flasher" position, circuit is completed from "L" terminal of flasher units through switch to stop lights and directional signal lights. All lights flash at a steady cycle until switch is placed in "OFF" position.

SWITCH

Emergency flasher switch is a double-pole, single-throw, lever type switch, secured to dash panel with a hex-head nut. To remove switch, remove nut and name plate, pull switch from under dash, and disconnect wires.

IMPORTANT: Make sure wires are clearly identified before removing from switch to insure proper position when installing switch.

TAILLIGHTS

Taillights are mounted in engine compartment door below stop and directional signal lights. Taillight circuit is energized with "MASTER" switch in "NITE" or "PARK" position. Taillight circuit, together with all marker lights, door step lights, and instrument panel lights, is protected by number 13 circuit breaker on control panel at left of driver. Taillight circuits and connections are shown on applicable "Lighting System Wiring Diagram" in back of this manual.

BULB REPLACEMENT

Using a small bladed tool, carefully pry the loop of the lens retaining ring from groove in light body. Remove the retaining ring completely, then remove the lens. Examine lens gasket and replace if necessary. Replace the bulb, then install lens and lens retaining ring. NOTE: Make sure ring is fully seated in body groove after installing.

MARKER LIGHTS

A marker light is mounted at each corner of coach near top. Marker light circuits are energized with "MASTER" switch in "NITE" or "PARK" position. Circuit is protected by number 13 circuit breaker on control panel at left of driver. To replace bulb in marker lights, it is necessary to separate the light housing from the coach roof. Housing is attached with two screws. Unhook the back retaining clip from the small stud on the light housing partition, then separate the socket plate from the light housing. This will expose the bulb.

NOTE: If lens gasket is in poor condition, install new gasket. This also applies to gasket between light housing and coach roof.

IDENTIFICATION LIGHTS (MICHIGAN MARKER)

Six identification lights (Michigan Marker) are mounted - three at rear of coach above window and three at front of coach above destination sign.

Light circuits are energized when "MASTER" switches are placed in "NITE" or "PARK" position. Circuit is protected by number 13 circuit breaker on control panel at left of driver. Front and rear light bulbs are accessible for replacement after removing lens.

DESTINATION SIGN STAND-BY LIGHTS (TRANSIT MODELS)

Four bulbs installed in destination sign compartment can be used as destination sign lights with the fluorescent lights turned off. Lights are controlled by "MASTER" switch in conjunction with the "STAND-BY SIGN" switch on recessed switch panel at left of driver. Lights are illuminated with "MASTER" switch in "NITE" position and "STAND-BY SIGN" switch in "STAND-BY SIGN" position, or with "MASTER" switch in "PARK" position regardless of the position of the other switches.

Bulbs are accessible for replacement through the destination sign compartment door inside the coach. Observe caution on door regarding high voltage in the fluorescent lighting system.

DESTINATION SIGN LIGHTS (SUBURBAN MODELS)

Five bulbs mounted behind destination sign provide illumination for destination sign. Lights are controlled by "MASTER" switch on driver's control panel. When "MASTER" switch is placed in "NITE" or "PARK" position, sign is illuminated. Refer to "Coach Lighting Wiring Diagram - SDH and SDM" at back of this manual. Bulbs are accessible for replacement through the destination sign compartment door inside the coach.

INTERIOR LIGHTING EQUIPMENT

GAUGE AND TELL-TALE LIGHTS

Gauge and tell-tale light bulbs are mounted in bulb sockets which snap into the gauge and tell-tale housings on under side of panel. Operation of tell-tale lights is explained under "Tell-tale Alarm System" in "WIRING AND MISCELLANEOUS ELECTRICAL" section. To replace any bulb, pull bulb socket out of opening in housing. After replacing bulb, press bulb socket firmly into housing.

FRONT AND REAR STEP LIGHTS

Rear step light (Transit Models) is illuminated when "MASTER" switch is in "NITE" or "PARK" position. Entrance door step light is controlled by a door switch, which closes when entrance door is open. Circuit to switch is energized when "MASTER" switch is in "NITE" or "PARK" position. Bulbs are accessible after removing the light lens. Lens is attached to housing with two screws.

ENGINE COMPARTMENT LIGHTS

Engine compartment lights are controlled by a switch on engine compartment control panel. Circuit is protected by Number 2 circuit breaker in engine compartment apparatus box. Bulbs are exposed and are readily accessible for replacement.

EMERGENCY DOOR LIGHT (WHEN USED)

Emergency door light (Special Equipment), mounted above emergency door, is operative when "MASTER" switch is in "NITE" or "PARK" position. Light circuit is protected by No. 13 circuit breaker on control panel at left of driver and is shown on applicable "Lighting System Wiring Diagram." A tell-tale light on driver's gauge and tell-tale panel is incorporated in circuit to warn driver when door is open.

DOME LIGHTS (SUBURBAN MODELS)

Dome lights are mounted on ceiling along center aisle. Lights are controlled by "MASTER" switch in conjunction with the "DOME" light switch on recessed switch panel at left of driver. Dome lights are protected by No. 1 or 15 circuit breaker on control panel at left of driver. Refer to "Lighting System Wiring Diagram - SDH and SDM" at back of this manual. Dome lights will light with the "MASTER" switch in any position and "DOME" switch placed in "ON" position, or with "MASTER" switch in "PARK" position and "DOME" switch in "NORMAL" position. To replace bulbs, remove one screw and lower hinged lens.

READING LIGHTS (SUBURBAN MODELS)

Reading lights are mounted just below package racks. The reading light circuit, which is also controlled by the "DOME" switch in "NORMAL" position is energized only when "MASTER" switch is in "NITE" position. Whenever reading light circuit is energized, individual reading light switches can be controlled by the passenger. Reading lights are protected by two circuit breakers mounted on the regulator and blower control panel underneath coach. Reading light circuits are shown on "Lighting System Wiring Diagram - SDH and SDM" at back of this manual. Each light has one bulb and one switch. To replace bulb in light assembly, remove two screws attaching lens and retainer.

BAGGAGE COMPARTMENT LIGHTS (SUBURBAN MODELS)

Baggage compartment lights are controlled by individual switches as each door is opened and closed. Bulbs are exposed and are readily accessible for replacement.

FLUORESCENT LIGHTING SYSTEM (TRANSIT MODELS)

NOTE: Refer to figure 8 and observe the caution stickers that are shown, before any repair or checks are made on the fluorescent lighting system.

Dome lights and destination sign light are fluorescent tube lamps. All other lights on vehicle are conventional incandescent bulb or sealed-beam type units. Dome and destination sign lights are mounted in plastic sockets (fig. 9). Dome light sockets are mounted on a base plate which is attached to the ceiling. Wiring harness connections at sockets are made through connector plugs behind the base plate. Lights are ballasted by capacitors installed in the light socket at rear end of each dome light and at right end of destination sign light. Socket at opposite end of each light has a spring-loaded end plug which permits removal and installation of the light.

The power supply on standard coaches is mounted on partition above and to rear of driver's seat (fig. 10), and is enclosed by a cover having screened opening at top and bottom. On some coaches,

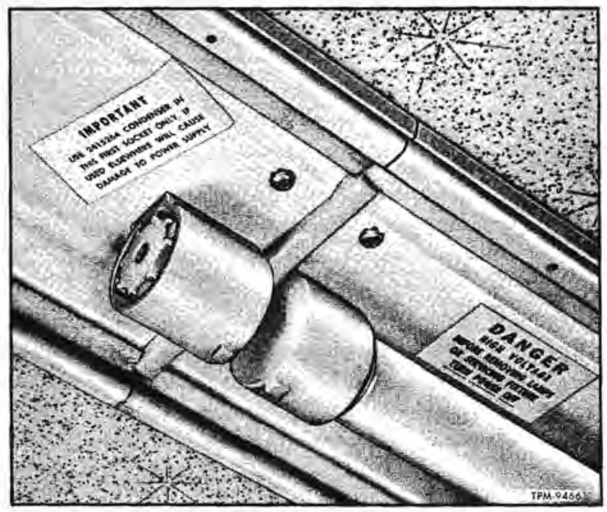


Figure 8—Dome Lamp Caution Stickers

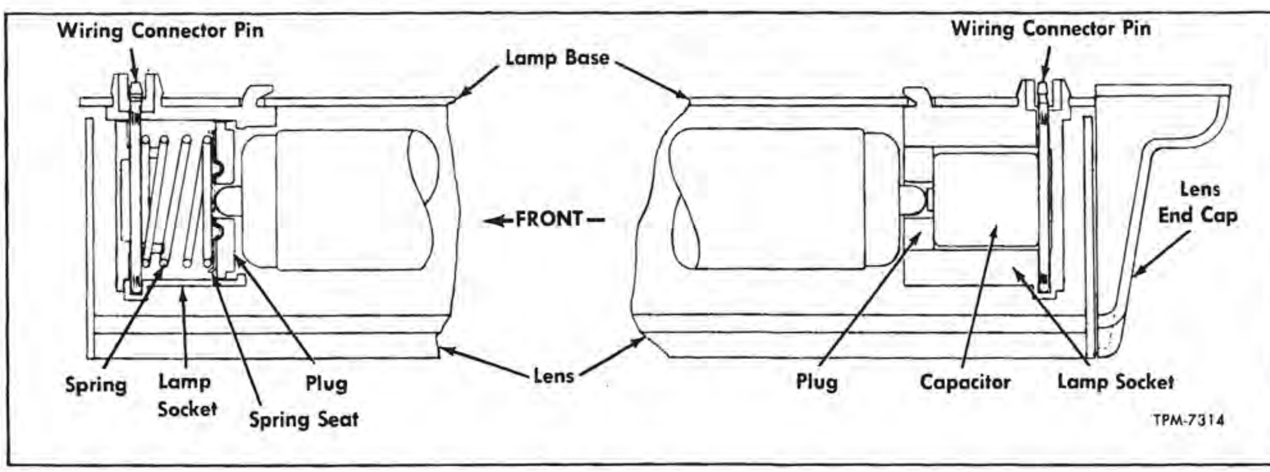


Figure 9—Dome Lamp Socket Installation

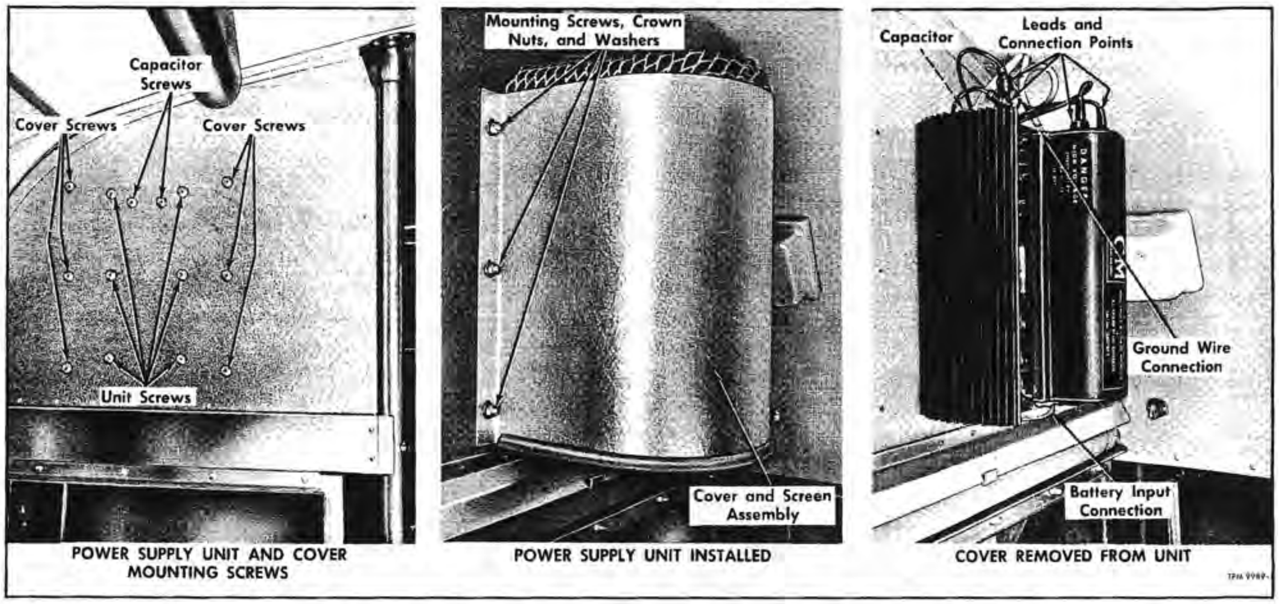


Figure 10—Power Supply Unit Installation Views (Standard)

as special equipment, the power supply unit is mounted on access panel at entrance door stepwell front trim panel (fig. 11). Refer to "Power Supply Unit" later in this section for test and repair procedures.

With "MASTER" switch in "NITE" position ("STAND-BY SIGN" 'switch in "OFF" position and "DOME" switch in "OFF" position), dome and destination sign lights are on, together with other night time operating lights. Dome and destination sign lights only can be turned on by placing "DOME" switch on driver's control panel in "DOME" position, regardless of the position of the other switches.

PRECAUTIONS

The following precautions must be observed when operating or servicing the fluorescent lighting system. Failure to observe these precautions may result in damage to the power supply unit which will necessitate replacement of the unit.

DO NOT OPERATE POWER SUPPLY UNIT -

1. With all fluorescent lamps removed.
2. With high voltage leads disconnected.
3. For periods in excess of one minute when troubleshooting faulty operation.
4. With loose connections in feed or ground circuit. Severe damage will result if the power supply unit is operated for prolonged periods of time with loose connections in the direct current feed junctions.
5. Do not attempt to operate additional loads or use commercial fluorescent lighting equipment on the power supply.
6. CAUTION: VOLTAGE ON OUTPUT SIDE OF POWER SUPPLY UNIT IS DANGEROUS. DO NOT TOUCH ANY HIGH VOLTAGE ELECTRICAL CONNECTIONS WITH HANDS WHEN THE LIGHTS ARE TURNED ON. EXCEPT WHEN NECESSARY TO HAVE LIGHTS ON FOR TROUBLESHOOTING, ALWAYS TURN LIGHTS OFF WHEN WORKING ON THE FLUORESCENT LIGHTING SYSTEM.

TROUBLESHOOTING SYSTEM

Faulty operation of the fluorescent lighting system will be evidenced by one of the following:

1. Reduced light output.
2. Lamps flash but do not stay lit.
3. Lamps fail to light.

Make a visual inspection for loose or broken electrical connections and make any necessary repairs.

Turn lights on by placing "MASTER" switch in "NITE" position (with "STAND-BY SIGN" and "DOME" switches "OFF"), then check for battery voltage at the input terminal of the power supply unit. If not voltage is present, turn "MASTER" switch off and place "DOME" switch on driver's control panel in "DOME" position. Again check for voltage at the power supply unit input terminal.

If voltage is obtained through the "DOME" switch but not through the "MASTER" switch, an open circuit exists between the "MASTER" switch and the dome lamp relay. Check for faulty destination sign relay and check Nos. 1 and 9 circuit breakers for open circuit. Destination sign relay and circuit breakers are located on apparatus panel at left of driver.

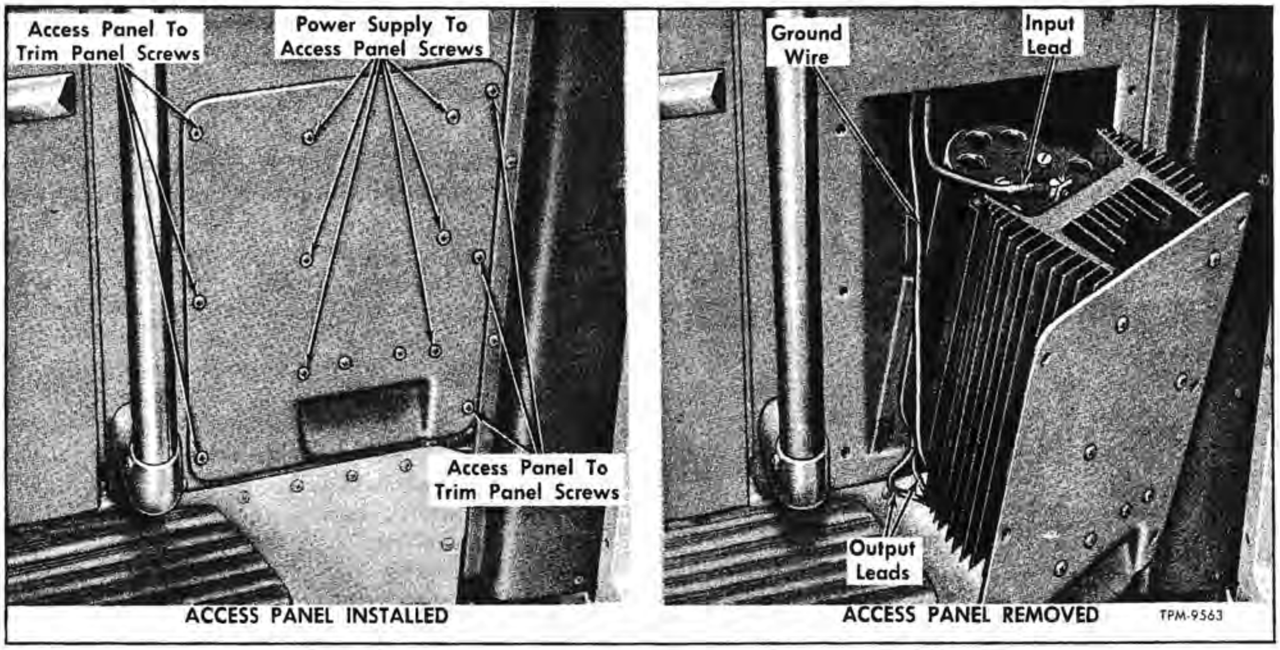


Figure 11—Power Supply Unit Installation Views (Special Equipment)

If no voltage is obtained with either switch on, refer to "Lighting System Wiring Diagram - TDH & TDM" in back of manual, and make a point-to-point check for circuit continuity to locate the open circuit.

If no trouble is indicated in the low voltage circuit and voltage is present at the power supply unit input terminal, the following procedures should locate the source of the trouble in the high voltage circuit.

1. Reduced Light Output. If there is a marked reduction in the illumination of the coach interior with engine running which cannot be corrected by tightening loose connections, the power supply unit should be tested and repaired as directed under "Power Supply Unit" later in this section. Continued use under this condition will seriously damage unit.

2. Lamps Flash But Do Not Stay Lit.

a. A shorted capacitor in one lamp will cause the system to overload. The lamp with the short-circuited capacitor will flash; the other lamps may or may not flash.

b. Turn lights off and remove all lamps that flashed.

c. Turn lights on; remaining lamps will light. One at a time, replace lamps which were removed. When the lamp which has shorted capacitor is installed, the system will again overload and that lamp will flash. The capacitor at this particular lamp must be replaced.

CAUTION: Be sure to turn off lights before removing capacitor.

d. Turn light switch off, then remove the capacitor located behind the power supply unit on coaches having supply unit mounted behind driver's seat. On coaches having supply unit mounted in dash compartment, the capacitor is located on access panel below unit. Turn light switch on. If lights operate, this is an indication that capacitor is shorted and must be replaced.

e. To replace the short-circuited capacitor, remove the end plug from the lamp socket. Install new capacitor with terminal toward open end of socket, install end plug in socket, then install lamp.

NOTE: The socket at the rear end of dome light nearest the destination sign uses 2415264 capacitor. This capacitor is used in this socket only. if used elsewhere it will cause damage to power supply. Refer to figure 8.

3. Lamps Fail to Light. With lights turned off, remove high voltage connections from supply unit by pulling wiring harness plugs out of sockets. With an ohmmeter, check each high voltage lead for grounds. Check for circuit continuity between the two high voltage leads. Any continuity between the high voltage leads indicates a short-circuited wiring harness. If ohmmeter indicates no ground or short circuit, test and repair power supply unit as directed later under "Repair."

4. Turn light switch off, then remove the capacitor located above the power supply unit on coaches having supply unit mounted behind driver's seat; on coaches having supply unit mounted in dash compartment, the capacitor is located on access panel below unit. Turn light switch on. If lights operate, this is an indication that capacitor is shorted and must be replaced.

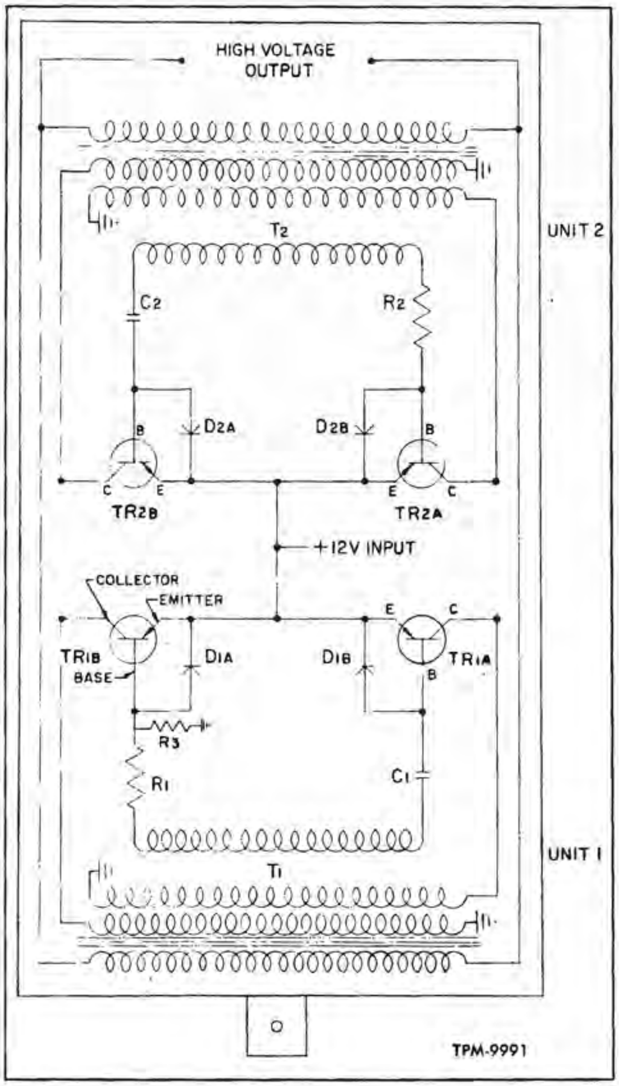


Figure 12—Power Supply Unit Circuitry Diagram

DOME LAMP SOCKETS

Lamp sockets are mounted on a base plate which is attached to coach ceiling. To replace any socket, it is necessary to remove the lamp lens, remove the base plate attaching screws, and lower the base plate for access to the wiring harness connector and socket attaching screws.

To remove lens, remove retaining screws at one side of lens, swing lens down, and unhook bead at other side of lens from base extrusion. To install lens, hook beaded edge of lens into base extrusion, swing lens up, and install retaining screws.

Socket assembly at rear end of each dome lamp (right end of destination sign lamp) consists of the socket housing and contact pin assembly, ballast capacitor, and end plug (fig. 9).

Socket assembly at front end of each dome lamp (left end of destination sign lamp) consists of the socket housing and contact pin assembly, spring, contact plate, and end plug.

POWER SUPPLY UNIT

DESCRIPTION AND OPERATION

The power supply consists basically of two units interconnected to operate in parallel. Each individual unit incorporates a transformer, a pair of power transistors, two silicon diodes, a resistor and a capacitor. The transistors act as electronic reversing switches operating alternately to direct the DC power from the battery through the transformer primary winding; first in one direction and then in the opposite direction. The primary current is magnetically induced into the high voltage output winding and simultaneously to the low voltage feed-back winding. The high voltage produced is 1000 volts at 7500 cps, and is used to power the fluorescent lights. The low voltage feed-back current provides switching energy for the transistors. The feed-back current is controlled by the silicon diodes, resistor and capacitor. An additional resistor is added from one transistor base (control element) to ground for the purpose of starting the transistor switching action when the power supply unit is initially placed in operation. Transformers are connected so that the high voltage secondary windings are connected in parallel.

Figure 12 shows power supply unit circuitry with each major unit identified. Figure 13 shows corresponding items in actual location on assembly in respect to circuitry diagram (fig. 12).

POWER SUPPLY UNIT REPLACEMENT

On standard coaches, power supply unit is mounted on partition above and to the rear of the driver's seat (fig. 10), and is enclosed by a cover having screened opening at top and bottom. On some coaches, as special equipment, the power supply unit is mounted behind closure panel at right side of dash (fig. 11).

CAUTION: Before attempting to remove or install power supply unit, observe "PRECAUTIONS" previously in this section.

REMOVAL

Mounted in Back of Driver (Fig. 10)

1. Make sure both the "MASTER" switch and the "DOME" switch are in "OFF" position.

2. Remove six crown nuts and screws which attach cover assembly over the power supply unit. Remove cover assembly.

3. Disconnect input lead at bottom of power supply unit. Right view of figure 10 identifies wiring connections at unit.

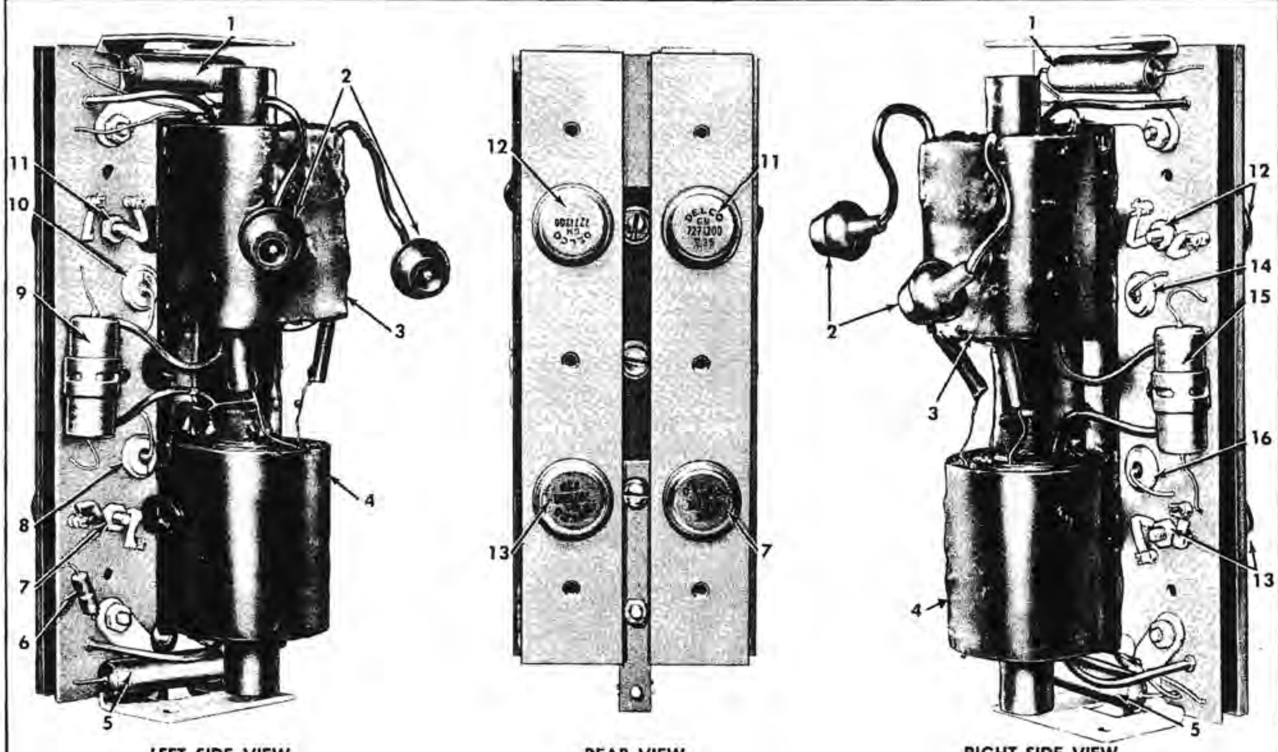


Figure 13—Power Supply Unit Components

4. At top of supply unit, disconnect capacitor leads from rubber-covered terminal sockets in unit cover.

5. Disconnect ground wire from supply unit.

6. While supporting weight of power supply unit, remove six screws which attach unit to partition. Screws are accessible at rear of partition. Remove unit.

Mounted Behind Dash Panel (Fig. 11)

1. Make sure both the "MASTER" switch and "DOME" switch are in "OFF" position.

2. Remove six screws attaching access panel to trim panel.

3. Swing access panel out, then disconnect ground wire, disconnect input lead from input terminal at top of power supply unit, and pull two wiring harness plugs out of output terminal sockets at bottom of power supply unit.

4. Remove access panel and power supply unit from opening.

5. Remove six screws attaching power supply unit to access panel.

INSTALLATION

Mounted in Back of Driver (Fig. 10)

1. Make sure both the "MASTER" switch and the "DOME" switch are in "OFF" position.

2. Place supply unit with heat sink assembly to partition and attach with six screws. Tighten screws firmly.

3. Connect ground wire to unit.

4. At top of unit, connect condenser leads to rubber-covered terminal sockets in unit cover.

5. Connect input lead at bottom of power supply unit.

NOTE: Make sure all connections are secure.

6. Attach cover over the supply unit to partition with screws, washers, and nuts.

Mounted Behind Dash Panel (Fig. 11)

1. Make sure both the "MASTER" switch and "DOME" switch are in "OFF" position.

2. Install power supply unit on access panel and attach with six screws.

3. Position access panel and power supply unit at opening.

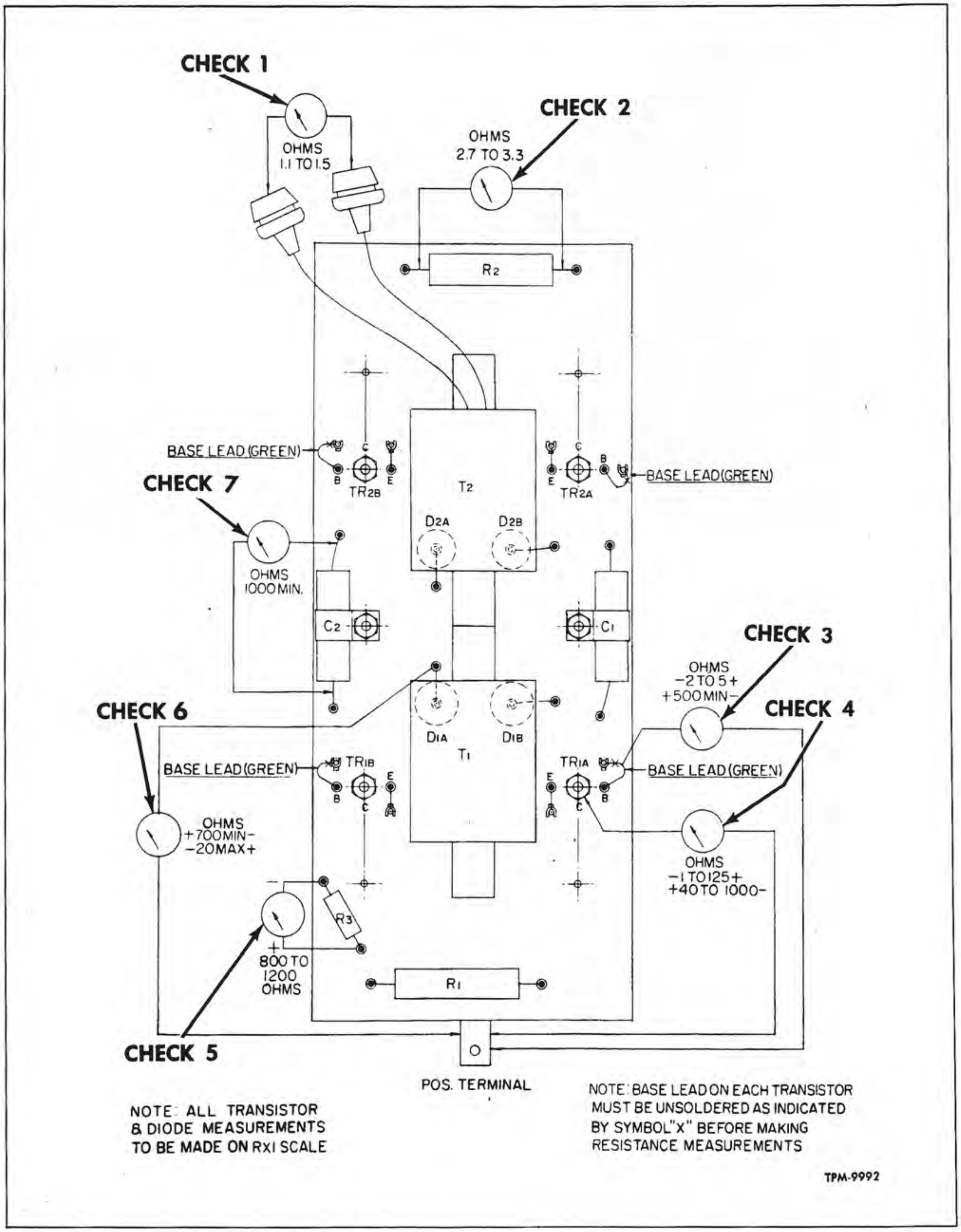


Figure 14—Power Supply Unit Ohmmeter Checks

4. Connect wiring harness leads to power supply unit output terminals by inserting plugs firmly into output terminal sockets at bottom of unit. Connect input lead to input terminal at top of power supply unit, tightening terminal screwfirmly. Connect ground wire, and tighten nut firmly.

5. Install access panel over opening in trim panel and attach with six screws. Tighten screws firmly.

DISASSEMBLY

1. After unit has been removedfrom mounting, place on a clean work bench.

2. Remove screws attaching plastic cover to power supply unit. Remove cover, unsnapping output terminal connector grommets from holes in cover.

NOTE: It is not necessary to remove heat sink from panel board unless component parts are to be replaced. If parts are to be replaced, remove six Allen head screws underneath heat sink and separate panel board from heat sink.

TROUBLESHOOTING UNIT

(Refer to Figure 14)

NOTE: When troubleshooting unit, use an ohmmeter having a 1-1/2 volt dry cell battery, such as a Simson Model 260 Multimeter. When this Multimeter is used, the "Rx1" scale must always be used. The polarity of the leads must be observed to correctly determine a faulty component.

TRANSFORMERS (CHECK 1)

Connect ohmmeter as shown in check 1. Reading should be 1.1 to 1.5 ohms. If reading is below 1.1 to 1.5 ohms, transformer(s) is shorted. If a very high (infinite) reading is obtained, transformer(s) is open.

RESISTORS R1 AND R2 (CHECK 2)

Connect ohmmeter as shown in check 2 to resistors R1 and R2. A reading of 2.7 to 3.3 ohms should be obtained. If reading is above or below 2.7 to 3.3 ohms, resistor is defective.

TRANSISTORS TR1A, TR1B, TR2A, AND TR2B

CHECK 3: Before making ohmmeter checks as shown in "Check 3" of Figure 14, unsolder the base lead having green insulating loom from terminal lug. Figure 15 shows the base lead connection. Make two checks at each unit, reversing the polarity of the leads for the second check. Make sure all transistors are checked. Ohmmeter readings for each polarity is shown in Figure 14 at "Check 3." NOTE: Do not resolder transistor base lead until all Resistors, Transistors, Diodes, and Capacitor checks have been made.

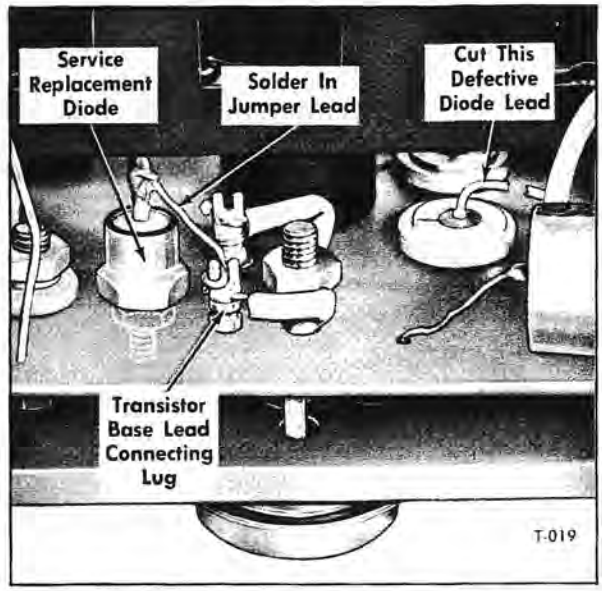


Figure 15—Service Replacement Diode Installed

CHECK 4: Connect ohmmeter to each transistor as shown in "Check 4" of figure 14. Make two checks at each unit, reversing the polarity of the leads for the second check. Ohmmeter readings for each polarity are shown in figure 14 below "Check 4."

RESISTOR R3 (CHECK 5)

Connect ohmmeter as shown in "Check 5" to resistor R3. Make sure ohmmeter leads are correct in respect to polarity as shown. A varied reading of 800 to 1200 ohms should be obtained. If a very low or infinite reading is obtained, resistor is defective and should be replaced.

DIODES D1A, D1B, D2A, AND D2B (CHECK 6)

Connect ohmmeter to all diodes as shown in "Check 6" of figure 14. Make two checks at each unit, reversing the polarity of the leads for the second check. Ohmmeter readings for each polarity are shown in "Check 6" of figure 14. If readings do not agree with those in figure 14, diode is defective. Instructions for installing replacement diode are explained later under "Repair."

CAPACITOR C1 AND C2 (CHECK 7)

Connect ohmmeter to each capacitor as shown in "Check 7" of figure 14. A minimum reading of 1000 ohms should be obtained. If reading is below 1000 ohms, capacitor is shorted and should be replaced.

NOTE: Resolder the transistor base lead having green insulating loom to terminal lug that was disconnected before making check.

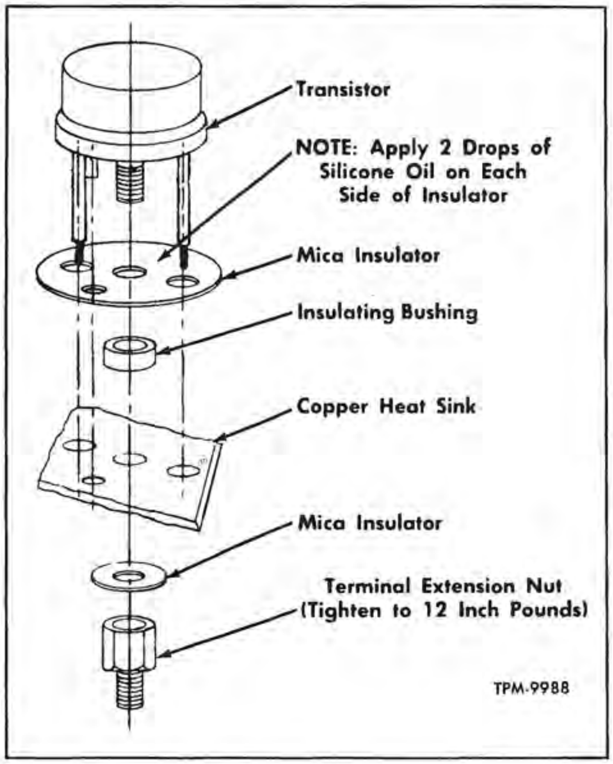


Figure 16—Installation View of Transistor

REPAIR

When replacing a component, use any good grade of radio-type rosin core solder. Never use additional fluxes or "non-corrosive" pastes.

Use a soldering iron having sufficient heating capacity to solder or unsolder connection quickly. This will tend to localize the heat which is important when soldering transistor leads and printed circuit boards. TOO MUCH HEAT WILL DAMAGE THE TRANSISTORS OR WILL LOOSEN THE COPPER FOIL LAMINATIONS FROM THE PRINTED CIRCUIT BOARDS.

Install a Service Replacement Diode as Follows:

NOTE: Figure 15 shows a service replacement diode installed. A nut and lock washer secures this diode to printed circuit board and holes are provided in board for this purpose.

1. Insert threaded stud end of service replacement diode down through hole in printed circuit board. Secure diode firmly with nut and washer.
2. Cut a short piece of jumper wire and solder one end to diode lug and the opposite end to transistor base lead (green) connector lug as shown.
3. IMPORTANT: Cut or break the lead at top of defective diode at point shown in upper right portion of figure 15.

NOTE: It is not necessary to remove the defective diode from power supply unit.

When replacing transistors, refer to figure 16 for correct position of insulators and bushings. Make sure the mating surfaces of the finned aluminum and copper heat sink are very clean before transistor is installed. Apply several drops of silicone oil on the mating surfaces between the aluminum and copper heat sinks when reassembling.

Inspect transformers for defective lead-in wires and insulation. Repair or replace if found to be defective.

ASSEMBLY

1. If removed during "Disassembly," install heat sink to panel board, using six Allen head screws.

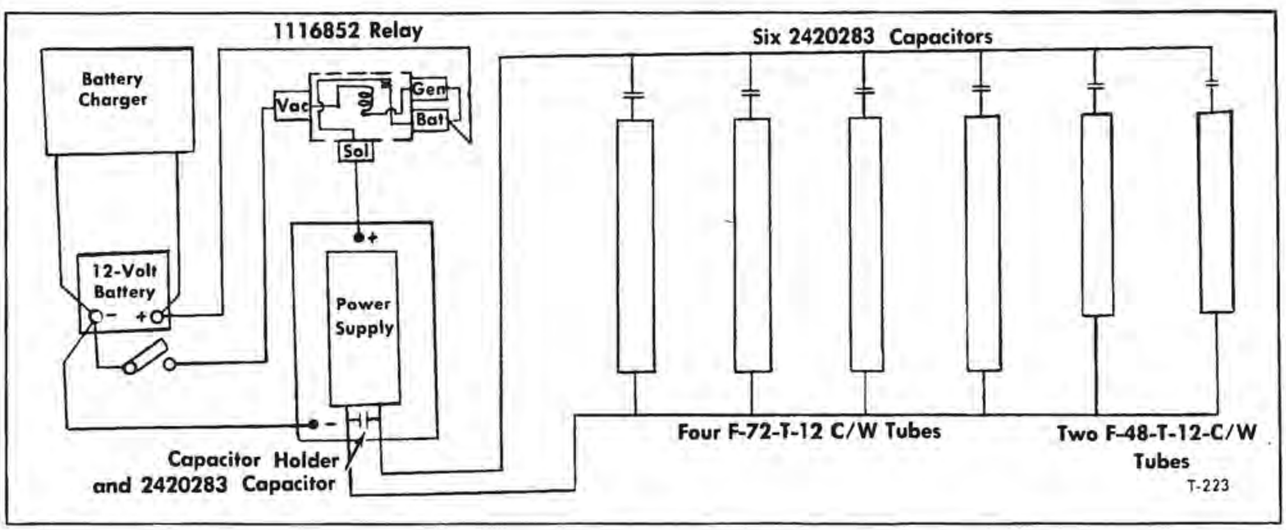


Figure 17—Schematic Diagram of Power Supply Unit Bench Test Hook-Up

2. Position output terminal connector grommets in plastic cover. Position cover in proper position and install attaching screws.

3. Install in vehicle as explained previously under "Replacement."

POWER SUPPLY BENCH TEST

As it is not possible to measure output voltage directly or indirectly from the output terminal of the power supply unit, the following procedure should be observed when bench testing the fluorescent light power supply unit: (Refer to figure 17 for schematic diagram of electrical connections necessary for the following test.)

1. Attach a battery charger capable of supplying twenty amperes to one 12-volt battery.

2. Adjust battery charger to maintain a 14-volt output at the battery post.

3. Attach eighty inches of fourteen gauge wire to the "POS" post of the battery.

4. Connect a relay to the eighty inches of wire at any point between the battery "POS" post and the "POS" post of the power supply. Refer to figure 17 for relay hook-up.

5. Connect a second length of fourteen gauge wire, eighty inches long, to the ground of the power supply unit. Attach the opposite end of this wire to the "NEG" post of the battery.

6. Wire the output side of the power panel to a bank of four Slimline fluorescent tubes F-72-T-12-c/w and two Slimline fluorescent tubes F-48-T-12-c/w. NOTE: The fluorescent tubes must be wired in parallel. Tubes must be of the same type as actually used in the coach to be tested and will require 12-lamp socket assemblies, seven capacitors, and one capacitor holder as used on the coach.

7. After mounting parts called out in step 6 on a board, the test can be made. Allow power panel to operate for at least one hour.

8. If the unit operates for one hour, it can be considered satisfactory; if unit fails to operate satisfactory, recheck resistance of all units as previously directed under "Troubleshooting," then replace defective parts.

LIGHT BULB DATA

Name	Qty.	Candlepower	Trade No.
Headlight Sealed-Beam Unit			
(Inside—Stamped No. 1)	2	37.5	4001
(Outside—Stamped No. 2)	2	37.5-50W	4002
Instrument Panel Lights	2	2	57
Tell-tale Lights	10	2	57
Rear License Plate Light	1	4	67
Corner Marker Lights	4	6	89
Destination Sign Standby Lights (Transit)	4	15	93
Door Step Lights	2	21	1141
Taillights	2	4	67
Front Directional Lights	2	21	1141
Stop and Rear Directional Lights	2	21	1141
Engine Compartment Lights	6	21	1141
Side Visual Lights	2	4	67
Dome Lamp (Transit Models)	4	Slimline (Cool-White)	F72"-T12
Dome & Destination Sign (Transit Models)	2	Slimline (Cool-White)	F48"-T12
Michigan Marker Lights	6	4	67
*Emergency Door Light	1	4	68
Driver's Light	1	15	93
Freon Receiver Tank Bulb	1	6	89
Rear Exit Door Light	1	6	89
Dome and Reading Lights (Suburban Models)	AR	21	1141
Destination Sign (Suburban Models)	5	15	93
Baggage Compartment (Suburban Models)	5	15	93

*Double Contact

NOTE

All Wiring Diagrams are Located in Back of This Manual.

When Making Electrical Connections, Always Refer to Wiring Diagrams to Make Sure of Proper Connections.

Keep All Connections Clean and Tight. A Clean and Tight Connection is a Good Connection.

The Batteries are the Heart of the Electrical System; they must be serviced at regular intervals to assure trouble-free operation of all electrical units.

Diesel Engine

Coach is powered by 6V-71 GM Diesel engine as standard equipment; however, the 8V-71 is available as special equipment. Engine, transmission, and radiator comprise a unit power plant which is supported on engine cradle assembly and installed transversely in engine compartment at rear of coach (figs. 1 and 2).

This section of manual covers description and maintenance of engine accessories which are not included in DIESEL ENGINE MAINTENANCE MANUAL or in other sections of this manual. Also included is the procedure for replacing the complete power plant and cradle assembly. Refer to ELECTRICAL SYSTEM (SEC. 7) for information on electrical units such as generator and starter.

Maintenance of cooling system units is covered in COOLING SYSTEM (SEC. 6), while fuel system maintenance procedures are in FUEL SYSTEM (SEC. 12) in this manual. Engine general data is given at end of this section.

DIESEL ENGINE ACCESSORIES

Engine accessories described in following paragraphs are standard or special equipment and are not covered in current DIESEL ENGINE MAINTENANCE MANUAL or in other sections of this manual.

OIL PRESSURE GAUGE

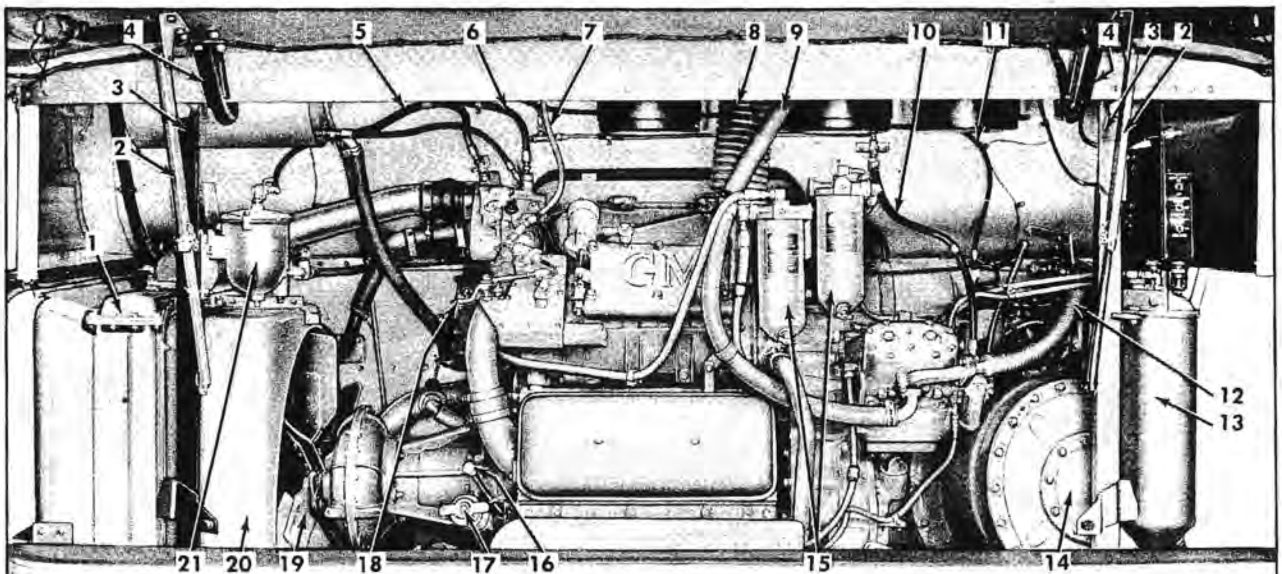
An oil pressure gauge is installed in oil pressure sending manifold on engine compartment bulkhead (fig. 3) for convenience when working on engine. The registering gauge at driver's instrument panel is electric type interconnected with sending unit at oil pressure manifold in engine compartment. Electric oil gauge circuit is operative only when the "MASTER" switch is in "DAY" or "NITE" position. See "Alarm and Signal Wiring Diagram" at back of book.

TEST

In case electric oil gauge fails to function or if it gives an apparent false reading, system may be checked as follows:

1. Disconnect wire from engine unit and connect a test lamp of not more than 2 C.P. between battery terminal of starter solenoid and body of the unit. If lamp fails to light, the unit is not grounded,

8



1 Radiator
2 Door Support
3 Engine Support Hanger
4 Door Hinge
5 Vent Line
6 Deaeration Line
7 Engine Stop Air Line
8 Blower Intake Hose
9 Air Compressor Intake Hose
10 Air Compressor Governor Line
11 Oil Pressure Line
12 Air Compressor Discharge Line
13 Engine Oil Filter
14 Transmission
15 Fuel Filters
16 Engine Oil Dipstick
17 Engine Oil Filler
18 Throttle Control
19 Fan Blades
20 Fan Shroud
21 Water Filter

T-115

Figure 1—Power Plant Assembly Installed—6 Cylinder with Hydraulic Transmission

and the threaded hole and the threads on the unit should be checked for metal to metal contact. If the lamp lights, the unit can be considered grounded. (DO NOT USE A LAMP OF OVER 2 C.P.)

2. Remove the wire from the unit terminal and connect the test lamp between the unit terminal and the battery post on the starter solenoid. If lamp lights, start engine and observe if lamp changes intensity. A satisfactory unit will change the lamp intensity at different engine speeds. (Changes in oil pressure.)

3. Replace the wire and check wiring for open circuit between unit and gauge on instrument panel, referring to "Alarm and Signal Wiring Diagram."

4. If units and circuits pass above tests, replace the gauge and check for operation at various engine speeds.

5. Do not attempt repairing gauge or sending unit. When replacing sending unit do not use thread compound as this will prevent proper ground and cause faulty gauge reading.

LOW OIL PRESSURE SWITCH

Low oil pressure electrical switch is installed in oil pressure sending manifold (fig. 3), which is mounted on engine compartment bulkhead. Manifold is connected with engine oiling system by a flexible tube.

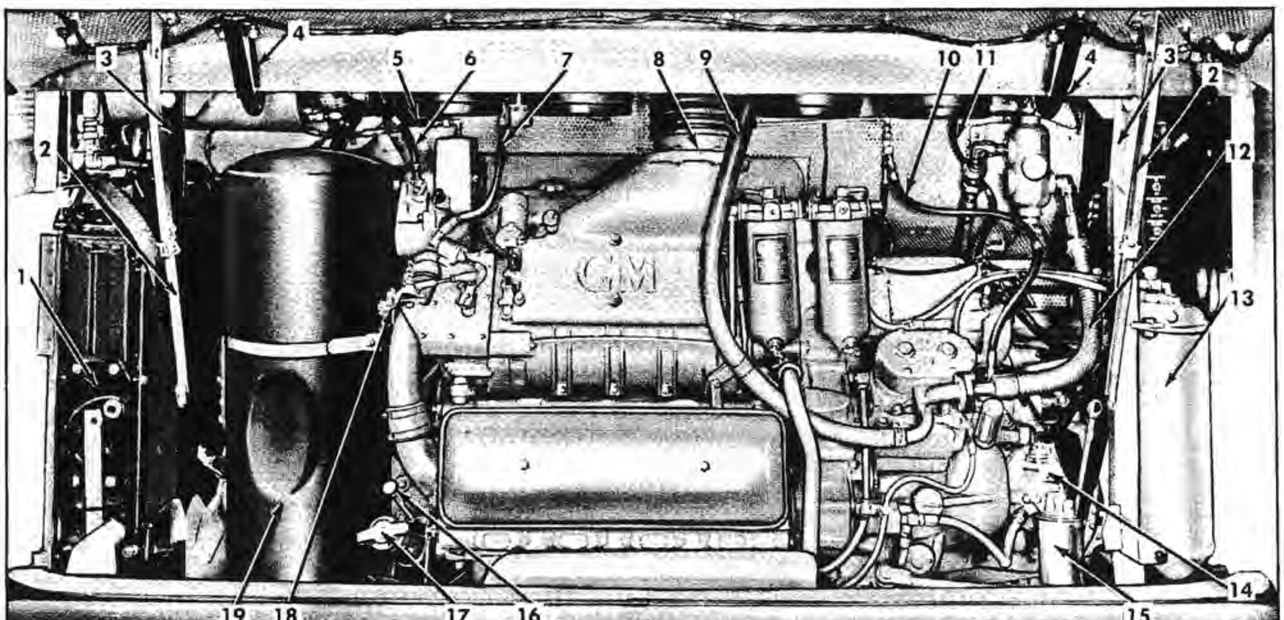
When engine is running, the oil pressure acts upon a diaphragm to hold a pair of switch contacts open. However, if pressure should drop below 3 to 4 pounds, points will close completing circuit. When points close, tell-tale alarm buzzer sounds, and low oil tell-tale light illuminates. Whenever alarm buzzer sounds or low oil tell-tale lights, stop engine immediately and correct cause of low pressure.

CIRCUIT TEST

Low oil pressure indicating system is interconnected with control switch so that system is inoperative when control switch is off.

With "MASTER" switch in "DAY" or "NITE" position, and engine not running, low oil pressure tell-tale light should be illuminated and buzzer should sound. If buzzer sounds and light does not illuminate, replace bulb. If light is illuminated and buzzer does not sound, check the alarm buzzer.

If light fails to illuminate and buzzer fails to sound with master control switch turned on, momentarily connect the two wire terminals at pres-



1 Radiator
2 Door Support
3 Engine Support Hanger
4 Door Hinge
5 Deaeration Line
6 Vent Line
7 Engine Stop Air Line
8 Blower Intake Hose
9 Air Compressor Intake Hose
10 Air Compressor Governor Line
11 Oil Pressure Line
12 Air Compressor Discharge Line
13 Engine Oil Filter
14 Transmission
15 Transmission Oil Filter
16 Engine Oil Dip Stick
17 Engine Oil Filler
18 Throttle Control
19 Muffler

TPM-9343

Figure 2—Power Plant Assembly Installed—8 Cylinder with Mechanical Transmission

sure switch. Failure of tell-tale lights or buzzer to sound indicates that the circuit to these units is at fault. Refer to "Alarm and Signal Wiring Diagram" in back of manual for electrical circuit.

SOLENOIDS

Emergency stop solenoid assembly is installed at engine blower housing (fig. 4) and releases a choke valve to restrict air intake by engine.

NOTE: In some instances engine will not stop completely, as sufficient air may pass the valve to permit engine to continue to operate, but at a substantially reduced speed.

For normal use to stop engine, a solenoid valve (fig. 6) on bulkhead in engine compartment is used to admit air pressure to air cylinder which actuates lever on governor housing and moves engine injectors to no-fuel position. This mechanism operates automatically when master control switch is turned to "OFF" position.

EMERGENCY STOP SOLENOID

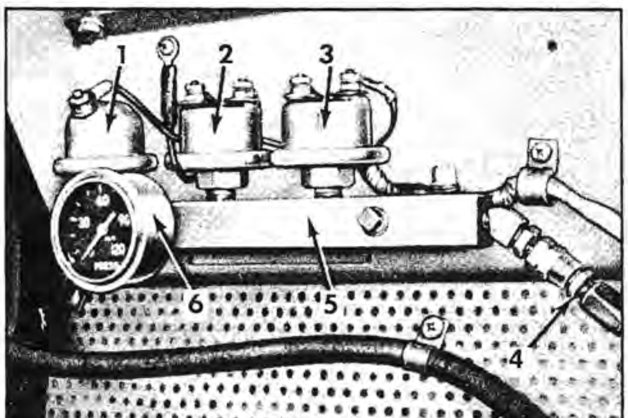
Key numbers in text refer to figure 5.

Solenoid assembly components can be replaced as necessary when repairing the assembly.

Disassembly

1. To remove solenoid assembly from engine, wires must be disconnected from terminal and cam lock must be removed. Remove two mounting bolts holding solenoid assembly to blower housing.

2. Bend tangs on case (3) to permit removal of plate (5). Remove plate and gasket (5 and 4). Remove plunger and rod assembly (6) from case and coil assembly (3). Remove spring (7).



1 Oil Pressure Gauge Sending Unit	3 Air Conditioning Oil Pressure Sending Unit
2 Low Oil Pressure Tell-tale Sending Unit	4 Oil Pressure Line
	5 Oil Pressure Manifold
	6 Oil Pressure Gauge T-120

Figure 3—Oil Pressure Gauges and Manifold—6 Cyl. Shown

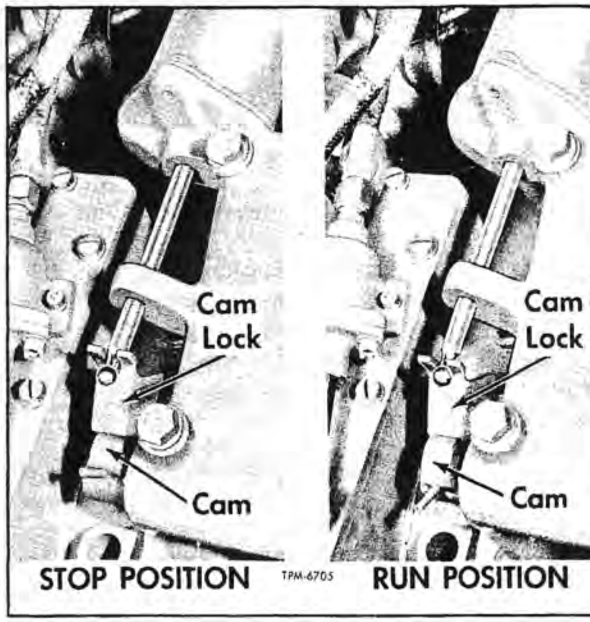


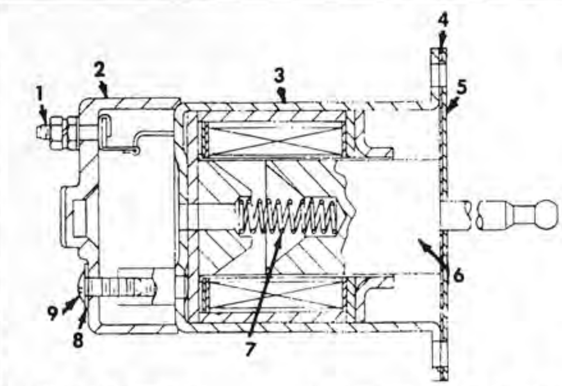
Figure 4—Emergency Stop Mechanism at Blower Housing

3. Remove screw (9) and washer (8) to permit inspection of coil wire attached to terminal (1).

Assembly

1. Be sure coil wire is securely attached to lug on terminal (1), then install cover (2) on case and coil assembly (3), and attach with two screws (9) and washers (8).

2. Place spring (7) in counterbore in plunger, then insert plunger into place in case and coil assembly. Slide plate (5) with gasket (4) on solenoid rod and bend tangs on case to hold plate (5) in place.



1 Wire Terminal	6 Plunger and Rod Assy.
2 Cover	7 Plunger Spring
3 Case and Coil Assy.	8 Washer
4 Gasket	9 Cover Screw
5 Plate	TPM-7065

Figure 5—Emergency Stop Solenoid

3. Insert plunger rod through guide on blower housing, and install two mounting bolts. Engage cam lock with plunger rod and bolt lock to blower housing. Attach wire to terminal (1). Solenoid and mechanism is installed as illustrated in figure 4.

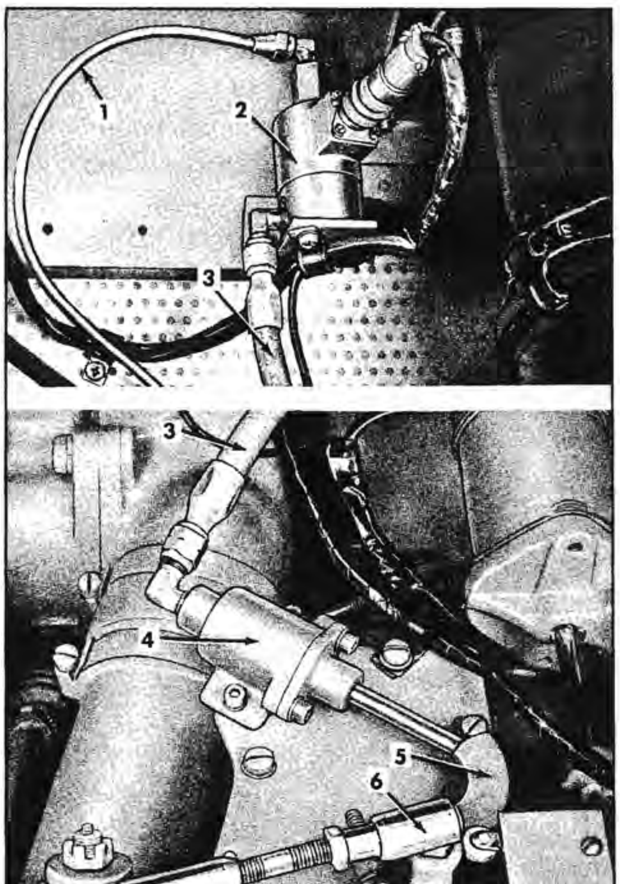
NOTE: Cam (fig. 4) must be set in "run position" before engine can be started.

ENGINE STOP SOLENOID VALVE

Solenoid valve shown in figure 7 can be disassembled for cleaning and inspection. Plunger, spring, and seals are available for service replacement.

Disassembly

1. Remove threaded connector (10) and seal (11) from bottom of valve assembly, then remove thin nut (9) which holds housing and coil assembly to sleeve assembly (5).



1 Air Pressure Line
2 Engine Stop Solenoid
3 To Engine Stop Cylinder
4 Engine Stop Cylinder
5 Governor Stop Lever
6 Throttle Link

TPM-9401

Figure 6—Engine Stop Solenoid and Air Cylinder Installatioı

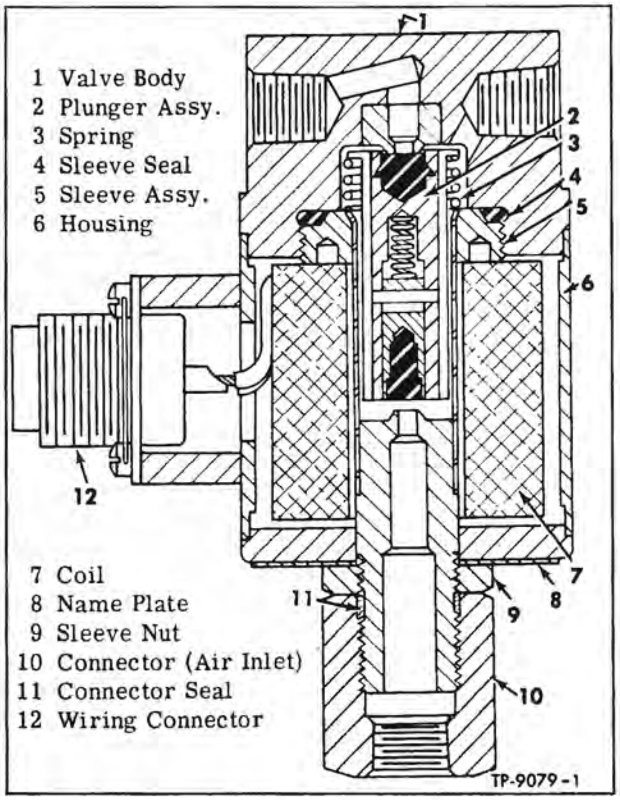


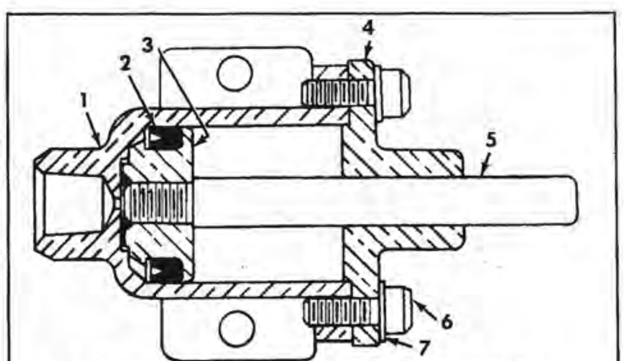
Figure 7—Engine Stop Solenoid Valve

2. Remove housing and coil assembly by sliding off lower end of sleeve assembly.

3. Using spanner wrench remove sleeve, plunger, and spring (5, 2, and 3) from valve body (1).

4. Separate plunger and spring from sleeve and remove seal (4) from valve body.

NOTE: Seals (4 and 11) should be discarded and new seals should be obtained for use when assembling valve.



1 Cylinder
2 Piston Cup
3 Piston
4 Cylinder Cap
5 Piston Rod
6 Cap Screw
7 Lock Washer

TPM-8739

Figure 8—Engine Stop Air Cylinder

Assembly

Examine valve seats and mating surfaces and check condition of spring. Obtain new parts as required and follow directions below to assemble.

1. Assemble spring (3) on plunger (2) then insert plunger into sleeve assembly (5).
2. Place new seal (4) in valve body then screw sleeve into body using spanner wrench.
3. Assemble housing and coil assembly over sleeve, then install name plate (8) and sleeve nut (9).
4. Place new seal (11) in groove in sleeve, then install connector (10) and tighten while holding nut (9).

CAUTION: Overtightening nut (9), will put excessive stress on sleeve; tighten nut only as necessary to seat parts solidly.

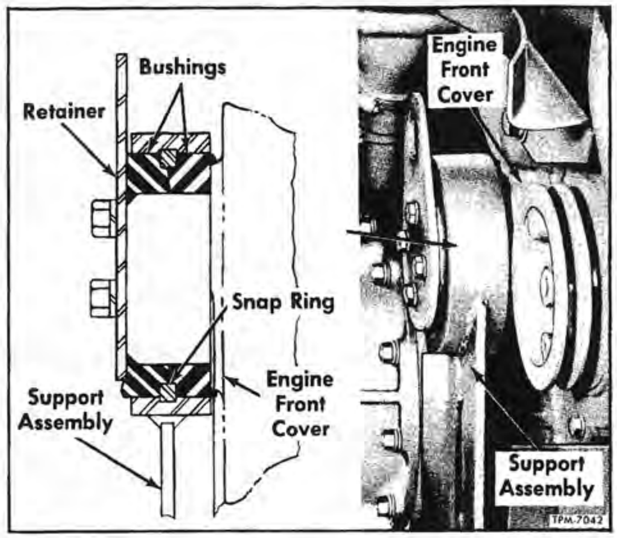


Figure 9—Engine Front Mounting

ENGINE SHUT-OFF AIR CYLINDER

Engine shut-off air cylinder (fig. 8) is mounted on engine governor cover with piston rod aligned with shut-off lever on governor shaft (fig. 6). When "MASTER" control switch is turned to "OFF" position, the engine stop solenoid valve on engine compartment bulkhead panel is de-energized and spring moves valve plunger to close exhaust passage and open air inlet passage in valve. With air pressure applied to shut-off air cylinder the piston pushes rod out against governor lever and moves engine injector racks to no-fuel position, thereby stopping engine.

AIR CYLINDER REPAIR

Disassembly

1. Disconnect air line from air cylinder.
2. Remove two socket-head bolts which mount cylinder on governor cover, then remove air cylinder.
3. Remove two screws and lock washers (6 and 7) which secure cap (4) on cylinder (1). Remove cap (4) from piston rod.
4. Pull piston and rod assembly out of cylinder.
5. Clean and inspect components.

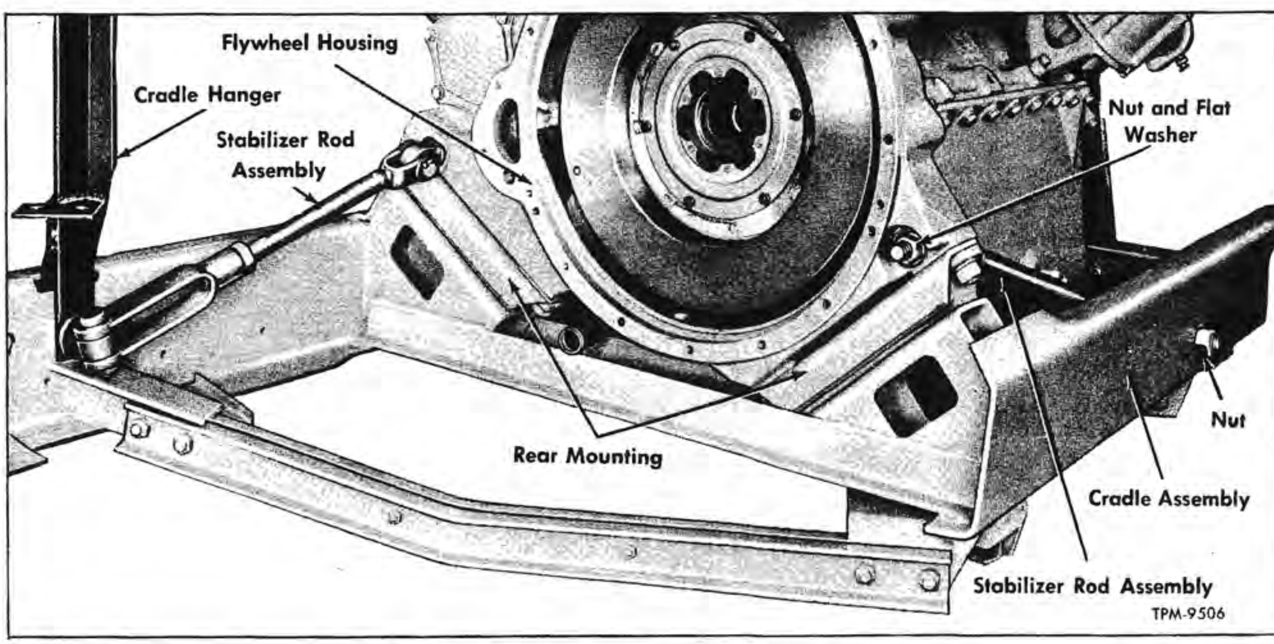


Figure 10—Engine Mounting and Stabilizer Rods—6 Cylinder Shown

Assembly

1. Lubricate piston cup (2) and bore in cylinder (1).

2. Insert piston and rod assembly into cylinder bore using care to prevent damage to piston cup (2).

3. Install cap (4) on cylinder. Use lock washers (7) under heads of cap screws (6) and tighten screws to secure cap (4) on cylinder (1).

4. Install cylinder assembly on governor cover, and connect air line to cylinder.

ENGINE MOUNTING AND REPLACEMENT

Engine is supported by three cushion type mountings. Front of engine is mounted on two round rubber bushings and a support (fig. 9), while two flat rubber mountings are used at rear (fig. 10). Transmission is bolted to engine and the complete power plant including radiator (6-cylinder only), exhaust system, and rear bumper is supported on cradle. Two stabilizer rods (fig. 10) anchor the engine in position on cradle.

Brackets (figs. 11 and 12 at lower edge of bulkhead support the front side of cradle, while rear side is supported by two hanger and brackets suspended from support beam at rear of coach body. Instructions which follow describe method of replacing the complete power plant assembly. A special dolly must be used to support the power plant at cradle, and provide a means for moving the assembly out of engine compartment. Refer to figure 11 and 12 for location of various disconnect points in replacing power plant.

POWER PLANT REMOVAL

Key numbers in text refer to figures 11 and 12 unless otherwise indicated.

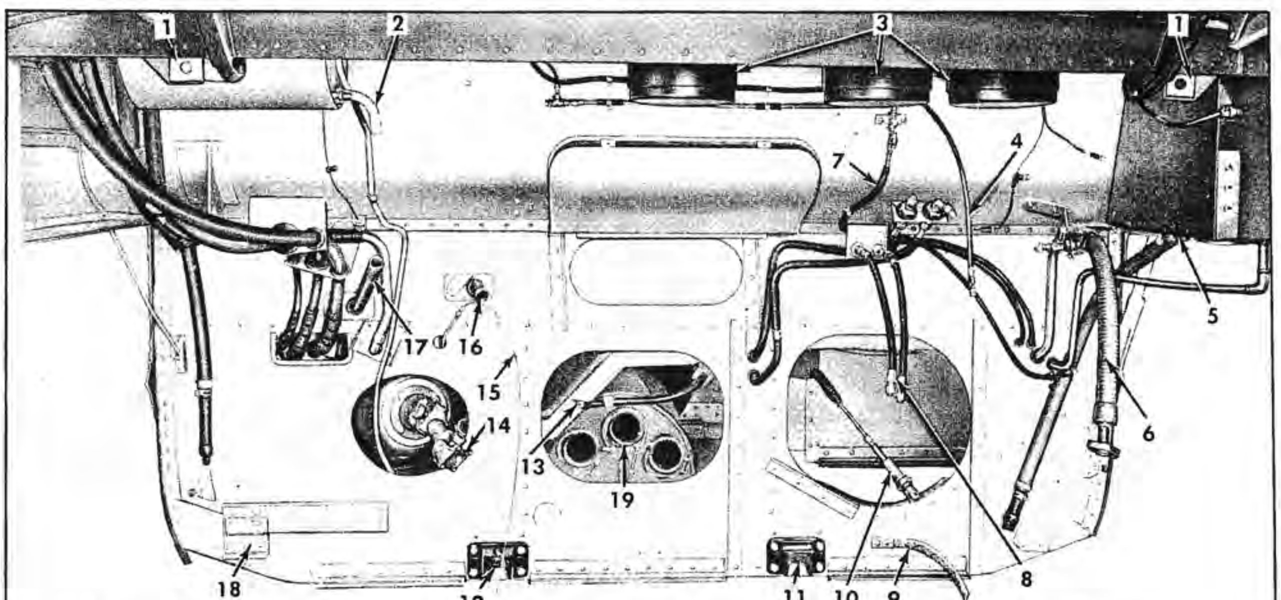
1. Remove dust shields below power plant, and drain cooling system, referring to COOLING SYSTEM (SEC. 6) for draining procedure.

NOTE: Before proceeding with removal operations, disconnect cables from battery terminals and exhaust air from air system.

2. Raise radiator closure door and closure door at right side of engine compartment.

3. Remove engine compartment rear door by detaching door supports from cradle support hangers and removing hinge to body bolts also disconnect light wiring.

4. Remove vertical muffler (fig. 2) to provide



1 Engine Hanger Bracket
2 Pump Return Line
3 Air Cleaners
4 Oil Pressure Line
5 Wiring Connectors
6 Air Compressor Discharge Line
7 Air Compressor Governor Line
8 Fuel Lines
9 Ground Strap
10 Transmission Control
11 Cradle Bracket - R.H.
12 Cradle Bracket - L.H.
13 Battery Cables
14 Air Conditioning Drive
15 Accelerator Cable
16 Heater Return Line
17 Heater Supply Line
18 Radiator Support Bracket
19 Muffler

Figure 11—Engine Compartment Disconnect Points—6 Cylinder Shown

access to hose clamps and heater lines; also, on coaches with horizontal muffler remove nuts and loosen tail pipe to muffler clamps.

5. Disconnect propeller shaft and transmission control as directed in respective sections of this manual. Disconnect ground strap (9).

6. Working below coach, disconnect cables (13) from starter or coach body.

7. At right-hand support hanger and engine oil filter (fig. 13), disconnect oil lines and remove filter bracket bolts. Remove filter.

8. Disconnect wiring and cable from bottom of electrical apparatus box (5), also disconnect wires from switch at governor cover on coaches with hydraulic transmissions.

9. Disconnect air compressor discharge line. (6), and compressor governor line (7).

10. Disconnect fuel lines (8) at junction bracket on engine.

11. Disconnect blower air intake hose, also air compressor air intake hose.

12. Disconnect air line from engine shut-off air cylinder.

13. Disconnect water filter (when used) and cooling system vent line.

14. Disconnect water hose (18) from engine to radiator (8-cyl.) and loosen heater line hose clamps at (16 and 17).

15. Disconnect accelerator control cable (15) from engine at governor.

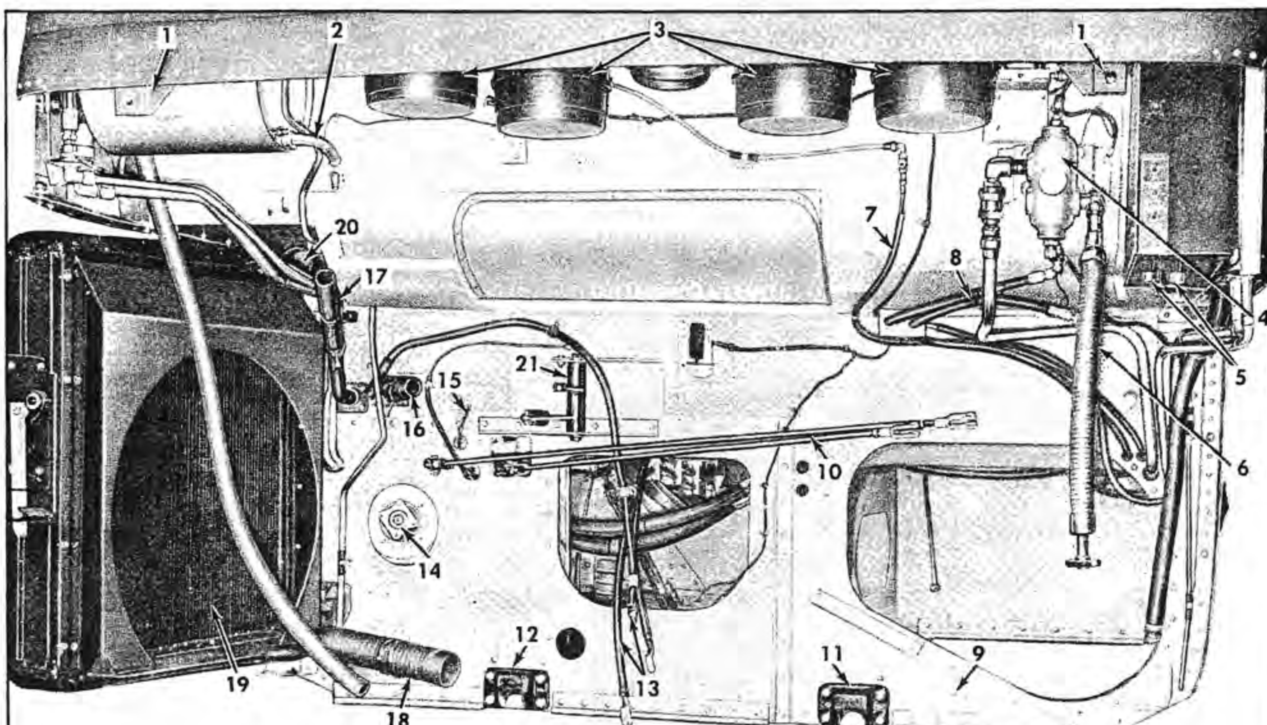
16. Loosen hose (20) at connector on top of radiator used on 8-cylinder engine models.

17. On 6-cylinder engine vehicles only, remove bolts from radiator lower support member bracket (18, fig. 11) and bolt and rubber mountings at radiator upper support.

18. Disconnect oil pressure manifold to engine oil line (4) at engine.

19. Remove right brace member from bracket and from cradle rear member.

20. On mechanical transmission and clutch equipped coaches, disconnect transmission and clutch control rods (10) as directed in respective sections of this manual.



1 Engine Support Hanger Bracket
2 Tank to Pump Line
3 Air Cleaners
4 Discharge Muffler
5 Wiring Connectors
6 Air Compressor Discharge Line
7 Air Compressor Governor Line
8 Fuel Lines
9 Ground Strap Terminal
10 Transmission Control Rods
11 Cradle Bracket - R.H.
12 Cradle Bracket - L.H.
13 Battery Cables
14 Air Conditioning Drive
15 Accelerator Cable Tube
16 Heater Return Line
17 Heater Supply Line
18 Radiator Outlet Hose
19 Radiator
20 Radiator Inlet Hose
21 Clutch Control Levers

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Figure 12—Engine Compartment Disconnect Points—8 Cylinder Shown

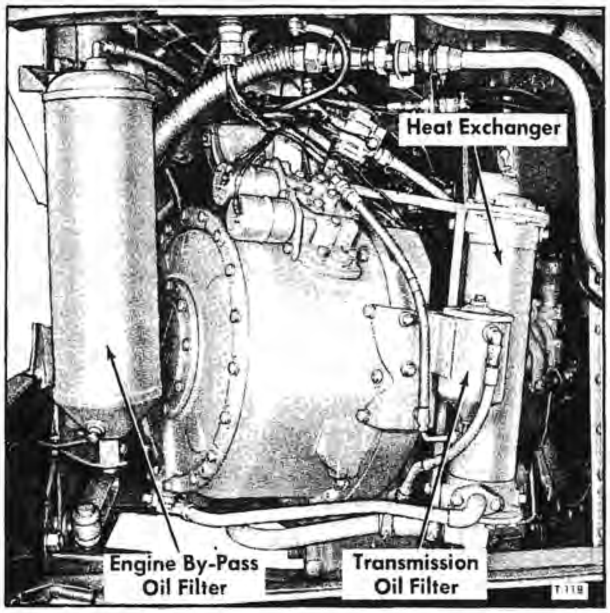
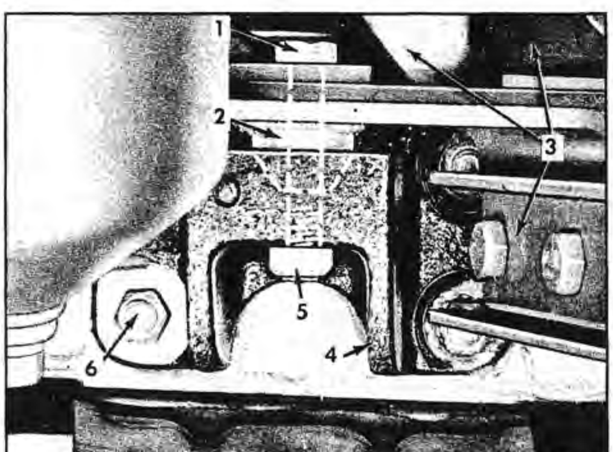


Figure 13—Engine Oil By-Pass Filter, Transmission Oil Filter, and Heat Exchanger Installed

SAFETY CAUTION

Before proceeding with step 21 below, block coach body securely. When adjusting dolly to take weight of power plant, the coach body may be inadvertantly raised just enough to cause height control valves to exhaust, in which case entire weight of rear end of coach will be placed on dolly.



1 Bolt Head	5 Self-Locking Nut
2 Cradle Locating Boss	6 Bracket to Bulkhead Bolts
3 Cradle Members	
4 Bulkhead Bracket (L.H.)	TPM-6990

Figure 14—Construction at L.H. Cradle Bracket at Bulkhead

21. Position engine dolly under cradle and adjust to take weight off cradle hangers, then remove bolts from hanger bracket (1), also remove bolts from cradle brackets (11 and 12). Move power plant away from engine compartment slowly, meanwhile checking as necessary to see that all lines, wiring, and controls are disconnected.

22. Radiator and shroud assembly, and transmission assemblies may be removed by following the pertinent instructions in COOLING SYSTEM (SEC. 6) and HYDRAULIC DRIVE TRANSMISSION MANUAL. Diesel engine may be lifted off cradle using lifting brackets provided at cylinder head.

Refer to DIESEL ENGINE MAINTENANCE MANUAL for repair information covering fluid fan drive mechanism.

ENGINE CRADLE AND MOUNTING INSPECTION

1. Inspect cradle members and engine front support members for wear and possible fractures. Repair as necessary.

2. Check condition of bulkhead brackets and bolts. Replace as necessary.

ENGINE MOUNTINGS

1. Inspect engine front mounting bushings (fig. 9). If bushings are deteriorated or damaged, replace bushings.

2. Inspect engine rear mounting assemblies and engine stabilizer rods (fig. 10). If mountings are oil-soaked or show evidence of failure, replace mountings.

INSTALLING POWER PLANT

Key numbers in text refer to figures 11 and 12 unless otherwise indicated.

Make necessary repairs to exhaust system units before installing power plant. Fan, radiator assembly, and transmission should be assembled to engine, since attaching parts are readily accessible with power plant removed. Refer to applicable section in this manual for details and procedure for installing engine accessories.

The steps listed below should be followed in the order given to install power plant.

1. Move power plant assembly into position, with cradle engaging brackets (11 and 12). Install bolts with nuts at bottom (fig. 14).

2. Install support hangers and connect at brackets (1). Tighten all bolts including those at bulkhead brackets firmly.

3. Remove dolly from cradle.

4. On 6-cylinder engines only, connect radiator support member at bracket (18, fig. 11), and install radiator mounting parts at upper support, also tighten hose clamps at radiator connection on surge tank.

5. Connect heater lines (16 and 17) and install engine thermostat housing to surge tank pipe and hose. Heat shield must be in place to shield muffler heat from hose at right-hand end of pipe.

6. Connect oil pressure line (4) at engine, and connect air line between solenoid valve and shut-off air cylinder on engine governor.

7. Connect wiring to bottom of apparatus box in engine compartment, also connect wiring at switch on transmission governor housing.

8. Connect and adjust accelerator control. Refer to FUEL SYSTEM (SEC. 12) for instructions.

9. Install air intake hose at air cleaner manifold, also connect air compressor intake hose.

10. Connect water filter lines (when used) and cooling system vent line (2).

11. Connect fuel lines (8) at junction bracket on engine.

12. Install oil filter assembly at right support hanger and connect lines (fig. 13).

13. Connect wiring at bottom of electrical apparatus box.

14. Install air compressor discharge line (6) and compressor governor line (7).

15. Referring to respective sections of this manual, connect propeller shaft and transmission control.

16. Reconnect drive to engine as directed in AIR CONDITIONING (SEC. 26) of this manual.

17. On vehicles with mechanical transmission and clutch install control rods and readjust as necessary as directed in respective sections of this manual.

18. Connect cables (13) at starter and connect ground strap (9).

19. Install cradle brace member and baffles bolting member to bracket and cradle.

20. Install air cleaner to blower intake hose; also, install air compressor air intake hose.

21. Install vertical muffler on 8-cylinder engine coaches, or reconnect exhaust pipes to horizontal mufflers, using attaching clamp.

22. Install compartment rear door and prop in open position.

23. Refer to COOLING SYSTEM (SEC. 6) and fill system as instructed.

24. Install dust pans below power plant.

25. Connect battery cables and start engine. Check for oil and water leaks.

26. Close right, left, and rear engine compartment doors.

EXHAUST MUFFLER REPLACEMENT

The exhaust muffler used on these coaches are mounted vertically in engine compartment (fig. 2) on 8-cylinder engines or horizontally between engine and rear axle bulkheads (fig. 15) on 6-cylinder engines.

REMOVAL

Vertical Type

At bottom remove clamp bolt and nut, then lower clamp down onto exhaust pipe. At center of muffler remove clamp bolt and nut, then remove clamp. Muffler can now be lifted upward and outward to remove.

Horizontal Type (Fig. 15)

1. Remove nuts at three clamps securing exhaust and tail pipes to muffler. Position clamps rearward on pipes.

2. Support muffler, then remove nuts from hanger strap eye bolts, then lower muffler to remove.

INSTALLATION

Vertical Type

Set muffler in place on exhaust pipe, then install clamp attaching muffler to exhaust pipe. Install center strap around muffler and secure with strap eye bolt and nut.

Horizontal Type

1. Position muffler assembly in hanger brackets, then install hanger straps around muffler and over hanger brackets. Install strap eye bolts and nuts.

2. Install clamps securing tail and exhaust pipes to muffler. Tighten clamp nuts securely.

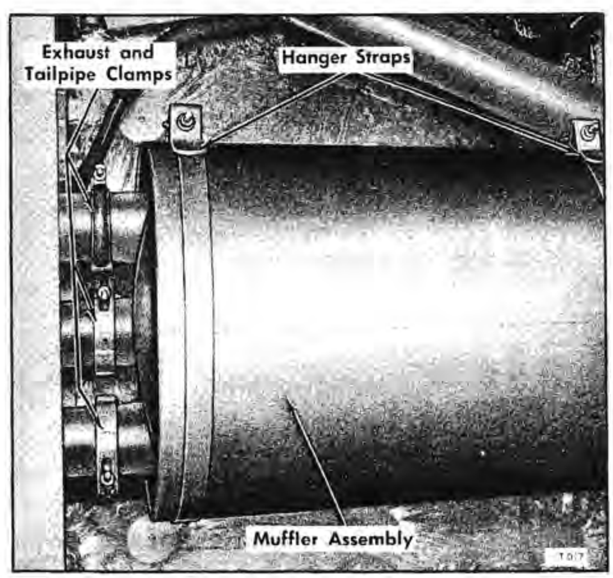


Figure 15—Exhaust Muffler Installed—Horizontal Type

SPECIFICATIONS

ENGINE
- Model-6 Cyl. 6V-71
- Model-8 Cyl. 8V-71
- Bore .... 4¼"
- Stroke .... 5"
- Displacement (Cu. In.)(6V) 425.6
- Displacement (Cu. In.)(8V) 567.5
- Engine Rotation .... Counterclockwise
- Firing Order ... 6V-71 .... 1L - 1R - 2L - 2R - 3L - 3R
- Firing Order ... 8V-71 .... 1L - 1R - 2L - 2R - 4L - 4R - 3L - 3R
- Engine Governed Speed (No Load) .... 2150 RPM

Low Oil Pressure Switch
- Make .... AC
- Type F-1
- Contacts Break (Lbs. Pressure) 2-3

Oil Pressure Gauge on Instrument Panel
- Make .... AC
- Type .... Electric
- Gauge Unit No. 1509089
- Sending Unit No. 1506502
- Voltage 12
- Range 0-120

Oil Pressure Switch
- Make .... AC
- Type .... F

Emergency Stop Solenoid
- Make .... Delco-Remy Division
- Model 1114404
- Voltage 12
- Current Consumption (Amps.) .... 11.5-14.0@9 Volts

Engine Stop Solenoid Valve
- Make .... Skinner Chuck Co.
- Model V5-23150
- Plunger Spring
  - Approx. Free Height .... ⅜"
  - Height Under Load of 4.5-5.5 oz. .... $\frac{3}{16}$"

Fuel System

Fuel system units covered in this section include: fuel tank, lines, and filters; accelerator pedal and linkage; air cleaners; and system specifications. Other items, such as injectors, engine governor, fuel pump, and blower are covered in current Diesel Engine Maintenance Manual. Approved specifications for Diesel fuel oil will be furnished upon receipt of request.

FUEL TANK AND LINES

Schematic layout of fuel tank, lines and filters is shown in figure 1. Tank is installed in compartment at right side of coach and is equipped with a signaling device which emits a whistling sound as tank is filled. Two fuel lines run from tank to engine compartment at rear of coach. Pump at engine draws fuel through supply line and primary filter and discharges fuel through secondary filter and into fuel manifold passage in engine left-hand cylinder head. Crossover lines connect fuel passages in left and right cylinder heads at front of engine. Surplus fuel is returned to tank through return line. Primary and secondary fuel filters are mounted on engine as shown in figure 7, and use disposable elements, as illustrated in figures 8 and 9. Refer to "Fuel System Maintenance" later in this section for method of servicing. Check valve located in supply line at mounting bracket (fig. 1), serves to keep supply line full of fuel while servicing filters, or when fuel lines are disconnected in engine compartment. The restricted fitting in return line at engine junction bracket (fig. 1) serves to assure the fuel pressure required to feed injectors.

ACCELERATOR AND LINKAGE

Accelerator pedal and linkage at front of coach is shown in figure 2. Pedal movement is transmitted to rear of coach through flexible cable encased in metal tubing. Linkage in engine compartment is shown in figure 4.

Adjustable stop screw at floor limits accelerator pedal travel. Boots are clamped in place at control cable telescopic ends to exclude dust and moisture. Linkage at front of coach (fig. 2) is accessible from below vehicle. Operation and maintenance of accelerator interlock air cylinder (8, fig. 2) is covered in BODY (SEC. 3) under "DOORS AND CONTROLS" of this manual.

ACCELERATOR LINKAGE
REPLACEMENT AND ADJUSTMENT

Key numbers in text refer to figure 2, except as otherwise indicated.

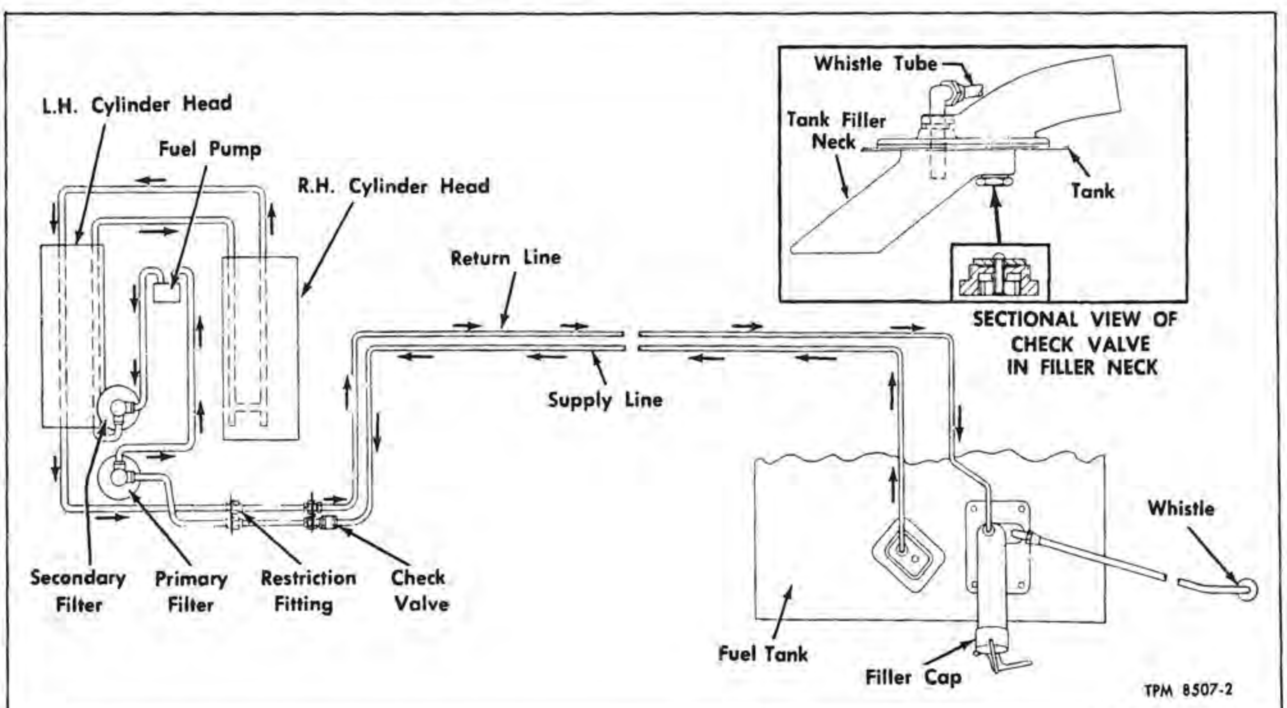


Figure 1—General Arrangement of Fuel Tank, Lines, and Associated Units

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FUEL SYSTEM

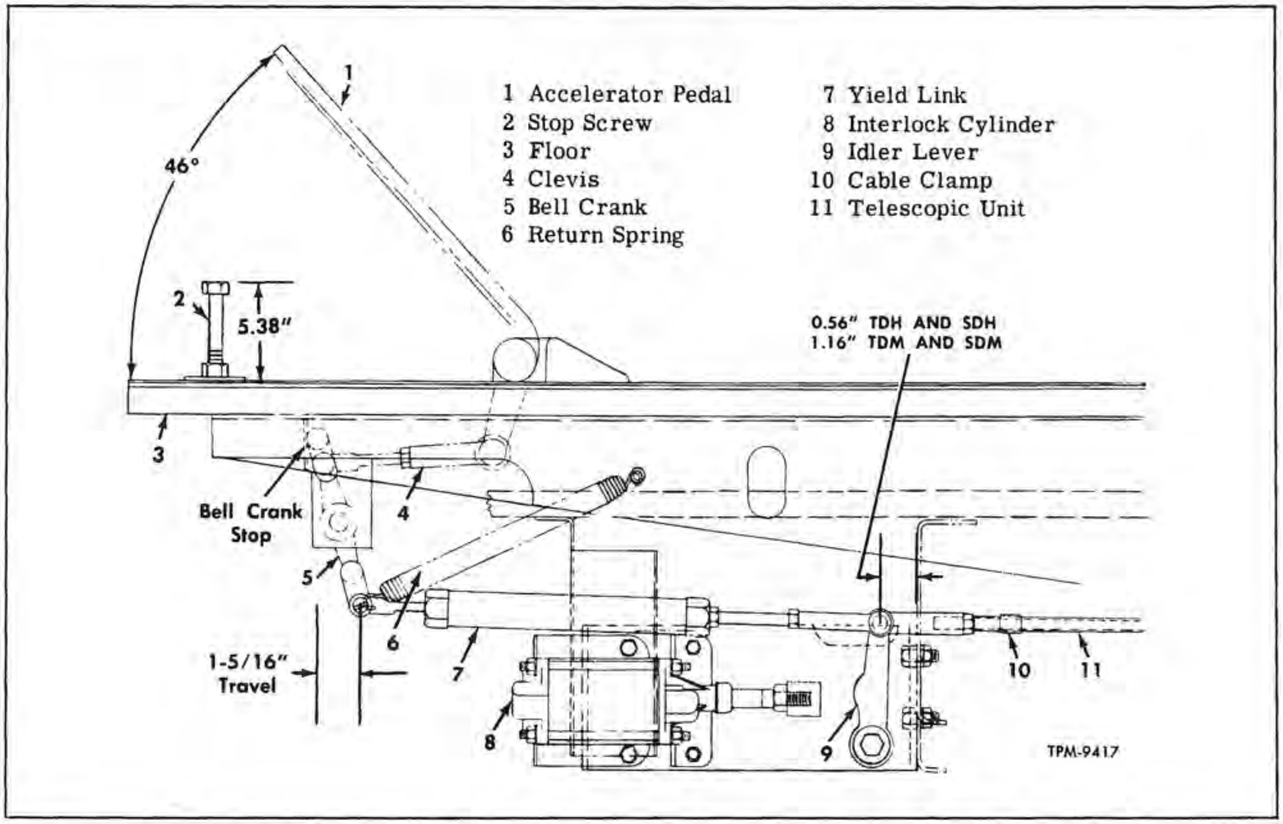


Figure 2—Accelerator Pedal and Linkage At Front of Coach

Removal

1. Unhook spring (6) at front end of coach below floor.

2. Loosen cable clamp (10) and remove lock; then if necessary to remove cable, loosen clamp 4, fig. 4) and remove lock in engine compartment then pull cable out of conduit.

3. At front end, remove clevis pins and attaching parts to remove accelerator interlock (when used) yield link (7), or cable outer slider end on coaches without interlock, bell crank (5) etc.

4. Removing clevis pin (5) and flat washers (fig. 4) at bell crank on engine permits removal of clevis and adjustable yoke (6) (fig. 4) with boot as an assembly.

Cleaning and Inspection

1. Wash cable in suitable cleaning solvent to remove old lubricant.

2. Carefully examine cable for kinks and for broken strands. If any damage is evident, new cable must be installed. Overall length of cable is 510 inches. Ends of new cable must be chamfered by grinding. To prevent frayed windings, grinding must be done only in direction of outer windings.

3. Inspect cable conduit for breaks, dents, and flat spots. Any condition which would prevent free movement of cable necessitates replacing damaged section of conduit.

CAUTION: When replacing conduit, make sure it is clean and that cable will pass through it freely. Use extreme care in installing conduit to prevent bending or flattening.

Front Linkage Installation and Adjustment

Key numbers in text refer to figure 2.

1. Assemble front linkage components as shown in figure 2. On coaches with hand throttle (fig. 3) the hand throttle lever must be assembled on bellcrank pin as shown in figure 5. With return spring (6) installed so upper end of bellcrank (5) is held against stop on bracket, adjust clevis (4) as necessary to position pedal (1) at 46-degree angle as shown.

2. Adjust stop screw (2) to 5.38" height as shown and check operation of pedal.

NOTE: If pedal position and stop screw height are correct, lower end of bellcrank (5) will travel 1-5/16 inches as pedal is depressed from released position to stop screw.

3. On coaches equipped with accelerator interlock, assemble yield link assembly (7), idler lever (9), and telescopic unit (11), with clamp (10) and boot. Adjust clevis on yield link (7) so clevis

pin will be to dimension shown in figure 2, from bulkhead.

4. On coaches not using accelerator interlock, attach telescopic unit assembly to bellcrank (5).

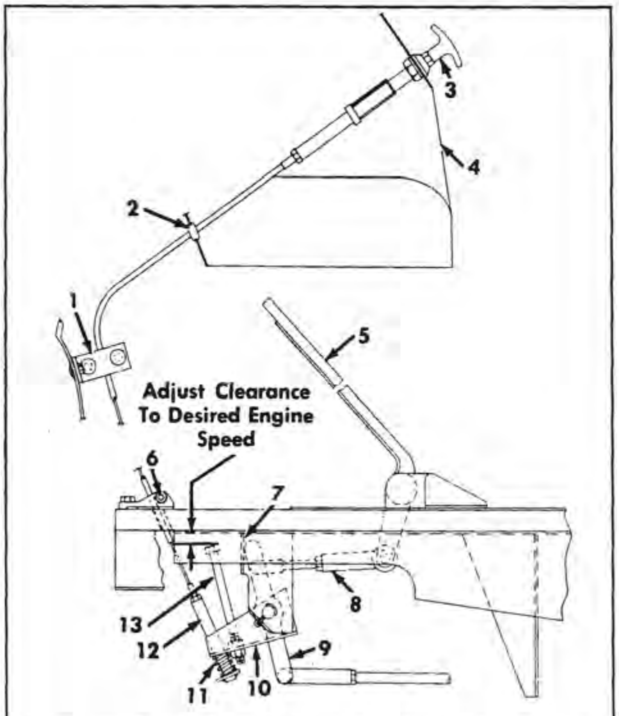
5. Before clamping boot in place, lubricate inner and outer tubes of telescopic unit with special lubricant and adjust outer tube in clevis so there is 3/8 inch from end of outer tube to swivel (fig. 4).

6. Fit boot over swivel and clamp forward end to outer tube with breather hole downward.

Installing Cable

1. Dip end of cable in special lubricant as specified in LUBRICATION (SEC. 13) of this manual, then feed cable into conduit from rear end applying lubricant to cable as cable is installed. Continue to feed cable into conduit until cable emerges at front end of front telescopic unit (11, fig. 2). Test cable for free movement.

2. Install lock to secure cable to front telescopic unit (11, fig. 2). Slide clamp (10, fig. 2) over lock and tighten clamp bolt. Install rubber seal on front end of cable and push seal against sliding end.



1 Upper Guide Bracket	8 Adjustable Yoke
2 Grommet	9 Bell Crank
3 Throttle Handle	10 Throttle Lever
4 Instrument Panel	11 Spring
5 Accelerator Pedal	12 Cable End
6 Lower Guide Bracket	13 Adjustable Stop Bolt
7 Stop Bracket	

TPM-9418

Figure 3—Hand Throttle Installation (Spec. Equip.)

Installation and Adjustment of Linkage in Engine Compartment

Key numbers in text refer to figure 4.

1. If link assembly (8) is removed, adjust length so ball studs will fit into lever and bellcrank (7) and lever (10) with approximately 3-3/4 inch between hole center lines as shown.

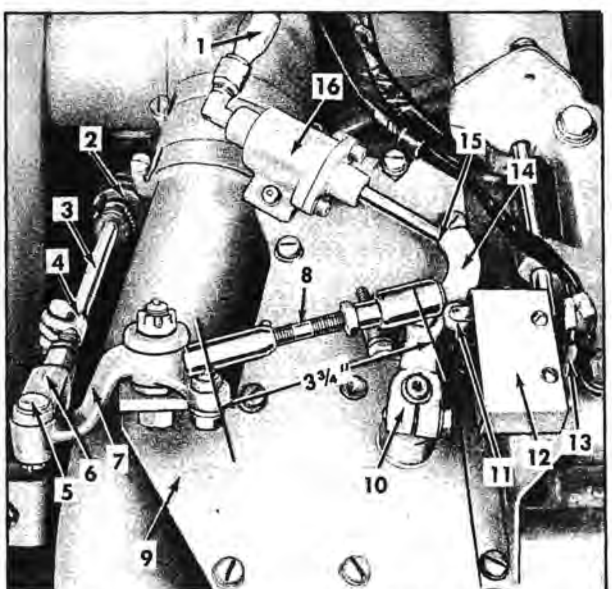
2. Lubricate inner and outer tubes of telescopic unit sliding end (3) with special lubricant, slide boot (2) on outer tube. Block accelerator pedal down against stop screw, then place outer sliding end (3) over cable and inner tube. While holding sliding end (3) 3/8 inch from swivel (fig. 5) install cable lock, slide clamp (4) over lock and tighten clamp bolt.

3. Cut off excess cable which may protrude more than 1/2 inch beyond end of threads on sliding end (3). Install rubber seal on rear end of cable and push seal tight against sliding end.

4. Release accelerator pedal. Fit boot (2) on swivel and clamp rear end to sliding end (3).

5. Install lock nut and adjustable yoke on threads at end of sliding end (4).

6. Using clevis pin and two flat washers as shown, connect sliding end yoke to bellcrank (7). Secure clevis pin with cotter pin.



1 Air Line	10 Throttle Lever
2 Sliding End Boot	11 Switch Lever Roller
3 Outer Sliding End	12 Switch Cover
4 Clamp	13 Wiring Terminals
5 Clevis Pin	14 Engine Stop Lever
6 Adjustable Yoke	15 Clearance Point
7 Bell Crank	16 Shut-off Air Cylinder
8 Link Assembly	
9 Governor Housing Cover	

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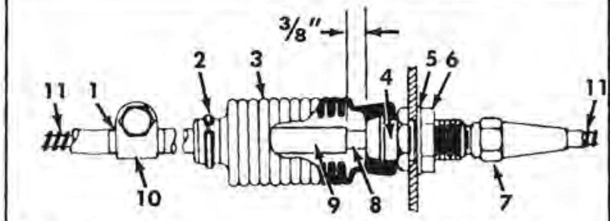
Figure 4—Accelerator Linkage At Engine Governor

FUEL SYSTEM



1 Cable Lock	7 Conduit Nut
2 Boot Clamp	8 Inner Sliding End
3 Boot	9 Outer Sliding End
4 Swivel Assembly	10 Clamp
5 Lock Washer	11 Cable
6 Nut	

TPM-7354

Figure 5—Installation At Sliding Ends

Setting Engine Shut-off Lever Position

Key numbers in text refer to figure 4, unless otherwise indicated.

1. With air pressure at 80 pounds or more, and "MASTER" control switch in "OFF" position, try moving shut-off lever (14) away from piston rod (16). It should be possible to move lever (14) approximately 1/16 inch away from piston rod air cylinder (16) at point 15.

2. If procedure in step 1 above shows a tight condition between rod and lever or if lever can be moved more than 1/16 inch, set position of lever (14) on governor shaft as directed in following step.

3. Exhaust air from shut-off air cylinder (16). Loosen clamp bolt on lever (14) sufficiently to permit lever to be pivoted on shaft with medium to heavy friction. Push lever toward piston rod. Turn engine control switch to "OFF" position to apply air to shut-off air cylinder (16), then with air applied to cylinder carefully pull shut-off lever away from end of rod to provide 1/16 inch at point 15, as described in step 1 above. Tighten clamp bolt in lever (14) to lock lever to governor shaft.

ENGINE MODULATING RELAY OVERRULE SWITCH

Key numbers in text refer to figure 4.

Engine modulating relay overrule switch (some models) is installed at engine governor housing and mounted on bracket which has elongated holes to permit moving the switch and cover.

Switch Replacement and Adjustment

Removal

1. Remove wires from switch terminals (13).

2. Remove two bolts which mount switch and cover on bracket. Separate switch and cover.

Installation and Adjustment

1. Be sure governor housing cover screws which attach switch bracket are tight. Place cover over switch and insert two switch mounting bolts through holes in cover and switch.

2. Position switch assembly on bracket and loosely install nuts and lock washers on mounting bolts.

3. With air exhausted from shut-off air cylinder (16) and accelerator released (governor linkage in idle position), move switch assembly so roller (11) contacts lever (10). Carefully move switch toward lever until faint click is heard which indicates that roller lever has actuated the switch, then tighten switch mounting bolts.

4. Attach wires to two end terminals (13), as shown. Center terminal on switch is not used.

5. Operate linkage to determine if lever (10) contacts roller (11) and breaks circuit when linkage returns to idle position.

FUEL SYSTEM MAINTENANCE

AIR INTAKE

ENGINE AIR INTAKE (Fig. 6)

Air for engine is taken in through two screened openings - one above each rear side window. Air passes through ducts which lead to air cleaners mounted to duct above engine compartment. After passing through air cleaners the air enters air cleaner manifold to which is connected the blower air intake. Arrows on figure 6 indicate direction of air flow.

Air supply for air compressor is drawn through hose installed between compressor inlet fitting and an elbow on pipe below air cleaner manifold.

A removable cover is provided at location shown in figure 6 for cleaning intake air ducts.

AIR CLEANERS

Air cleaners are used to remove dust and dirt before it reaches Diesel engine blower. Air cleaners are accessible from engine compartment. Refer to cross section view of air cleaner in figure 6 for construction. Intervals for servicing air cleaners and method of cleaning is contained in LUBRICATION (SEC. 13) of this manual.

SERVICING AIR CLEANERS AND AIR INTAKE SCREENS (Fig. 6)

Importance of keeping air cleaners in proper condition should be impressed on those responsible for mechanical upkeep of engine.

Unless air cleaners are cleaned periodically as service conditions require, they will not function properly, and in some instances, actually aggravate the condition which they are designed to prevent.

When air cleaner is loaded and dirty, and is used past its saturation point, some of this fine abrasive will get past cleaner and cause considerable damage to pistons, cylinder walls, and bearings.

For those reasons, air cleaners must be cleaned at regular intervals as specified in LUBRICATION (SEC. 13) of this manual.

Periodic inspection should be made at air intake openings to determine if screens have become clogged. Screens are held in place by screws and screens can be removed for cleaning. An access plate shown in figure 6 can be removed to permit cleaning of intake air duct when necessary.

PRIMARY AND SECONDARY FILTERS

Two fuel oil filters are mounted on engine as shown in figure 7, and sectionally illustrated in figures 8 amd 9.

Primary filter assembly uses a "sock" type element, while secondary filter element is a paper type. Elements are not cleanable and must be replaced whenever their efficiency is impaired due to accumulation of foreign matter. In order for these filters to function properly, they must be given proper care. Service in following manner:

PRIMARY FILTER

Primary filter (fig. 8) must be drained frequently because if water is present in the fuel it is most likely to accumulate in this filter. No definite draining periods can be given here, inasmuch as

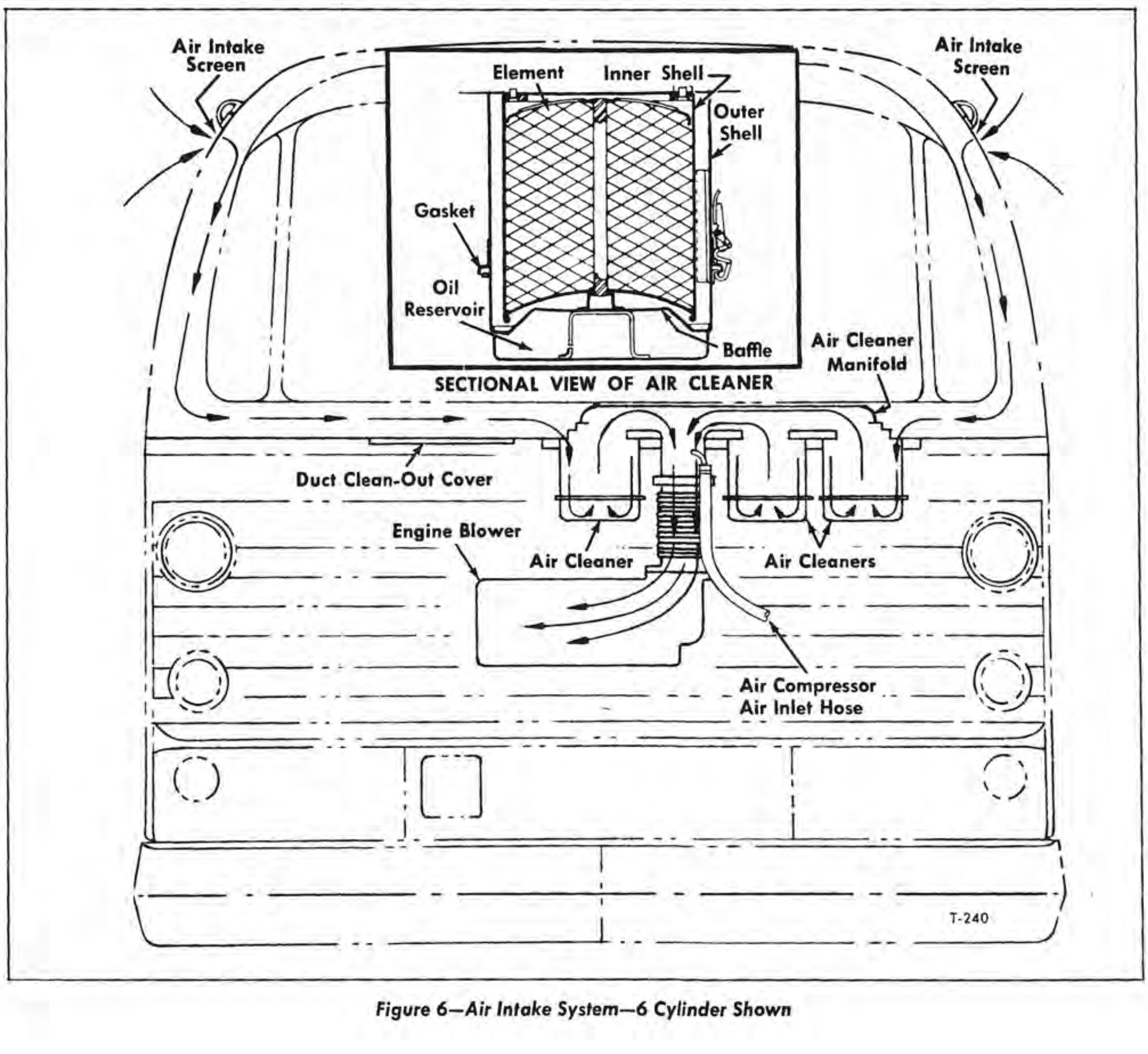
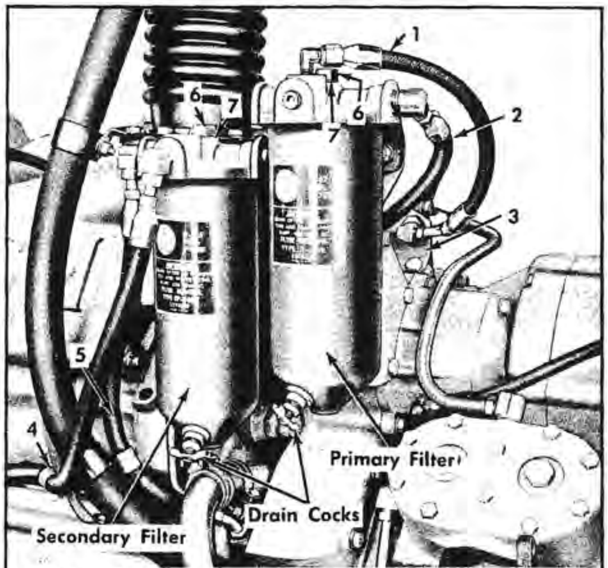


Figure 6—Air Intake System—6 Cylinder Shown



1 Line from Tank
2 Line to Pump
3 Fuel Line Junction Bracket
4 Line from Pump
5 Line to Cylinder Head
6 Bolt
7 Gasket

TPM 9507

Figure 7—Primary and Secondary Fuel Filters Installed (Typical)

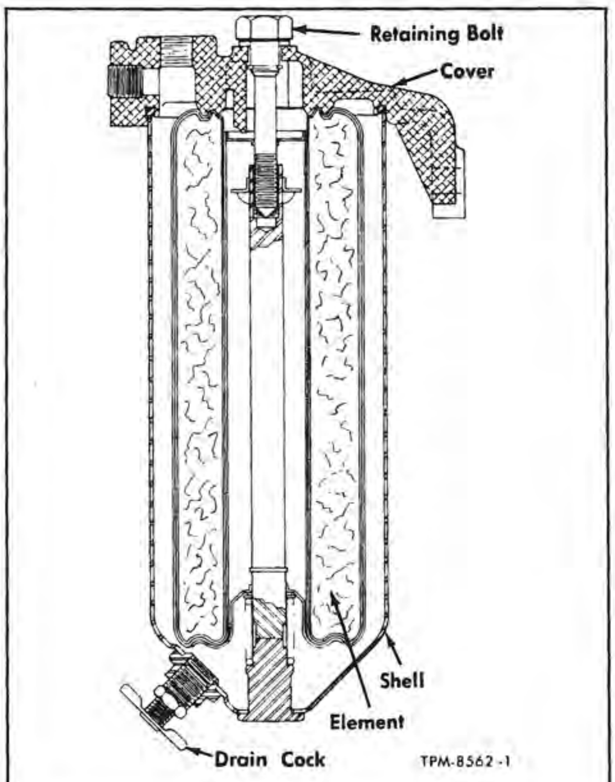


Figure 8—Sectional View of Primary Fuel Filter

the necessity for draining depends upon the cleanliness of the fuel put into the fuel tank. It is recommended, that a small amount of fuel oil be drained from this filter daily, noting the water content (if any), then from this experience definite draining periods may be established. Drain filter by opening drain cock at bottom of filter. If water in any amount is regularly found in this filter, it is an indication that something is wrong in the method of handling and storing of the fuel oil and a thorough investigation must be made to eliminate the trouble; then the fuel tank lines and both filters should be drained and cleaned. The only water that will normally accumulate in the fuel system is from condensation in the fuel tank.

Replacing Primary Filter Element

In addition to periodic draining as described in preceding paragraph, element should be replaced and filter should be thoroughly cleaned every 5,000 miles as follows:

1. Open drain cock at bottom of filter and allow filter to drain.
2. Remove bolt at top of filter and withdraw shell and filter element assembly. Lift filter element out of shell and discard element.
3. Wash all filter parts, in a suitable cleaning solvent.
4. Inspect filter housing gasket, element gasket, and bolt gasket, replace if not in good condition.
5. Install new element in filter shell, then install shell to cover. Tighten retaining bolt.
6. When engine has been started check carefully for oil leaks.

SECONDARY FILTER

It is recommended that secondary filter (fig. (10) be drained at same intervals as primary filter. Refer to "Primary Filter" in previous paragraph for intervals.

In addition to draining, the following check should be made at intervals of approximately 5,000 miles to determine the condition of the element, This check may be made by disconnecting outlet fuel line at filter and installing a pressure gauge connected to a "tee." Start engine and note presure on gauge. If the pressure reading is less than 15 lbs. at 2,000 rpm, the element must be removed and replaced. Do not open the filter except at time of element replacement. Replacement usually will be required every 10,000 miles or 500 hours. DO NOT ATTEMPT TO CLEAN AND REINSTALL FILTER ELEMENT.

Replacing Secondary Filter Element

If periodic check, as described in previous paragraph, indicates filter element should be changed, proceed in same manner as described in paragraph under heading "Replacing Primary Filter Element."

ACCELERATOR CONTROLS

Lubrication and Inspection

Clevis pins and pivot points at accelerator control linkage must be lubricated periodically as instructed in LUBRICATION (SEC. 13). Cable and sliding ends are lubricated at time cable is installed and periodic lubrication is not required; however, the boots (3, fig. 5) should be inspected at regular inspection intervals. If cable requires replacement, lubricant as specified in LUBRICATION (SEC. 13) of this manual, must be applied. Since correct adjustment of accelerator controls is necessary to prevent excessive strain on linkage, a periodic check should be made to assure proper adjustment as previously described under "Accelerator Linkage Replacement and Adjustment," in this section.

EMERGENCY STOP MECHANISM

Inspection

Make periodic inspection of emergency stop solenoid to assure its being operative. Mounting bolts must be tight and wire connection clean and tight. Refer to ENGINE (SEC. 8) for other maintenance procedures and for solenoid specifications.

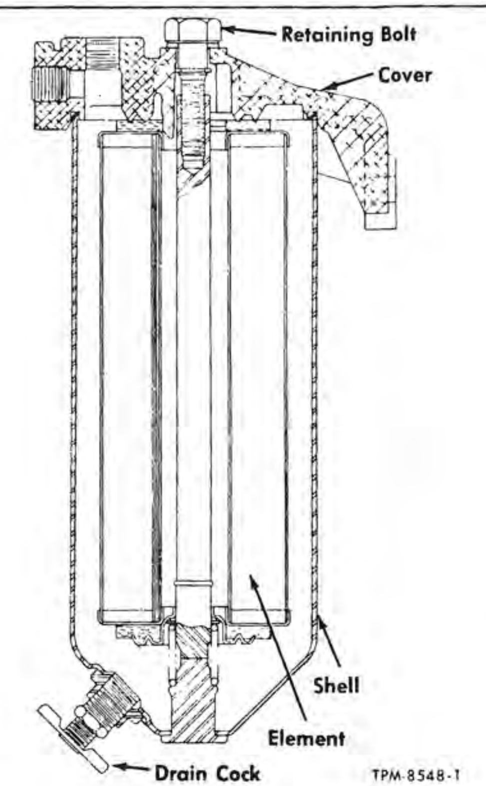


Figure 9—Sectional View of Secondary Fuel Filter

Refer to next page for Fuel System Specifications.

SPECIFICATIONS

FUEL FILTER

Primary

Make	AC
Type	Disposable
Element Type No.	T-552

Secondary

Make	AC
Type	Disposable
Element Model	TP-540X

AIR CLEANERS

Number Used	(3-6V or 4-8V)
Make	AC
Type	Oil Bath
Capacity	2 Qts. Ea.

FUEL TANK

Capacity	95 gal.

Lubrication

USE OF CHART

The separate lubrication chart at back of this manual indicates location of points requiring periodic lubrication. This chart will serve the purpose of approximately locating various fittings and points of lubrication. When necessary, more detailed information on accessibility of lubrication points is described in following paragraphs.

INTERVALS

Intervals indicated on the chart are recommended for normal service. More frequent intervals may be used, if necessary, under severe operating conditions. A continuous oil testing program on engine transmission and axle lubricants taken at regular intervals is strongly recommended, to establish realistic drain periods commensurate with severity of service and to maintain a regular check on engine, transmission or axle condition. This service can be made available by oil suppliers. (See also "OIL CHANGE PERIODS".)

METHODS OF LUBRICATION

Various methods of applying lubricant are described in following paragraphs.

Whenever cleaning, removal or disassembly procedures are necessary to lubricate various units, such procedures are listed in applicable sections in the manual.

LUBRICANTS

Types of recommended lubricants are indicated on the chart by symbols. Descriptions of these lubricants are given in following paragraphs covering each type. In the selection of the proper type of lubricants, the reputation of the oil supplier must be considered, as he must be responsible for the quality and performance of his product. Descriptions of the lubricants given will assist the operator to demand the correct quality and type.

MEANING OF LUBRICANT SYMBOLS

Symbol	Type of Lubricant
E	Engine Oil
SG	Steering Gear Lubricant
MP	Multi-Purpose Gear Lubricant
G	Straight Mineral Gear Oil
C	Chassis Lubricant
S2	High Temperature Grease
S3	Petroleum Jelly (Petrolatum)
S7	Refrigeration Machine Oil
S13	Radiator Shutter Fluid
S19	Type A Fluid
S20	Special Lubricant
S25	Air Conditioning Compressor Oil
S26	Special Multi-Purpose Grease

LUBRICATION AT ASSEMBLY

In addition to items shown on chart, some items require lubrication only at assembly. Refer to applicable section in manual for lubrication procedures on such items.

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ENGINE OIL (SYMBOL "E" ON CHART)

TYPES OF OIL

Crankcase oils in service, unless protected by suitable addition agents, oxidize, form sludge and varnish, and under some driving conditions corrosive acids may accumulate in the crankcase. Heavy Duty engine oils minimize the formation of these harmful decomposition products and generally aid in obtaining extended trouble-free service.

The oil industry markets various types of engine oil under certain service designations, such as "ML," "MM," "MS," "DG," "DM," and "DS." Best quality heavy duty engine oils are designated as for service "DG," "DM," or "DS."

RECOMMENDATIONS

The responsibility for engine oil quality and performance - the application of the engine oil to the particular engine operating conditions - must remain with the engine oil supplier.

The selection of a reliable supplier, therefore with close attention to his oil and filter element change recommendations can provide satisfactory lubrication and longer life for your engine.

Supplement 1 (S-1) heavy duty engine oils designed for service "DM" and which meet or exceed the requirements of MIL-L-2104A are recommended for use in Diesel engines. Supplement 1 (S-1) oils which are also "MS Sequence Qualified" would be most desirable.

Series 3 type engine oils (for service "DS") should be used only to overcome sludging conditions encountered with light load operation at temperature of 0°F. or below.

In some types of operation, multiviscosity engine oil may prove to be satisfactory. Application of this type of oil should be worked out with the supplier on his assurance of quality and satisfactory performance of his product in your engines.

LUBRICATION

Regardless of oil type used, suppliers should assure the following in furnishing oil for GM Diesel engines:

1. Good resistance to "scuffing" or excessive wear.
2. Good resistance to formation of high or low temperature deposits.
3. Good protection against rust and corrosion.
4. Good resistance to oxidation, thinning out in service, and excessive consumption.

"The use of proprietary blends of supplementary additives or concentrates such as engine oil supplements, break-in oils, tune-up compounds, friction reducing compounds, etc., is not recommended in lubricating oils of the Diesel engines in GMC Truck & Coach vehicles. A lubricating oil additive is available from GMC Dealers specifically for gasoline engines."

CHANGING OIL

The engine is initially filled with lubricating oil of high quality. This oil should not be drained until the regular change period that has been established for your operation.

The intervals at which crankcase oil should be changed depend entirely upon the type and quality of oil used, the severity of vehicle operation, and the mechanical condition of the engine. Oil changing is closely related to filter element and air cleaner element changing. THE OIL MUST BE CHANGED OFTEN ENOUGH TO KEEP IT NON-ABRASIVE, NONCORROSIVE AND REASONABLY CLEAN. It is imperative that regular intervals be established and crankcase oil and oil filter element be changed regularly.

Crankcase should be drained only after running when oil is hot.

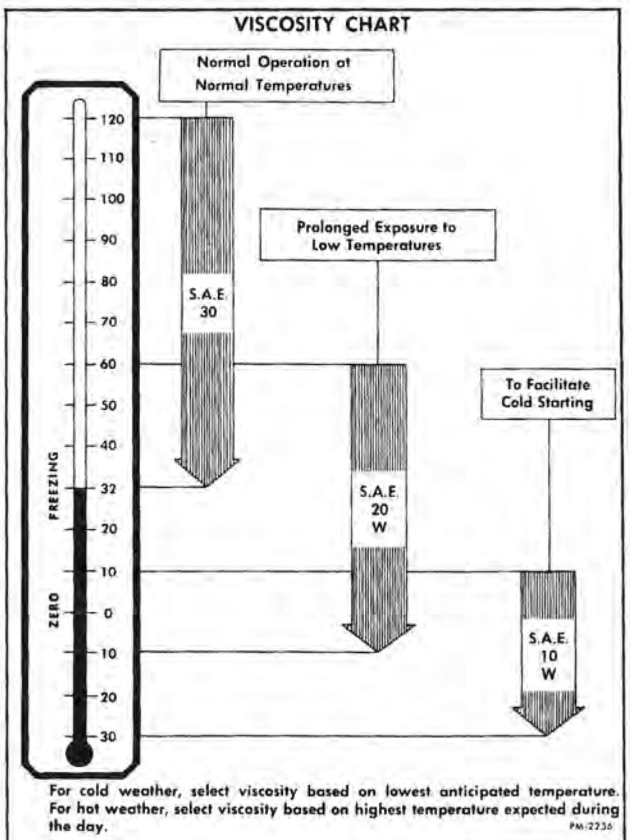


Figure 1—Engine Oil Viscosity Chart

OIL CHANGE PERIODS

(See "INTERVALS" Also)

In general service, using fuels conforming to GMC fuel recommendations, and using oil of MIL-L-2104A Supplement 1 or A.P.I. Service Classification "DM" (see Note 2), drain crankcase every 4,000 miles or 30 days, whichever occurs first (see Note 1).

If Series 3 oil is used, oil change period should be on oil suppliers recommendation (see Note 1).

Note 1

Use of independent laboratory oil analysis reports or oil supplier recommendation should be made to determine if more or less frequent oil and filter change periods are required, or possible.

Note 2

Some suppliers designate as "MS-DM."

VISCOSITIES

Atmospheric temperatures and severity of service determine the viscosity grade of engine oil to use.

As a guide to the selection of the proper grade or viscosity of oil to be used at various atmospheric temperatures, refer to "Viscosity Chart" shown in figure 1. If cold starting is a problem, use of lighter oil will lessen starting difficulties.

CHECKING OIL LEVEL

Daily, or oftener if necessary, check oil level. Make the check preferably after a day's run and after engine has been stopped for a few minutes. Remove dipstick, wipe clean with cloth, reinsert and remove again. The upper mark on engine oil dipstick is "FULL," the lower "ADD." Keep level as close as possible to "FULL" mark without overfilling. Do not operate with level below "ADD" mark.

TRANSMISSION (MECHANICAL)

Transmission lubricant should be Heavy Duty engine oil of the same type as used in engine.

VISCOSITY

During summer (Above 32°F.) use S.A.E. 30 or S.A.E. 20 during winter (Below 32°F.).

CHECKING LEVEL

Transmission oil level dipstick is marked "OIL LEVEL." The dipstick is located in a tube at side of transmission and is accessible after transmission compartment door is opened.

Oil level should be checked immediately after a run when the oil in transmission is hot. The oil level should then be at "OIL LEVEL" mark on dipstick.

DRAINING

Drain after first 3,000 miles of operation and thereafter at recommended intervals.

Transmission should be drained while unit is warm, preferably immediately after a run. Drain plug is located in the transmission case sump at bottom of flywheel housing and is accessible under the engine compartment after compartment bottom pan is dropped. On wet clutch, also remove plug at bottom of flywheel housing to completely drain the transmission and clutch. Magnetic type plugs should be thoroughly cleaned before reinstalling.

FILLING

After thoroughly draining, fill through filler plug hole at top of transmission. Run engine several minutes, then recheck oil level at dipstick immediately after stopping engine. Level should be brought to "OIL LEVEL" mark on dipstick.

OTHER ENGINE OIL USES

BLOWER AIR CLEANERS

Blower air cleaners, accessible after engine compartment door is raised, should be serviced at intervals recommended on chart. If service conditions warrant, cleaning and servicing intervals should be more frequent.

1. Release two latches near bottom, then pull reservoir downward.

2. Lift oil baffle from reservoir, then pour oil from reservoir. Clean reservoir and baffle in cleaning fluid to remove all accumulated deposits.

3. Pull element downward and out of cleaner body. Slush element up and down in bath of cleaning fluid, until all oil and dirt deposits are removed. Permit element to dry thoroughly, but do not use compressed air.

4. Whenever inspection indicates that space between body and liner is restricted, liner should be removed and cleaned.

5. Reinstall element in body liner, being sure that element is pushed up as far as possible.

Figure 2—Oil Level In Air Cleaner Reservoir

6. Fill reservoir up to "OIL LEVEL" mark on bracket at center of reservoir (fig. 2) using same grade of oil as used in engine. Install oil baffle at center of reservoir.

7. Install reservoir to cleaner body, then secure with two latches.

OIL FILTERS

Two engine oil filters are used on these vehicles. One filter is mounted near front of engine and is a "full-flow" type, also another filter is mounted at right engine cradle support and is a "by-pass" type.

Element changing periods are closly related to crankcase oil changing periods, the quality of oil used, and the type of operation.

"Full-Flow" Element Replacement

1. Remove drain plug from filter housing and drain oil from filter.

2. Loosen filter housing bolt, then remove bolt from housing. Remove element from housing.

3. Wipe out housing thoroughly. Check gasket surface at top of housing for dirt and burrs which might cause air leaks.

4. Install new element in housing. Install housing on filter base with filter drain plug away from engine.

5. Run engine for a few minutes. Check filter for leaks; then check dipstick level. Add oil to bring up to (not above) "FULL" mark on dipstick.

"By-Pass" Element Replacement

1. At engine cradle support, remove two bolts attaching filter mounting bracket to support.

2. At bottom of shell, loosen through bolt until shell and element assembly can be removed from base.

3. Remove element from shell and discard.

4. Clean shell thoroughly to remove all deposits of oil, dirt and so forth.

5. Install new element in shell. Position shell and element to base and tighten through bolt. Secure mounting bracket to engine cradle support.

6. Run engine for a few minutes. Check filter for leaks, then check dipstick for oil level. Add oil to bring up to (not above) "FULL" mark on dipstick.

AIR CONDITIONING CLUTCH AIR CYLINDER

Air cylinder is equipped with a square head pipe plug at end. At recommended intervals, remove plug and apply one ounce of S.A.E. 10 engine oil.

DOOR ENGINES - F. AND R.

At recommended intervals remove 1/8" pipe plug in end of door engine and apply 1 oz. of S.A.E. 10 engine oil.

STARTER

Starter is equipped with plugs at commutator, center bearing, and drive ends. At specified intervals, remove plugs and apply lubricant.

CONTROL ROD LINKAGE

All control rod linkage pins and joints should be oiled regularly with light engine oil. Use can or spray.

MULTI-PURPOSE LUBRICANT (SYMBOL "MP" ON CHARTS)

Multi-purpose gear lubricant must satisfactorily lubricate heavy duty coach axles under maximum torque and speed conditions. It must provide necessary and suitable load-carrying characteristics to prevent scoring and wear, good stability in storage and service, and give good resistance to corrosion. Suppliers should assure these characteristics and be responsible for the quality and satisfactory performance of their product. Many oil companies can supply lubricant, conforming with above description, under the requirements of Military Specification MIL-L-2105B or Timken Specification 0-65 (0-64 for cold weather).

REAR AXLE

Checking Level

At intervals indicated on chart, remove filler plug in differential cover. Add sufficient lubricant to bring level up to filler plug opening. Install and tighten plug. Check level after a run or while differential is warm.

Viscosity

S.A.E. 140 should be used the year around, except in cases of extremely low temperatures. If vehicle is parked in temperatures below +20°F., or operated in temperatures consistently below 0°F., it is advisable to use S.A.E. 90.

Draining and Filling

When axle is new, or after overhaul, it is recommended that lubricant be drained after first 3,000 miles of operation, and thereafter at recommended intervals. Draining at an early mileage removes fine particles of metal or other foreign material.

At recommended intervals, remove plug at bottom of housing to drain lubricant. Drain when unit is hot, preferably immediately after operation. Reinstall and tighten drain plug.

Fill axle to level of filler plug in housing cover. Install and tighten level plug. Capacity of rear axle is indicated on chart.

STRAIGHT GEAR OIL (SYMBOL "G" ON CHART)

Type of lubricant indicated by the symbol "G" on chart must be a straight mineral gear oil of the best quality.

UNIVERSAL JOINTS

At recommended intervals, use pressure gun to apply lubricant through fitting in universal joint trunnion. Apply until lubricant is forced out around trunnion seats. Use S.A.E. 140 the year around.

STEERING GEAR LUBRICANT (SYMBOL "SG" ON CHARTS)

The lubricant indicated by the symbol "SG" is a special steering gear lubricant, No. 0 grade with low cold test characteristics and extreme pressure properties. This type of lubricant is marketed by many oil companies. In the event that low cold test extreme pressure lubricant meeting the above specifications cannot be obtained, use #1 Multi-Purpose (lithium base) grease. Multi-Purpose "MP" lubricnt may be used for make-up only. "SG" lubricant should be used when filling empty gear.

STEERING COLUMN BEVEL GEAR HOUSING
Steering column gear housing is accessible from underneath at left front corner of coach. Clean breather at top of housing. Fill housing through fitting at bottom of housing, until lubricant is level with breather.

STEERING GEAR HOUSING
Steering gear housing is located on top of front axle. Clean breather in housing. Fill housing through fitting at bottom of housing, until lubricant is level with breather.

SPEEDOMETER AND TACHOMETER CABLES
Remove inside cable from cable housing. Coat lightly with lubricant and avoid excessive amount.

CHASSIS LUBRICANT (SYMBOL "C" ON CHART)

Chassis lubricant should be a high grade calcium, lithium, or aluminum soap pressure gun lubricant. Sodium soap grease may be used as chassis lubricant, but more frequent application may be required during wet weather. This lubricant should be used at all points indicated by the symbol "C" on chart.

Good quality multi-purpose lithium soap grease is recommended, especially for extreme operating conditions - water, heat, etc.

All pressure gun lubrication fittings must be clean before applying gun. Apply sufficient lubricant to thoroughly lubricate entire bearing or bushing.

LOCATION OF POINTS

The chart at back of book shows relative location of chassis lubrication points. Location described in following paragraphs, however, will assist in readily locating these points.

ENGINE COMPARTMENT
- Speedometer Adapter (When Used)
- Transmission Control Levers
- Control Rod Bell Crank Pins
- Clutch Release Cross Shaft
- Clutch Control Linkage

FRONT DOOR HINGES
Lower hinge fitting is accessible at underside of coach. Upper hinge is accessible inside coach.

REAR DOOR HINGES
Rear door hinge lubrication fittings are accessible at underside of coach. Upper fittings are accessible inside coach.

INSIDE COACH
- Accelerator Pedal
- Destination Sign Gears

UNDER VEHICLE (FRONT)
- Steering Knuckles
- *Steering Tie Rod Ends
- *Steering Drag Link Ends
- *Steering Drive Shaft U-Joints
- *Steering Drive Shaft Slip Joint
- Front Slack Adjusters
- Front Brake Camshafts
- Accelerator Interlock Lever
- Accelerator Control Lever
- Power Steering Cylinder Ends

UNDER VEHICLE (REAR)
- Rear Slack Adjusters
- Rear Brake Camshafts
- Prop. Shaft Slip Joint
- Parking Brake Camshaft
- Parking Brake Relay Levers
- Parking Brake Bell Crank
- Air Cond. Compressor Drive

* Use "SG" Steering Gear Lubricant at temperatures below $0^{O}F$.

HIGH TEMPERATURE GREASE (SYMBOL "S2" ON CHARTS)

The type of lubricant indicated by symbol "S2" on chart, should be a short fiber, non-fluid #2 sodium soap grease having a high melting point (300°F., min. melting point). No. 2 lithium soap base certified as approved by bearing manufacturer may also be used. DO NOT MIX GREASES.

WHEEL BEARINGS

Instructions for the removal, installation, and adjustment of wheel bearings will be found in "HUBS AND BEARINGS" (SEC. 19).

Cleaning

With a stiff bristle brush and cleaning solvent, thoroughly clean bearings and hubs, making sure that all old lubricant and dirt is removed. Check bearings and cups and replace damaged parts.

Packing

When packing by hand, be sure that lubricant is kneaded between rollers and races. A mechanical lubricator can be used; however, bearings must be thoroughly lubricated.

DO NOT FILL HUB. Coat inside of hub and axle spindle with thin coat (1/8" thick) of grease to retard rusting. Allow some excess grease at open end of bearings and around adjusting nut. DO NOT PACK HUB WITH GREASE. The lubricant in bearings is sufficient to provide adequate lubrication until next service period. Readjust bearings as described in "HUBS AND BEARINGS" (SEC. 19).

CAUTION: Do not use lubrication fittings on hubs. Lubricant must not be forced into hubs.

CLUTCH RELEASE BEARING (MECHANICAL)

Clutch release bearing is lubricated from a grease cup. At recommended intervals, turn cup down one full turn. Refill cup when empty.

BRAKE SHOE ANCHOR PINS

At recommended intervals, apply lubricant sparingly from a hand operated gun. Excessive lubricant may reach brake linings.

PETROLEUM JELLY (SYMBOL "S3" ON CHART)

The type of lubricant, indicated by symbol "S3" is petroleum jelly or petrolatum

BATTERY TERMINALS

Keep battery terminals clean. At regular intervals, remove cables; then clean terminals on cables and batteries. Apply petroleum jelly after tightening terminals to prevent corrosion.

REFRIGERATION MACHINE OIL (SYMBOL "S7" ON CHART)

Refrigeration machine oil is a highly refined straight mineral petroleum oil.

Windshield Wiper Oiler. Remove pipe plug in cover, then fill with lubricant. Replace plug.

RADIATOR SHUTTER FLUID (SYMBOL "S13" ON CHARTS)

Fluid indicated by symbol "S-13" on chart, is a special shutter fluid, available from your GMC dealer.

SHUTTER AIR FLUID

Remove plug at top of filter reservoir. Inject 1 oz. of fluid. Do not use a large quantity or at more frequent intervals than indicated on chart. Reinstall and tighten plug.

TYPE A FLUID (SYMBOL "S19" ON CHARTS)

Fluid indicated by symbol "S19" on chart, must be an "Automatic Transmission Fluid - Type A" supplied in containers bearing mark "AQ-ATF," followed by an identification number and letter "A." DO NOT USE ANY OTHER FLUID.

POWER STEERING SYSTEM

The supply reservoir and filter element assembly for power steering system is mounted on engine support hangers in engine compartment. The level of fluid in reservoir should be checked at intervals recommended on chart.

After thoroughly cleaning around cover, remove filler cap and dipstick from cover. Wipe dipstick with clean cloth, then recheck fluid level. Replenish fluid if necessary to bring level up to

"FULL" mark on dipstick. Be sure that fluid being added is clean, also that screen inside reservoir is not damaged if funnel is used.

Every 25,000 miles reservoir filter element should be replaced as directed in "POWER STEERING" (SEC. 16) of this manual.

BLEEDING POWER STEERING SYSTEM

Whenever a line is disconnected or a pump is replaced, the air that has entered the hydraulic system must be bled out, otherwise noisy and unsatisfactory operation will result.

1. Fill oil reservoir and let oil remain undisturbed for about two minutes.

2. Raise front end of vehicle so that wheels are off the ground.

3. Turn the wheels to right and left to the wheel stops to eliminate air pockets in power cylinder. Continue this operation until fluid in reservoir stops bubbling. Replenish fluid in reservoir during this operation.

4. Start the engine and run at idle for two minutes. Turn wheels right and left as before. DO NOT HIT WHEEL STOPS. Recheck fluid level, and hoses and connections for leaks. Continue this operation until oil is clear of bubbles.

5. Increase engine speed to approximately two-thirds of full throttle and continue to run at this speed until all signs of bubbles disappear from oil in reservoir as wheels are turned from right to left. DO NOT HIT STOPS.

6. Lower the vehicle and turn the wheels on the ground. Recheck system for leaks. Check fluid in reservoir and refill to "FULL" mark on dipstick as previously directed.

DO NOT USE HYDRAULIC BRAKE FLUID OR SHOCK ABSORBER FLUID. CARE SHOULD BE TAKEN TO KEEP THE FLUID CLEAN AND FREE OF WATER.

AIR CONDITIONING CONDENSER FAN DRIVE

Refer to "AIR CONDITIONING" (SEC. 26) for method of draining, filling, and replenishing fluid in system.

SPECIAL LUBRICANT (SYMBOL "S20" ON CHART)

Lubricant to be used on accelerator control cables is available through AC Spark Plug Distributors as "Type ST-640." Use this lubricant or equivalent. Refer to FUEL SYSTEM (SEC. 12) for control cable lubricating procedures.

AIR CONDITIONING COMPRESSOR OIL (SYMBOL "S25" ON CHART)

This fluid is a special wax-free, non-foaming, dehydrated type of oil, having a viscosity of about S.A.E. 10. This oil is available from many major oil companies under various trade names.

Refer to "AIR CONDITIONING" (SEC. 26) for method of checking, adding, and recharging an empty system.

SPECIAL MULTI-PURPOSE GREASE (SYMBOL "S26" ON CHART)

Lubricant indicated by symbol "S26" should be a Lithium Base #2 Grease with 3% Molybdenum Disulfide, commonly called "Multi-Purpose Grease No. 2 With 3% Moly."

Whenever accessible air conditioning compressor main bearing carrier should be hand packed as described in AIR CONDITIONING (SEC. 26) of this manual.

Lubricants Must Be Stored and Dispensed in Such a Manner That They Will Be Clean and Free of Contamination Due to Dirt or Other Foreign Matter.

Air Suspension

Information in this section covers complete description, operation, and maintenance of the air suspension system. Replacement of the various air suspension components is also covered. Since replacement of the front and the rear axle consists primarily of disconnecting and connecting the air suspension components, these procedures are also included in this section.

SYSTEM DESCRIPTION

The air suspension system for the most part, is made up of suspension supports, air bellows, height control valves, radius rods, and shock absorbers. The supports provide the means by which the suspension system is connected to the axles. The system operates automatically and maintains a constant ride height regardless of load or of load distribution.

Vertical loads are supported by eight rubberized nylon fabric air bellows assemblies (fig. 2). Four 8" bellows are used at front axle and four 10" bellows are used at rear axle. Bellows are installed between beams in coach body structure and suspension supports attached to axles as shown in figure 1. Upper bead of bellows is clamped between upper retainer and mounting surface. Lower bead is clamped between lower retainer and piston. When bellows assembly is installed, beads form air-tight seals.

The pressure in air bellows is varied automatically in proportion to vehicle load by height control valves. Three height control valves, one at front axle and two at rear axle, maintain constant vehicle height for all load conditions. Height control valve levers are connected to axles by links.

Radius rods, four at each axle, transmit driving and braking forces from axles to the coach body. These rods also control the lateral and longitudinal position of each axle under the vehicle. Each end of radius rods contains a rubber bushing that requires no lubrication. Telescoping type double-acting shock absorbers are mounted at ends of each axle. Stabilizer bar, attached in rubber mountings to body, is linked at both ends to rear suspension supports. Certain model coaches also have a front stabilizer bar.

Suspension supports at front axle and at rear axle are welded steel assemblies. Front suspension support includes bellows lower mountings. Four mounting studs are welded in place and attach to radius rod bracket. Rear suspension support includes mounting brackets for radius rod and shock absorber, bellows, stabilizer bar link, and brake chamber. Suspension support is bolted to axle bracket. Bracket is welded to axle.

SYSTEM OPERATION

Compressed air from the suspension air tank is supplied to height control valves. Pressure regulator valve, however, allows removal of air from main tank only when pressure is above 65 psi. A check valve at suspension tank prevents loss of air back into main system. An air filter is connected in line at pressure regulator valve. Height control valves, one at front axle and two at rear axle, meter air into the bellows as needed. Valves are actuated by the relative movement between body and axles.

Loading. As coach is loading, the body settles toward axles. This movement operates height control valves and valves meter air into bellows. Air pressure in bellows increases sufficiently to compensate for the additional load. This keeps the coach body at normal ride height.

Unloading. As the coach is unloading, the height control valves exhaust air from the bellows. Valves reduce air pressure in proportion to the decrease in weight, again keeping the coach body at normal ride height.

The height control valves are designed to operate only when load on coach is increased or decreased. Valves do not respond to rapid relative motion between axles and body such as that caused by road bumps. Refer to "Height Control Valves" later in this section for a detailed description of height control valve operation.

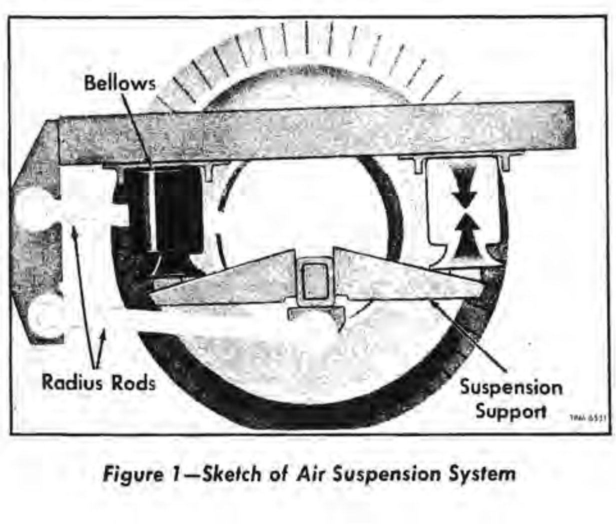


Figure 1—Sketch of Air Suspension System

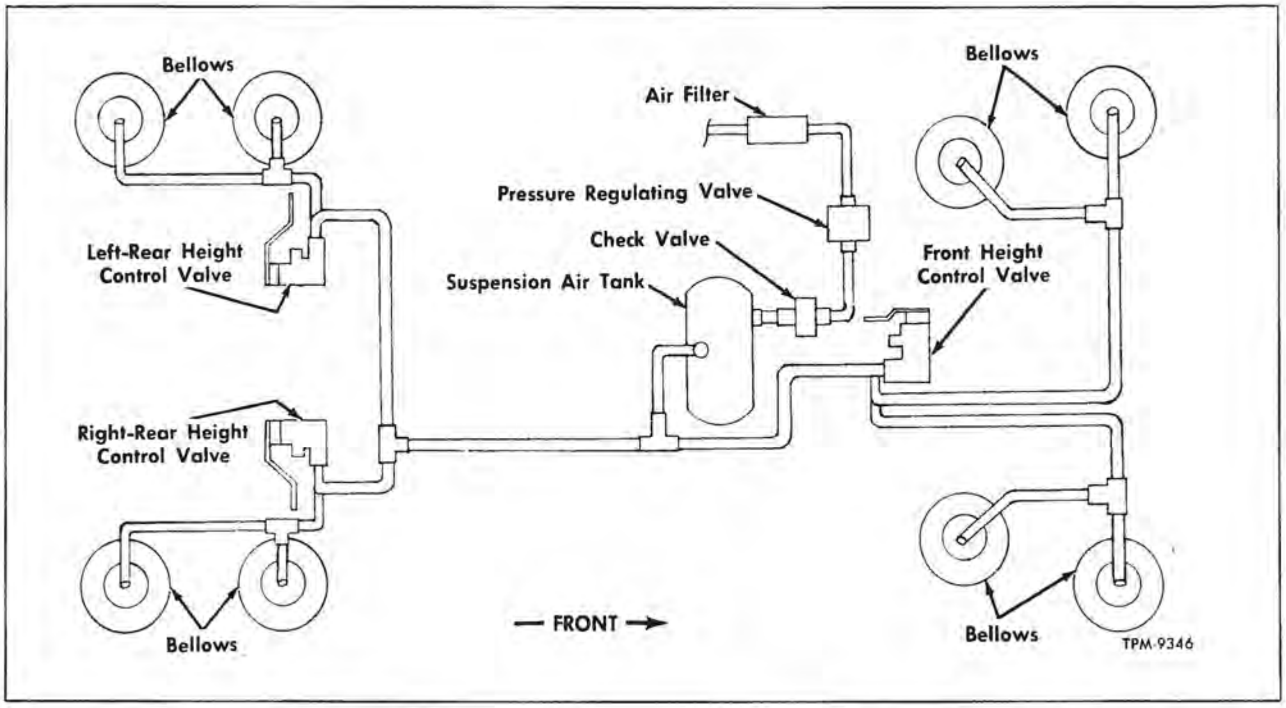


Figure 2—Schematic Diagram of Suspension Air System

SYSTEM MAINTENANCE

Air suspension system requires no lubrication, and with the exception of the inspection and test procedures outlined below, requires very little maintenance. By accomplishing these inspection and test procedures at established chassis inspection periods, sub-standard performance may be revealed before the condition becomes bad enough to cause operator complaints or failure on a run. Diagram of the suspension air system is shown in figure 2.

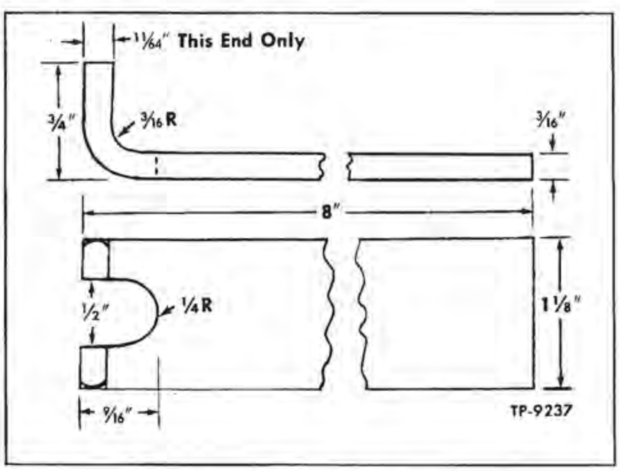


Figure 3—Special Tool For Drain Cock

CAUTIONS

1. Do not attempt to work under vehicle without first blocking body or placing vehicle over a pit. With air bellows deflated, there is not sufficient clearance under vehicle for a man on a creeper. When blocking body, place blocks under jack pads provided at front and at rear lower radius rod brackets. Jack pads are shown in figure 6.

2. Use no lubricant, not even water, on radius rod rubber bushings.

3. If necessary to tow vehicle with one end raised, axle must be chained to body. This is necessary since air pressure will be exhausted from bellows at the raised end. The weight of the axle hanging on the deflated bellows may damage bellows or shock absorbers. Chains can be secured around axle and through the axle bumper brackets.

AIR TANKS

Suspension air tank, as well as the main air tanks, must be drained daily to keep air system as free of moisture as possible. In cases of extreme cold weather, an alcohol evaporator should be installed to introduce alcohol vapor into the air system to prevent moisture from freezing. Two different type drain cocks are used on these air tanks. The conventional type with hand operated handle and a recessed-key type. A special tool (which can be made locally) must be used to open and close the recessed-key type drain cock. Dimensions for making this tool are shown in figure 3.

AIR LEAKAGE TEST

With the main air system at normal operating pressure (105-120 psi), coat all suspension air line connections and bellows mountings with soap and water solution. Air leakage will produce soap bubbles. No leakage is permissible. Leakage at air line connections can sometimes be stopped by tightening the connection. Where air line connections having rubber sleeves are used, replace rubber sleeve. If tightening mounting nuts does not stop leakage, remove and inspect bellows. Replace bellows, if necessary.

MOUNTING AND BELLOWS INSPECTION

Make a wrench check for loose suspension support stud and mounting bolt nuts, radius rod anchor bolts and nuts, shock absorber mountings and height control valve mountings. Suspension support, radius rod, and shock absorber mountings must be tightened to torque listed in "Specifications" at end of this section. Visually inspect all bellows for cracks, abrasions, or other damage which might develop into a rupture. Replace with new bellows if any damage is evident. Piston surface should be smooth and free from cracks.

RIDE HEIGHT CHECK AND ADJUSTMENT

Normal operating pressure is 105-120 psi. At

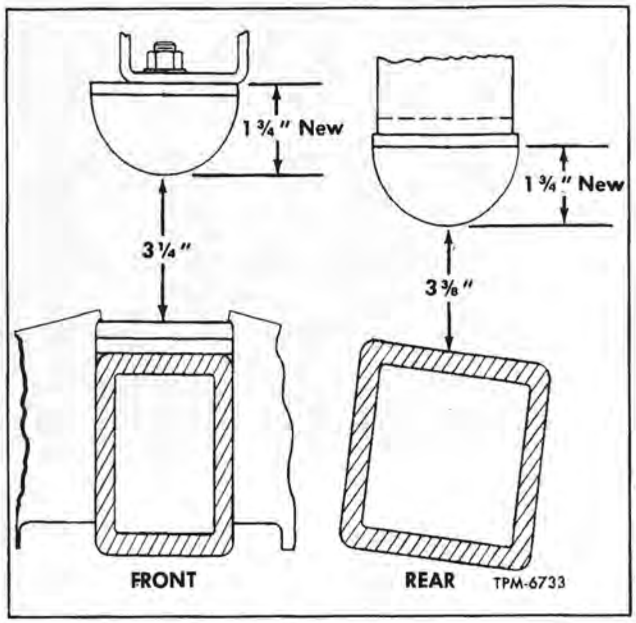


Figure 4—Normal Ride Height Clearance

this pressure, height control valves will automatically meter air into or out of bellows as load changes.

Normal Ride Height. Ride height measurements are taken between axle bumpers and top of axle housing as shown in figure 4. Clearance between bumper and axle at front is 3-1/4", and at rear 3-3/8".

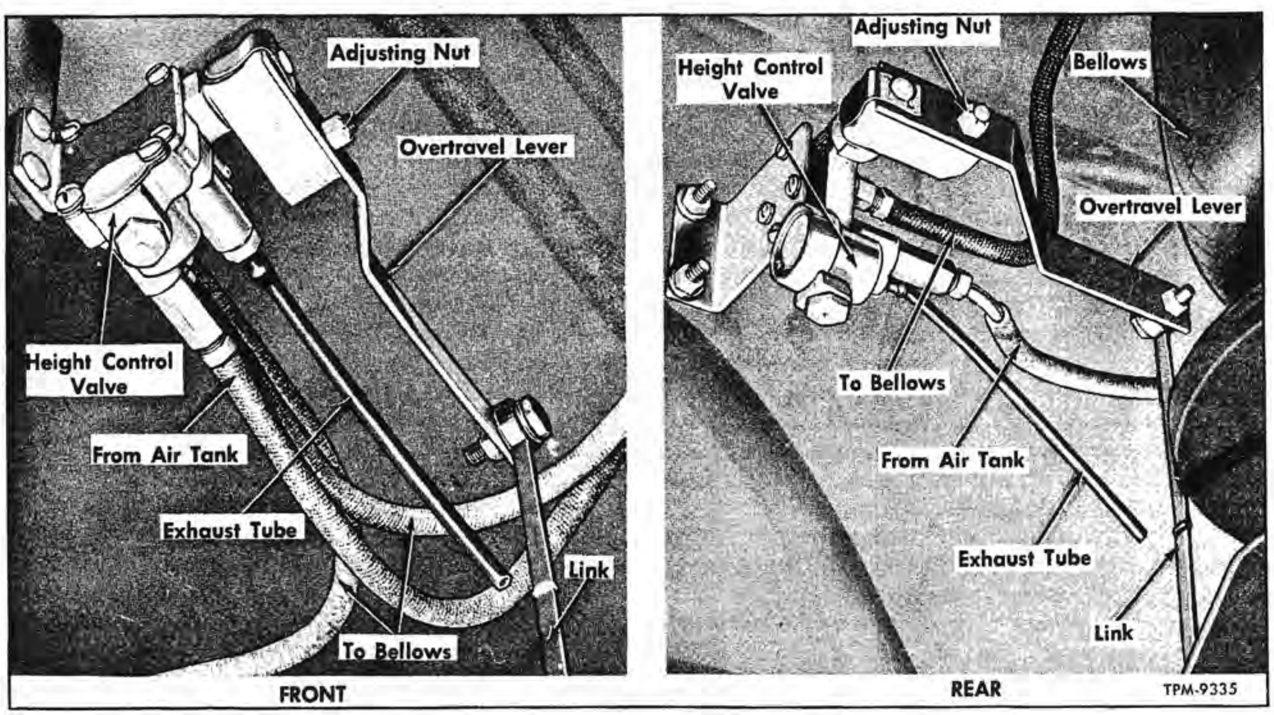
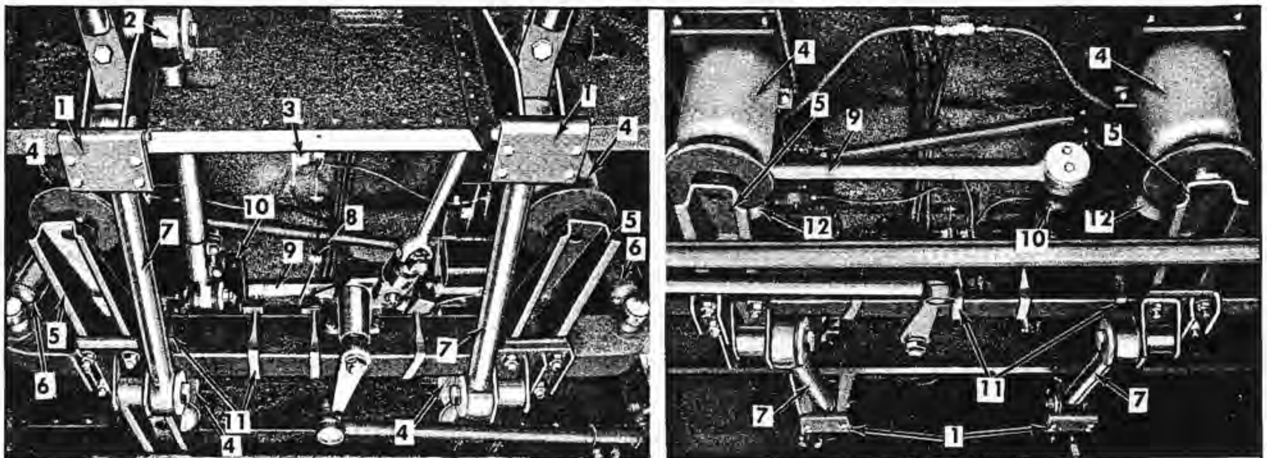


Figure 5—Height Control Valves Installed

AIR SUSPENSION



FRONT VIEW — REAR VIEW

1 Jack Pad
2 Radius Rod - Upper
3 Height Control Valve
4 Bellows
5 Suspension Support
6 Shock Absorber
7 Radius Rod - Lower
8 Height Control Valve Link
9 Radius Rod - Lateral
10 Upper Radius Rod Anchor Bracket
11 Rod Anchor Bracket U-bolts
12 Axle Rubber Bumper

TPM-6585-2

Figure 6—Front Axle and Air Suspension Installed

NOTE: Normal ride height clearance dimensions given are based on the thickness of new axle bumpers (fig. 4). If coach is left standing for extended periods without air pressure in the air suspension system, the weight of the body on the axle bumpers may cause the bumpers to take a permanent set in a flattened condition. Original thickness of new bumpers is shown in figure 4. If bumpers are flattened to less than the dimension shown, an equal amount should be added to the clearance specified to maintain normal ride height.

Overtravel Lever Adjustment. Change position of valve lever on overtravel assembly, if necessary, to obtain the above dimensions. Position of the lever may be changed by loosening nut (fig. 5) on adjusting bolt. Intake and exhaust valves of height control valve can then be operated independently of linkage.

Height control valve lever will move 3/16 inch up or down from neutral position (free travel) without causing any valve action. If amount of adjustment required falls within these limits, adjust lever the required amount. However, frame will not raise or lower until load is increased or decreased to actuate height control valve.

If any one of the height control valves does not function properly with the lever correctly adjusted, check for restricted air lines. If valve still does not hold frame at normal ride height with lever properly adjusted, and with no restriction in air line, valve should be removed and overhauled or replaced with a new or rebuilt unit. Refer to "Height Control Valves" later in this section.

FRONT AXLE AND FRONT SUSPENSION REMOVAL

The procedures which follow cover removal of front axle assembly and suspension components. Procedures also cover removal of suspension components from axle assembly. Method used to support axle and suspension units during removal and disassembly depends upon local conditions and available equipment. Front axle and air suspension components installed are shown in figure 6.

REMOVAL PROCEDURE

NOTE: Key numbers in text refer to figure 6.

1. Block rear wheels to prevent coach from rolling. Position a hydraulic floor jack under each lower radius rod bracket.

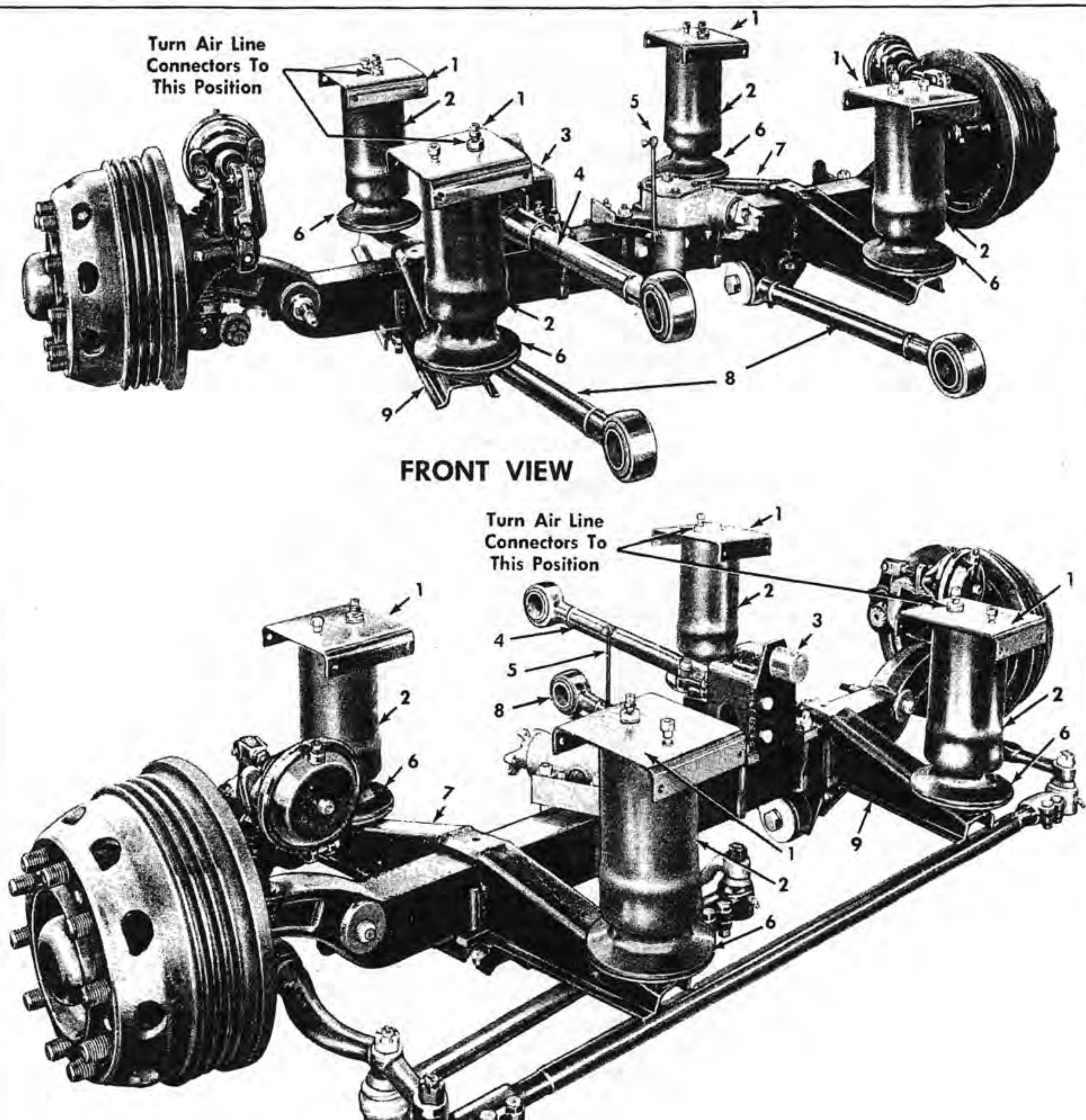
CAUTION: Blocks or special adapters should be used on jack lifts in a manner which will prevent axle from rolling off jacks when disconnected.

2. Raise front end of vehicle with jacks until bottom of body is approximately 18" from floor. Block body in raised position. Place each block directly under jack pads (1) provided at lower radius rod front anchor brackets.

IMPORTANT: Do not raise body with hoist or chain fall and permit axle to hang unsupported. The weight of the hanging axle may damage the bellows.

3. Lower jacks until body rests on blocks, but with jacks still supporting axle. Remove wheels and tires. Carefully swing ends of jacks out from under vehicle to provide free working area.

4. Exhaust compressed air from air supply



1 Bellows Mounting Plate
2 Bellows
3 Upper Radius Rod Mounting Bracket
4 Radius Rod (Upper)
5 Height Control Valve Link
6 Bellows Piston
7 Suspension Support (L.H.)
8 Radius Rod (Lower)
9 Suspension Support (R.H.)

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Figure 7—Front Axle and Suspension Components Assembled

system by opening drain cock in suspension air tank.

5. Disconnect steering gear drive shaft rear universal joint from steering gear.

6. Disconnect height control valve link (8) from bracket attached to steering gear support. Pull down on height control valve lever to exhaust compressed air from bellows.

7. Remove lock nuts from bolts attaching bellows mounting plates to brackets on body beam.

AIR SUSPENSION

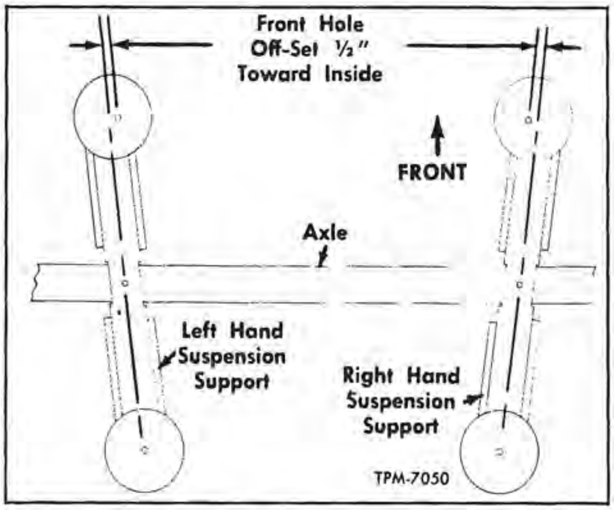


Figure 8—Front Suspension Support Position

8. Disconnect hoses from brake chambers, and air lines from bellows.

9. Disconnect both ends of lower radius rods (7), and upper and lateral radius rods (2, 9). Refer to "Radius Rods" later in this section.

10. Disconnect stabilizer bar (on those models using such assemblies). Refer to "Stabilizer Bar" later in this section.

11. Remove shock absorbers as directed in "Shock Absorbers" later in this section.

12. Lower axle on jacks until bellows mounting plates are clear of brackets and axle will clear underside of coach. Carefully pull jacks and axle assembly from under coach.

REMOVAL OF SUSPENSION COMPONENTS

NOTE: Key numbers in text refer to figure 7.

1. Support axle in such a position so that suspension supports may be removed easily.

2. Remove four nuts securing lower radius rod bracket on suspension support studs. Remove bracket from studs. Lift suspension support off top of axle.

3. Remove nuts from two U-bolts attaching upper radius rod bracket (3) to axle. Remove U-bolts and bracket.

FRONT AXLE AND FRONT SUSPENSION INSTALLATION

Assemble suspension units to axle as illustrated in figure 7, before moving axle under coach. The method used to support axle and suspension supports is dependent upon local conditions and available equipment. Key numbers in text refer to figure 7.

1. Install each suspension support (7, 9) on axle with hole in support over locating pin in axle. Supports are not interchangeable. When supports are properly installed, plate holes will be in position shown in figure 8.

2. Install brackets under axle on support studs. Bracket should fit down over locating pin so that radius rod anchor pin will be toward inside. Install washers and nuts and tighten to torque listed in "Specifications" at end of this section.

3. Place upper radius rod bracket (3) in position over locating pin on axle. Lateral radius rod anchor pin on bracket will be at rear of axle. Attach bracket to axle with two U-bolts and four nuts. Tighten nuts to torque listed in "Specifications" at end of this section.

INSTALLATION PROCEDURE

NOTE: Key numbers in text refer to figure 7.

1. If removed from suspension supports, bellows assemblies should be installed before axle is moved back under coach. Place each bellows assembly in position on suspension support and attach nut loosely on bellows lower stud. Place front and rear mounting plates on bellows assemblies as shown in figure 7. Front plates should have the larger of two holes toward the inside. Rear plates should have large hole at front. Rotate bellows assembly, if necessary, to align upper retainer studs with holes in plate. Install large nut and lock washer and small lock nut on each bellows. Tighten nuts to torque listed in "Specifications" at end of this section.

2. Position axle on two hydraulic floor jacks, with one jack lift under each lower radius rod axle bracket.

CAUTION: Blocks or special adapters should be used on jack lifts to prevent axle from falling off jacks.

3. Carefully move axle into position under coach. Lift axle and align bellows mounting plates with beam brackets. Plates should seat solidly against beams.

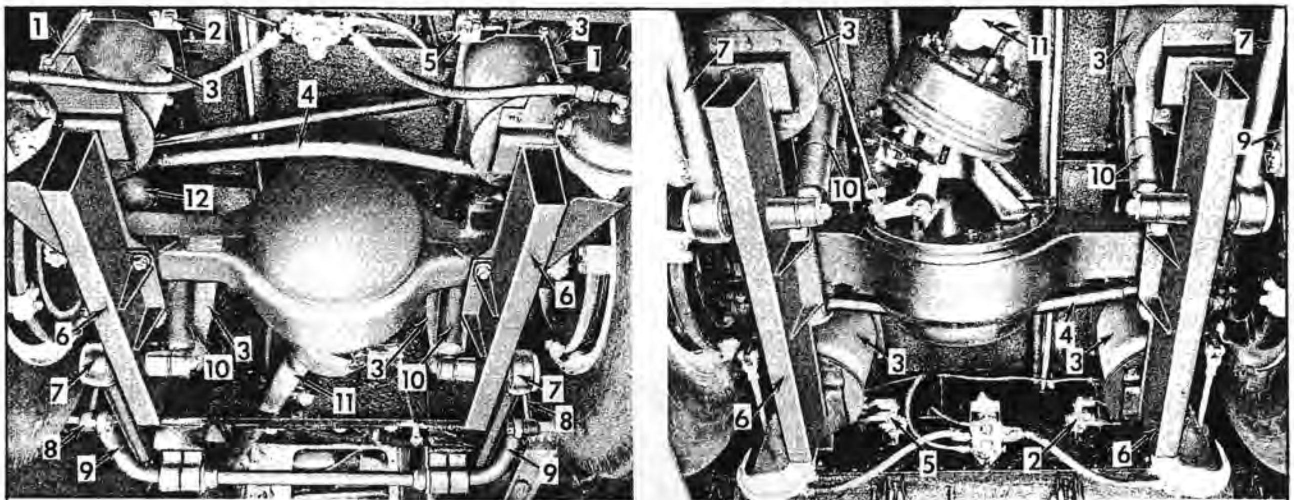
4. Connect upper radius rod (4) and lateral radius rod to anchor brackets. Refer to "Radius Rods" later in this section. Do not tighten cap screws or mounting bolt nut.

5. Insert four bolts from bellows side into mounting plates at each bellows and install four lock nuts. Tighten mounting bolt nuts and lower mounting stud nuts to torque listed in "Specifications" at end of this section.

6. Install lower radius rods (8). Refer to "Radius Rods" later in this section. Do not tighten cap screws or mounting bolt nuts.

7. Install shock absorbers as directed under "Shock Absorbers" later in this section.

8. Position each end of axle by raising or lowering jacks to provide a clearance of 3-1/4" (normal ride height) between axle bumper and contact surface on suspension support (fig. 4). Refer to "NOTE" under "Ride Height Check and Adjustment"



FRONT VIEW — REAR VIEW

1 Height Control Valve Link
2 Height Control Valve (R.H.)
3 Bellows
4 Radius Rod - Lateral
5 Height Control Valve (L.H.)
6 Suspension Support
7 Radius Rod - Lower
8 Stabilizer Bar Link
9 Stabilizer Bar
10 Shock Absorber
11 Propeller Shaft
12 Axle Rubber Bumper

Figure 9—Rear Axle and Air Suspension Installed

earlier in this section. With axle in normal ride height position, tighten radius rod cap screws and anchor bolt lock nuts to torque listed in "Specifications" at end of this section. Thread lock wire through cap screws and twist ends of wire together.

9. With axle still in normal ride height position (step 8 above), connect height control valve link (5) to height control valve.

10. Connect steering gear drive shaft to steering gear on axle.

11. Connect flexible hoses to each brake chamber. Make sure connections are tight. Connect air lines to bellows. Replace rubber sleeves if deteriorated or damaged.

12. On those models where used, install stabilizer bar and links as directed under "Stabilizer Bar" later in this section.

13. Swing jacks under vehicle to permit installation of wheels. Install wheels.

14. Raise coach and remove blocks from under body. Lower vehicle to floor and remove jacks. Build up air pressure in system to normal operating pressure. Wait a few minutes for air to flow into suspension system, then check clearance between axle bumpers and suspension supports (fig. 4). If clearance is appreciably more or less than 3-1/4", adjust overtravel lever on height control valve as necessary to obtain this dimension. Refer to "Ride Height Check and Adjustment" earlier in this section. Make sure lever adjusting nut is tight when adjustment is completed.

15. Check for air leakage at all bellows upper and lower mountings. Coat mountings with soap and water solution and watch for appearance of soap bubbles. No leakage is permissible. If leakage is evident, bellows must be disconnected and mating surfaces must be cleaned. Bellows must be replaced if bead is damaged.

REAR AXLE AND REAR SUSPENSION REMOVAL

The procedures which follow cover removal of rear axle assembly and suspension components. Procedures also cover removal of suspension components from axle assembly. Method used to support axle and suspension units during removal and disassembly depends upon local conditions and available equipment. Rear axle and air suspension units installed are shown in figure 9.

REMOVAL PROCEDURE

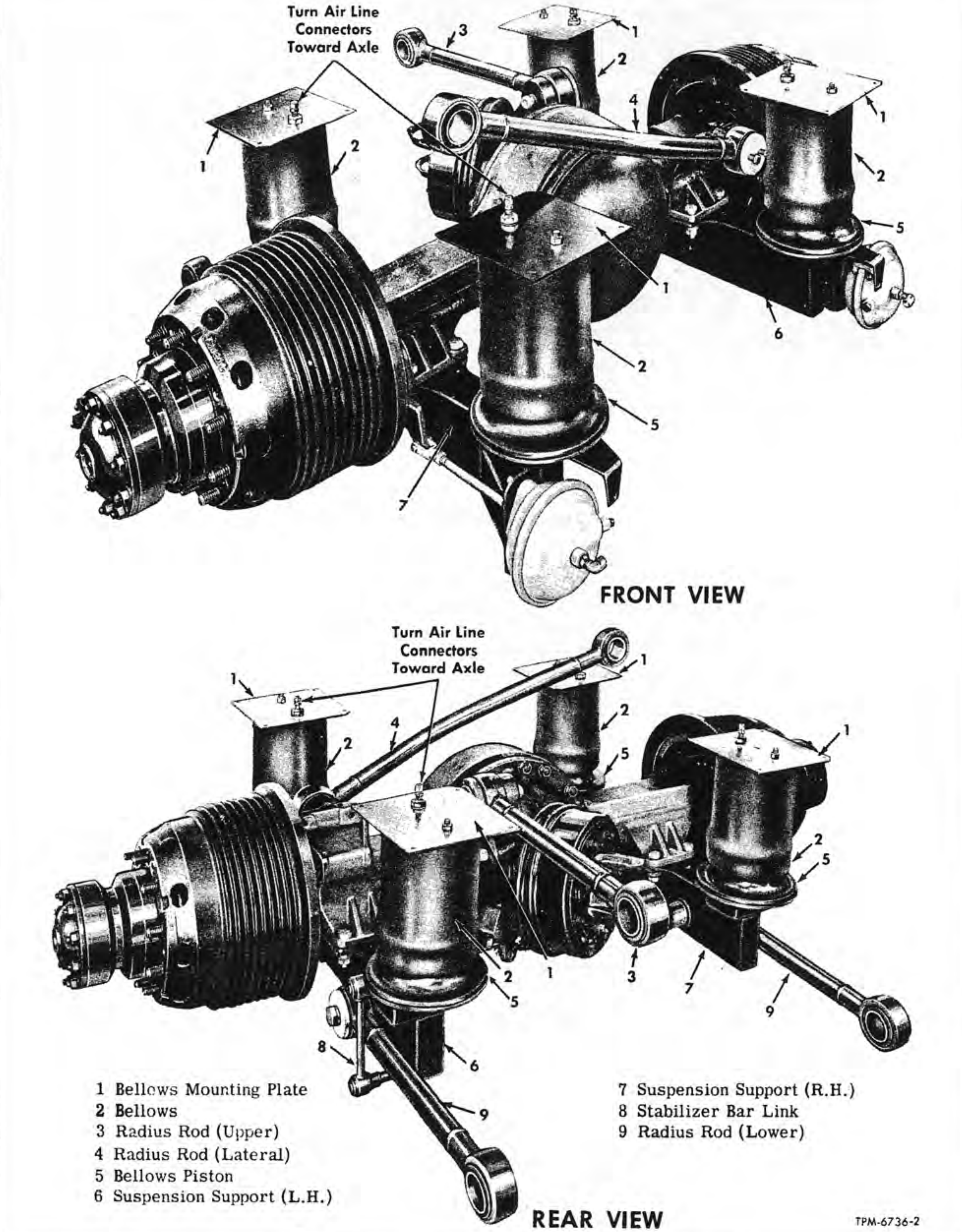
NOTE: Key numbers in text refer to figure 9.

1. Block front wheels to prevent coach from rolling. Position a hydraulic floor jack under center of each suspension support.

CAUTION: Jack lifts should be equipped with large bowls, or similar precautions should be taken to prevent axle from rolling off jacks when disconnected.

2. Raise rear end of vehicle with jacks until bottom of body is approximately 18" from floor. Block body in raised position. Make sure blocks are placed directly under jack pads at lower radius rod body brackets.

IMPORTANT: Do not raise body with hoist or



1 Bellows Mounting Plate
2 Bellows
3 Radius Rod (Upper)
4 Radius Rod (Lateral)
5 Bellows Piston
6 Suspension Support (L.H.)
7 Suspension Support (R.H.)
8 Stabilizer Bar Link
9 Radius Rod (Lower)

Figure 10—Rear Axle and Suspension Supports Assembled

chain fall and permit axle to hang unsupported. The weight of the axle will damage the bellows.

3. Lower jacks until body rests on blocks, but with jacks still supporting axle. Remove wheels and tires. Carefully swing jacks out from under vehicle to provide free working area.

4. Exhaust compressed air from air supply system by opening drain cock in suspension air tank.

5. Disconnect propeller shaft (11) and parking brake control rod from axle.

6. Disconnect height control valve links (1) from overtravel levers. Pull down on each height control valve lever to exhaust compressed air from bellows (3).

7. Remove four bolts and lock nuts attaching each bellows mounting plate to plate on coach body beam.

8. Disconnect flexible hoses from brake chambers, and air lines from bellows.

9. Disconnect stabilizer bar (9). Refer to "Stabilizer Bar" later in this section.

10. Remove lower (7), upper, and lateral (4) radius rods. Refer to "Radius Rods" later in this section.

11. Remove shock absorbers (10) as directed under "Shock Absorbers" later in this section.

12. Lower axle on jacks until bellows will clear underside of vehicle. Carefully pull jacks and axle assembly from under vehicle.

REMOVAL OF SUSPENSION SUPPORTS

NOTE: Key numbers in text refer to figure 10.

1. Support axle assembly so that suspension supports (6, 7) may be removed safely from axle.

2. Remove brake chambers and stabilizer bar links (8) from suspension supports.

3. Remove two lock nuts from studs at bottom of each bellows assembly. Remove bellows assembly from suspension support.

4. Remove four nuts, spacers, and bolts attaching each suspension support to axle housing. Remove suspension support.

REAR AXLE AND REAR SUSPENSION INSTALLATION

ASSEMBLY OF AXLE AND SUSPENSION SUPPORTS

Assemble suspension units to axle before moving axle under coach as illustrated in figure 10. Radius rods, however, should be installed after axle is in position. The method used to support axle and suspension supports is dependent upon local conditions and available equipment. Tighten all studs, bolts, and nuts to torque listed in "Specifications" at end of this section. Key numbers in text refer to figure 10.

1. Position each suspension support (6, 7) under axle. Radius rod and shock absorber anchor pins on supports should be on the parking brake side of the axle. Attach support to axle with four bolts, spacers, and nuts. Tighten nuts to torque listed in "Specifications" at end of this section.

2. Attach brake chambers and stabilizer bar links (8).

3. Position each bellows assembly on suspension support so that fitting at top will be toward axle. Place lock nuts on two mounting studs and tighten nuts to torque listed in "Specifications" at end of this section.

INSTALLATION PROCEDURE

NOTE: Key numbers in text refer to figure 9.

1. Center a hydraulic floor jack under each suspension support.

CAUTION: Jack lifts should be equipped with large bowls, or similar precautions should be taken to prevent axle from rolling off jacks when disconnected.

2. Carefully move jacks and axle assembly into position under coach. Lift axle and align plate on each bellows assembly with plate on beams.

3. Connect flexible hose to brake chambers. Make sure connections are tight. Connect air lines to bellows. Replace rubber sleeves if deteriorated or damaged.

4. Attach each plate with four bolts and lock nuts. Tighten lock nuts to torque listed in "Specifications" at end of this section.

5. Install shock absorbers (10) as directed under "Shock Absorbers" later in this section.

6. Connect lateral (4) upper, and lower (7) radius rods. Refer to "Radius Rods" later in this section. Do not tighten cap screws or lock nuts at this time.

7. Raise or lower jacks to provide an axle clearance of 3-3/8" (normal ride height) between rubber axle bumpers and axle as shown in figure 4. Refer to "NOTE" under "Ride Height Check and Adjustment" earlier in this section. With axle in normal ride height position, tighten radius rod cap screws and anchor bolt lock nuts to torque listed in "Specifications" at end of this section. Thread lock wire through cap screws and twist ends of wire together.

8. With axle still in normal ride height position (step 7 above), connect height control valve links (1) to valves.

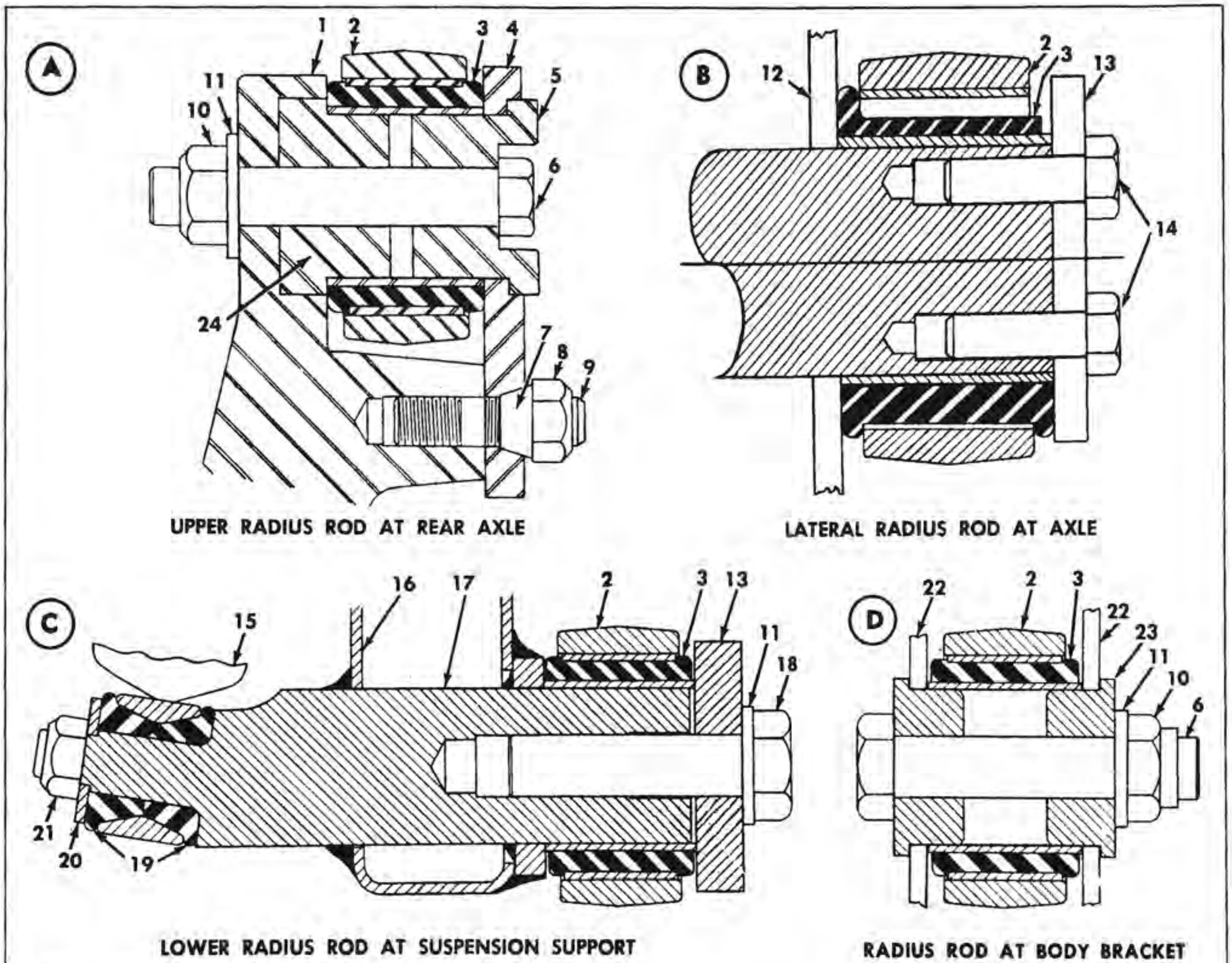
9. Connect propeller shaft (11) and parking brake linkage to axle.

10. Install stabilizer bar (9) and links (8) as directed under "Stabilizer Bar" later in this section.

11. Swing jack out of the way under coach and install wheels and tires.

12. Raise coach with jacks and remove blocks from under body. Lower vehicle to floor and remove jacks. Build up air pressure in system to

AIR SUSPENSION



1 Differential Carrier
2 Radius Rod
3 Rod Bushing
4 Anchor Plate
5 Anchor Pin
6 Anchor Bolt
7 Anchor Plate Stud Dowel
8 Anchor Plate Stud Nut
9 Anchor Plate Stud
10 Anchor Bolt Nut
11 Anchor Bolt Washer
12 Lateral Rod Bracket
13 Retaining Washer
14 Lateral Rod Cap Screw
15 Shock Absorber
16 Suspension Support
17 Anchor Pin
18 Bolt
19 Shock Absorber Bushing
20 Shock Absorber Mounting Washer
21 Shock Absorber Mounting Nut
22 Body Bracket
23 Anchor Washer
24 Sleeve

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Figure 11—Radius Rod End Mountings

normal operating pressure. Wait a few minutes for air to flow into bellows, then check clearance between axle bumpers and axle (fig. 4). If clearance is appreciably more or less than 3-3/8", adjust overtravel lever on each height control valve as necessary to obtain this dimension. Refer to "Ride Height Check and Adjustment" earlier in this section. Make sure lever adjusting nut is tight when adjustment is completed.

13. Check for air leakage at all bellows upper and lower mountings. Coat mountings with soap and water solution and watch for appearance of soap bubbles. No leakage is permissible. If leakage is evident, bellows must be disconnected and mating surfaces must be cleaned. Bellows must be replaced if bead is damaged.

RADIUS RODS

Radius rods are hollow steel tubes with steel forgings welded at each end. The front upper radius rod, however, has threads on axle end of tube and on forging, to provide an adjustment for front axle caster. These parts thread into a split clamp and are locked in place by two bolts, nuts, and lock washers.

Rear axle upper and lower radius rods are all interchangeable, and front axle lower radius rods are interchangeable. Radius rods are not interchangeable, however, between front and rear axles. Radius rod connections at axle and at body are illustrated in figure 11. These connections are typical for both front and rear rods.

RADIUS ROD REPLACEMENT (Fig. 11)

The following procedures include instructions for disconnecting and connecting radius rods at body and at axles. Lower radius rods must be disconnected at body before axle end can be removed from anchor pin. Raise body just enough to remove weight from air bellows and block in position before disconnecting radius rods. Refer to "Caution" at beginning of this section.

IMPORTANT: When any radius rod has been disconnected, correct clearance between axle bumpers must be obtained before tightening anchor bolts or cap screws. If connections are tightened without first obtaining this clearance, a torsional preload will be imposed on the rubber bushings when the body assumes normal ride height relative to the axles. Follow instructions under "Tighten Bolts, Nuts, and Cap Screws" (step 10 following).

1. Disconnect Radius Rod at Body (All Except Front Lateral. Remove nut from anchor bolt (D, fig. 11). Remove anchor bolt and anchor washer.

2. Disconnect Front and Rear Lateral Radius Rod at Axle and Front Rod at Body. Remove two cap screws and washer. Pull radius rod off anchor pin (B, fig. 11).

3. Disconnect Lower Radius Rods at Axle. Remove attaching bolt, plain washer, and large retaining washer from anchor pin. Pull radius rod off suspension support (C, fig. 11).

4. Disconnect Upper Radius Rods at Axle. Front radius rod may be disconnected at front axle by following step 1 (D, fig. 11) above. To disconnect rear radius rod at axle, remove two anchor plate stud nuts and two anchor plate stud dowels (A, fig. 11). Remove anchor bolt nut and anchor bolt washer. Remove anchor bolt, anchor pin, and anchor plate. Remove radius rod from sleeve.

5. Inspection. Clean all parts thoroughly. Inspect radius rods for bent condition and for evidence of cracks. Inspect bushings for signs of shearing, deterioration, or other damage. Any damaged part should be replaced with a new part.

When replacing, position split in bushing approximately 90^{o} to center-line of rod. Spaces between four rubber lobes of lateral radius rod bushing should be centered on horizontal and on vertical center-lines of rod end. Press in until bushing is centered in rod end. Use no lubricant, not even water, on rubber bushings.

6. Connect Lower Radius Rods at Axle. Place radius rod end over anchor pin. Position large washer and install bolt. Tighten bolt finger tight (C, fig. 11).

7. Connect Upper Radius Rod at Axle. Position upper radius rod in front axle bracket and on anchor pin at body end (after installing spacer) and install anchor washers, anchor bolt, and anchor bolt nut (D, fig. 11). Tighten nut finger tight.

Connect upper rod at rear axle as follows: (A, fig. 11) Place radius rod on sleeve. Place anchor plate over studs in differential carrier. Attach with two anchor plate stud dowels and two anchor plate stud nuts. Leave nuts loose. Insert anchor pin and anchor bolt. Install anchor bolt washer and nut. Leave nut loose.

8. Connect Radius Rod at Body (All Except Front Lateral). Place end of radius rod in position. Install anchor washers, anchor bolt, anchor bolt washer, and anchor bolt nut (D, fig. 11). Tighten nut finger tight.

9. Connect Front and Rear Lateral Radius Rods at Axle and Front Rod at Body. With rod end

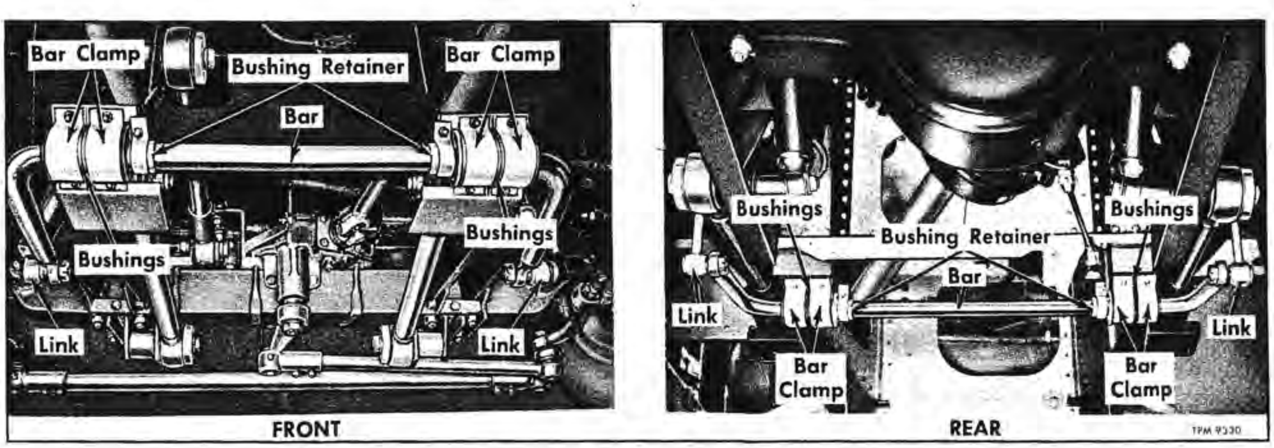


Figure 12—Stabilizer Bar Installed

already on anchor pin, position washer and install two cap screws. Tighten cap screws finger tight (B, fig. 11).

10. Tighten Bolts, Stud Nuts and Cap Screws. Refer to "Ride Height Check and Adjustment" earlier in this section for instructions on obtaining normal ride height clearance between axle bumpers and axles. After correct clearance is obtained, tighten bolts, nuts, and cap screws to torque listed in "Specifications" at end of this section. Thread lock wire through cap screws at axle and twist ends of wire together. Remove blocks and jacks from under vehicle.

STABILIZER BAR

Certain model coaches have both front and rear stabilizer bar assemblies. Front stabilizer bar is attached to front radius rod bracket adjacent to the jack pad (fig. 12).

Rear stabilizer bar is anchored to brackets on coach body bulkhead at rear axle (fig. 12). Bar helps to control vehicle stability. Rubber bushed clamps anchor bar firmly to brackets while links at each end of bar are attached to suspension supports. A retainer on bar is clamped flush against each inner rubber bushing. Instructions for removal and installation of stabilizer bar applies to both front and rear.

REPLACEMENT

Removal

1. Remove cotter pins and nuts from link ball studs. Discard cotter pins. Remove both stabilizer bar links.

2. Support bar and remove bolts from bar clamps at each side. Remove clamps, stabilizer bar, and rubber bushings. Loosen clamp nut and move each bushing retainer aside, if necessary.

Installation

1. Space bushings properly and place stabilizer bar in position under coach. While supporting bar, loosely attach a bar clamp around each bushing with bracket bolt nuts.

2. Wipe all grease, oil, or foreign matter from link stud tapers and from tapered holes.

NOTE: To avoid a preload on link stud rubber mountings, install links when vehicle is at normal ride height. Refer to "Ride Height Check and Adjustment" earlier in this section.

Install links and secure with nuts. Tighten clamp bolt nuts and link stud nuts to torque listed

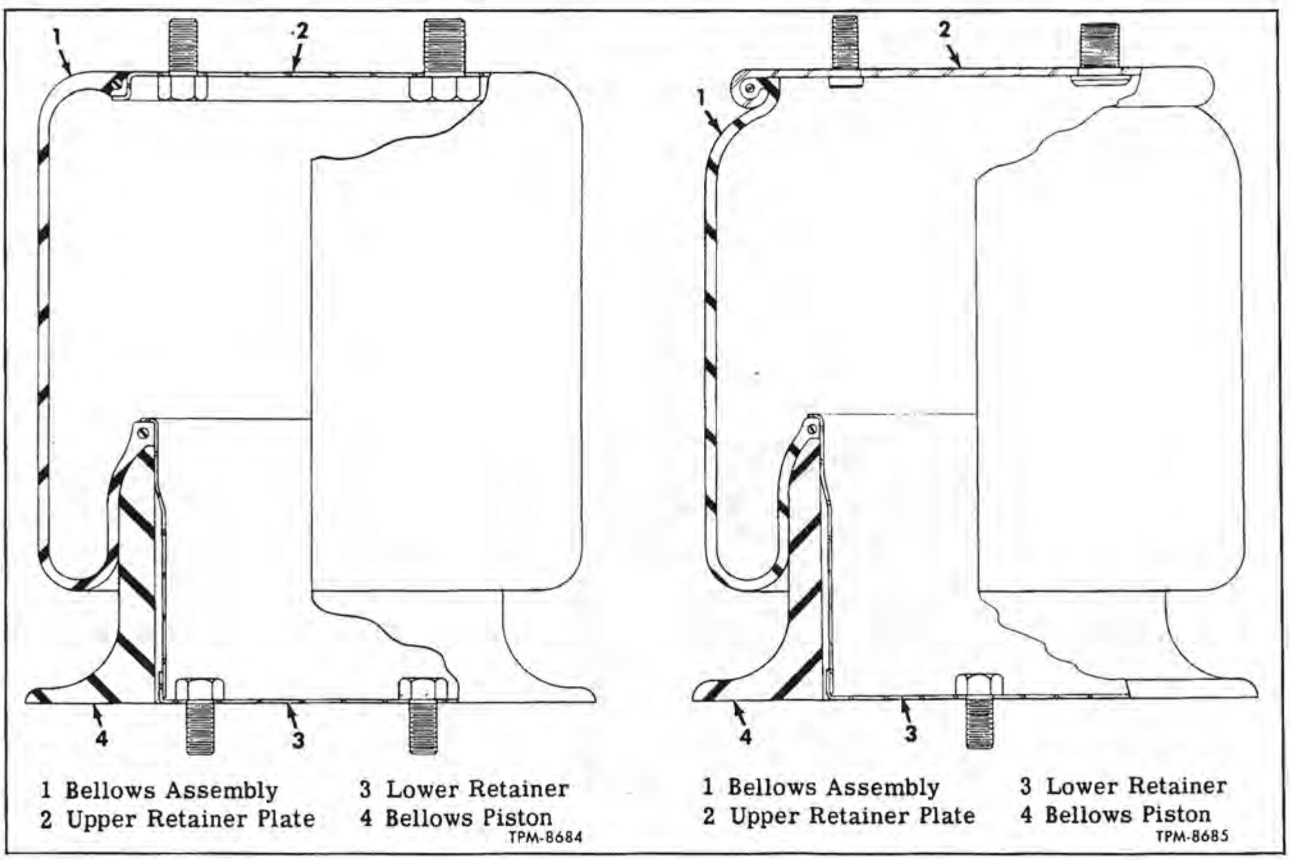


Figure 13—Sectional View of Air Bellows—Goodyear

Figure 14—Sectional View of Air Bellows—Firestone

in "Specifications" at end of this section. Advance each link stud nut to meet cotter pin slot and install new cotter pins.

3. If bushing retainers have been removed, place two halves around bar and against inside of rubber bushing. Slip retainer clamp over assembly and tighten nut to torque listed in "Specifications" at end of this section.

AIR BELLOWS

Four "rolling lobe" type bellows made of rubberized nylon fabric are mounted at each axle (figs. 7 and 10). These "air cushions" provide the flexibility between axles and coach body. At the same time, the bellows retain the compressed air which supports the body.

The square bead at each end of bellows is reinforced with wire. The opening at piston end (bottom) is smaller than opening at top. Top bead is clamped between upper retainer and mounting plate. Bottom bead is clamped between lower retainer and upper edge of piston as shown in figure 13 and 14. When bellows are inflated, beads form air-tight seals. In operation, the bellows folds down over piston, taking a lobe-shaped contour. One of the studs in upper retainer is drilled and threaded for an air line connection.

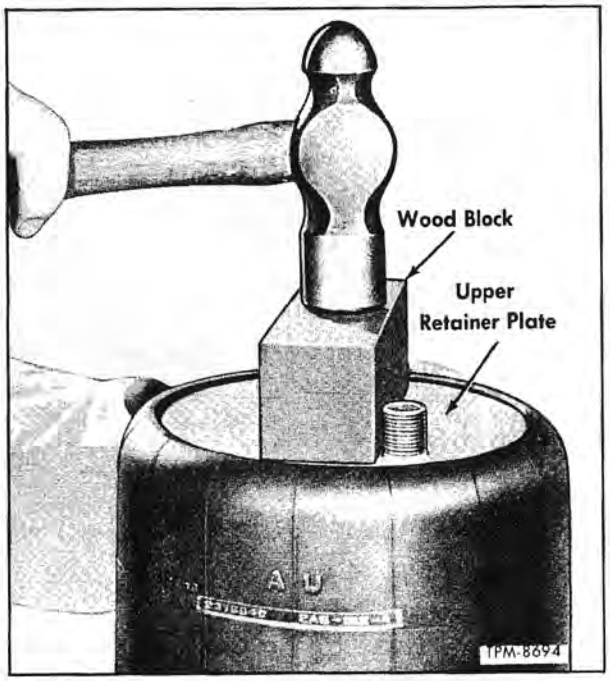


Figure 16—Loosening Retainer Plate From Bellows Bead

REMOVAL

1. Securely support coach body by placing blocks under body at points indicated for respective axle and suspension removal procedure.

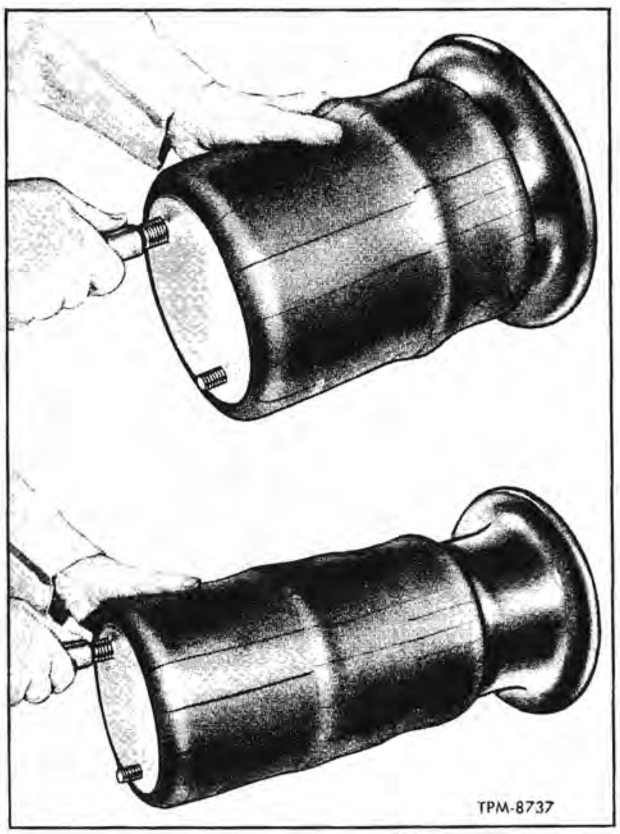


Figure 15—Removing Bellows Loop With Air Pressure

Figure 17—Removing or Installing Upper Retainer Plate

AIR SUSPENSION

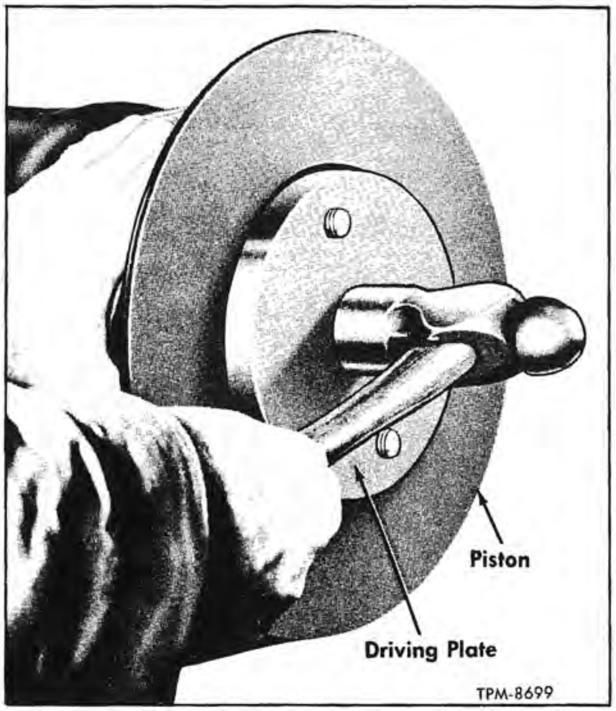


Figure 18—Removing Lower Retainer From Piston

2. If system is pressurized, disconnect height control valve link (one at front and two at rear), then pull down height control valve overtravel lever to exhaust air from bellows. Do not change height control valve lever adjustment.

3. Remove four nuts and bolts attaching mounting plate to beam. Remove lock nut from stud at bottom of bellows assembly (one stud on each front bellows, two studs on each rear bellows). Collapse bellows to get clearance, then disconnect air line and remove bellows assembly.

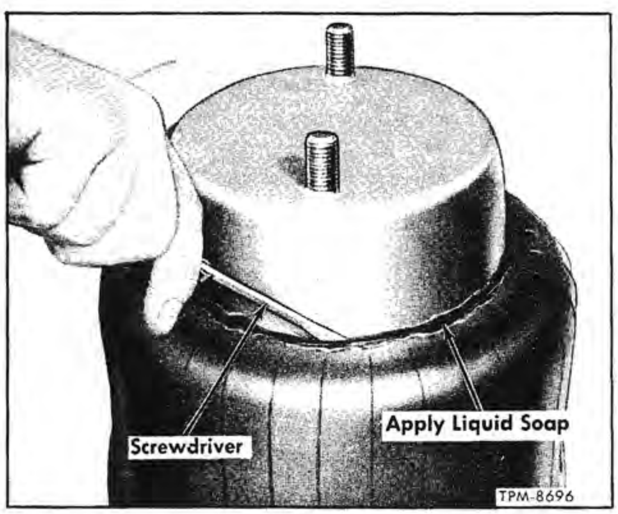


Figure 19—Loosening Bellows Bead From Lower Retainer

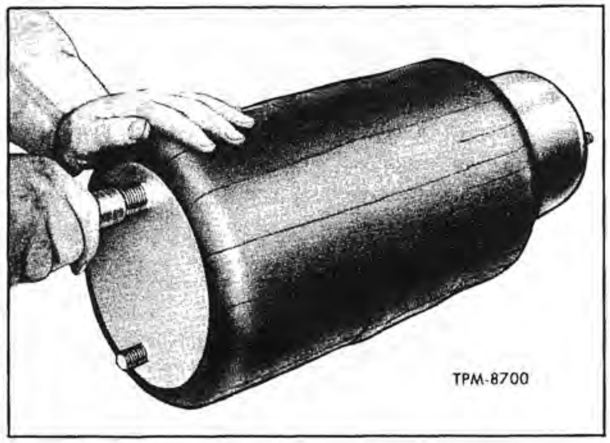


Figure 20—Seating Retainers In Bellows With Air Pressure

4. Remove nut and lock washer from large stud and remove nut from small stud attaching

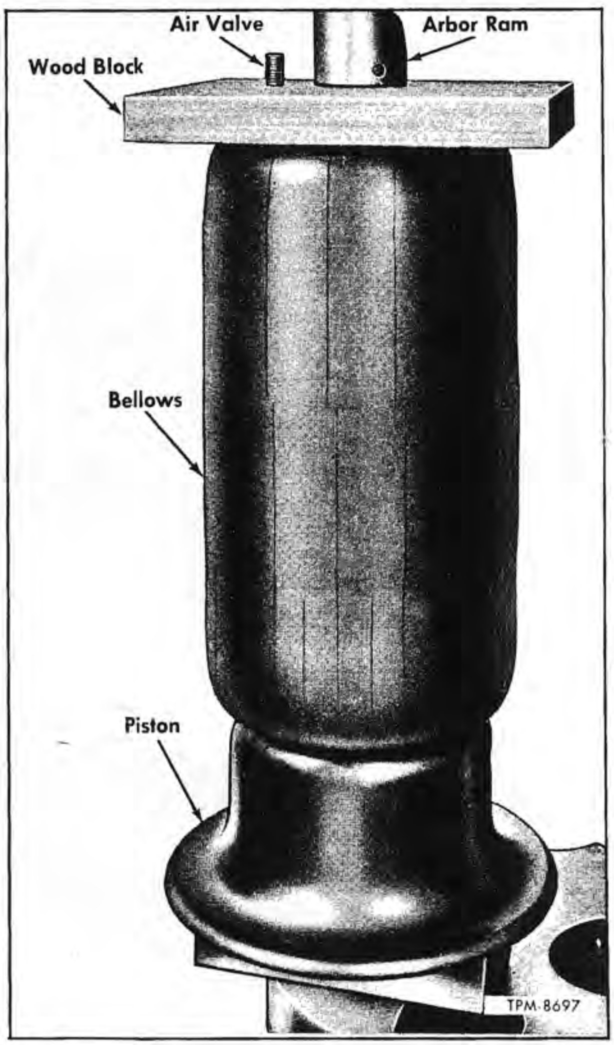


Figure 21—Forming Bellows Loop over Piston Using Arbor Press

mounting plate to upper retainer. Remove mounting plate.

DISASSEMBLY

NOTE: Bellows assembly shown in figure 14 can only be partially disassembled, therefore only paragraphs 1 and 4 are applicable to Firestone bellows.

1. With bellows assembly on bench, apply air through hollow fitting in upper retainer (fig. 15) until loop or fold is removed and bellows is straight.

2. Place wood block across upper retainer, then drive with hammer (fig. 16) until retainer is loose from bellows bead.

3. Press bellows to elongate opening, in order that upper retainer can be removed (fig. 17).

4. In many instances it will be necessary to drive lower retainer out of bellows. A locally made driving plate installed over end of retainer will prevent damage to retainer as it is driven from piston, as illustrated in figure 18.

5. Apply liquid soap or glycerine to lower retainer surface at point of bellows contact (fig. 19). Force screwdriver between retainer and bellows bead (fig. 19) to allow fluid to reach bellows bead.

6. When bead is loosened around entire surface of retainer, the retainer can be forced into bellows and removed through upper opening.

INSPECTION

Examine bellows inside and out for evidence of cracks, punctures, deterioration, or chafing. Replace with new bellows if any damage is evident. Any surface on upper and lower retainers or on piston that touches bellows should be smooth and free of cracks that might cause breaks or damage bellows. Check threads on studs. Replace any damaged parts.

ASSEMBLY

NOTE: Bellows assembly shown in figure 14 can only be partially disassembled, therefore paragraphs 1 through 3 are not applicable to Firestone bellows.

1. Install lower retainer assembly through bellows upper opening and into lower opening.

2. Install upper retainer in place in bellows, being sure that studs in upper retainer are at right angle to studs in lower retainer.

3. Apply air in bellows through opening in upper retainer stud (fig. 20) to seat lower and upper retainers in bellows.

4. Install piston over lower retainer.

5. Install air supply valve in upper retainer stud, then inflate bellows to 5 pounds pressure.

6. Using block of hard wood (1" x 10"), drill two 1" holes so that block will fit over two studs in upper retainer.

7. Install bellows assembly in arbor press

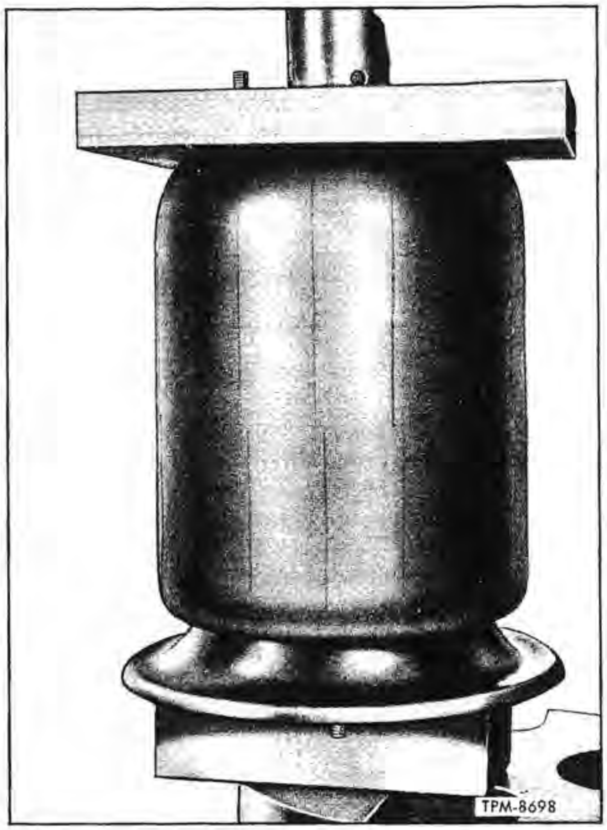


Figure 22—Bellows Loop Rolled over Piston

(fig. 21) with two studs in lower retainer astride a block so that assembly will rest against retainer and piston.

8. Install locally made block over top of bellows assembly with upper retainer studs through holes in block (fig. 21).

9. Operate arbor press so as to compress air and cause lower end of bellows to fold over piston. Continue to press until a dimension of approximately 12" overall height is obtained (fig. 22).

WARNING: Before releasing arbor press be sure that air is released from bellows by opening air valve.

10. Remove assembly from arbor press, then remove wood block and air supply valve.

INSTALLATION

1. Place mounting plate over studs in upper retainer. Edges of plate of front axle should extend downward. Install large nut and lock washer on large stud, and small nut on small stud. Tighten nuts to torque listed in "Specifications" at end of this section.

2. Place bellows assembly in position between suspension support and beam.

Front Bellows. The larger of two studs at top of each bellows assembly should be away from front axle. Seat mounting plate solidly against

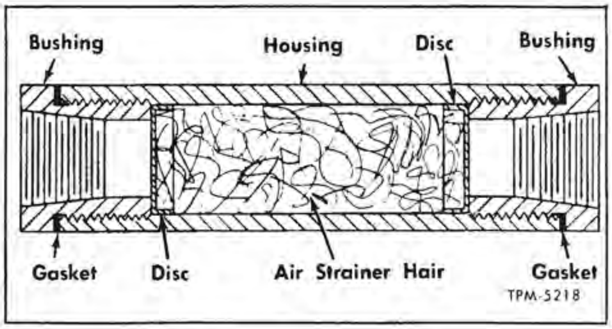


Figure 23—Air Filter

beam and attach with four bolts and lock nuts. Insert bolts from bellows side of plate. Install nut on stud at bottom of bellows. Tighten all nuts to torque listed in "Specifications."

Rear Bellows. The larger of two studs at top of each bellows assembly should be toward rear axle. Attach mounting plate with four bolts and four lock nuts. Install two lock nuts on studs at bottom of bellows. Tighten all nuts to torque listed in "Specifications" at end of this section.

3. Connect height control valve links, if disconnected. Make sure lever adjustment has not been changed.

4. Build up air pressure to normal operating pressure. Remove blocks from under coach.

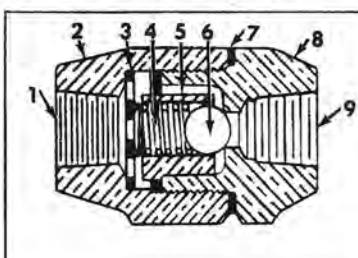
5. Check for air leaks at upper and lower mountings of bellows by coating with solution of soap and water. Any leaks showing up as bubbles must be stopped.

AIR FILTER

Air filter (fig. 23) is connected in air line at pressure regulator valve. Filter should be removed, disassembled, and cleaned yearly. Replace gaskets if necessary. Soak filter material in cleaning solvent. Dry the material and assemble filter. Tighten bushings firmly.

CHECK VALVE

Check valve (fig. 24) is spring-loaded ball type, permitting compressed air to flow in one direction only. Valve is located in air line between pressure regulating valve and suspension air tank. Check valves should be removed, disassembled, and cleaned at regular intervals. Check valve ball should be replaced if any wear or roughness is evident. Use a new gasket between valve cap and body when assembling valve. When installing valve, make sure that arrow stamped on valve cap points toward tank.



1 Air Outlet
2 Body
3 Spring Seat
4 Spring
5 Ball Guide
6 Ball
7 Gasket
8 Cap Nut
9 Air Inlet TP-9369

Figure 24—Air Tank Check Valve

PRESSURE REGULATING VALVE

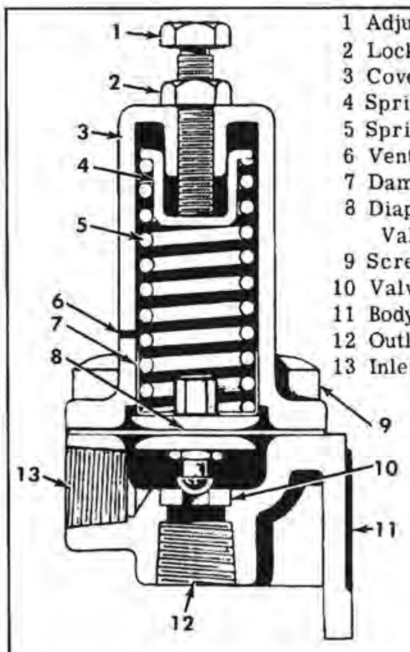
Pressure regulating valve (fig. 25) is mounted on coach body near suspension air tank. This valve serves two purposes. One purpose is to prevent entry of compressed air into air suspension system until pressure in air brake system reaches 65 psi. This makes possible a rapid build-up of air pressure for operation of air brakes. When brake system air pressure exceeds 65 psi, the pressure regulating valve opens and allows pressure to build up in suspension system. The second purpose of the valve is to prevent loss of brake system air pressure below 65 psi due to leakage in suspension system.

SERVICEABILITY TESTS

1. Operating Test

a. Exhaust compressed air from air system by opening drain cock at air tank. Close drain cock when tank is empty.

b. Connect a test air pressure gauge in brake



1 Adjusting Screw
2 Lock Nut
3 Cover
4 Spring Seat
5 Spring
6 Vent
7 Dampener
8 Diaphragm and Valve Assembly
9 Screw
10 Valve Seat
11 Body
12 Outlet Port
13 Inlet Port

Figure 25—Pressure Regulating Valve

system, preferably in line leading from air tank to pressure regulating valve.

c. Disconnect air line at bottom of pressure regulating valve.

d. Build up air pressure in system and note pressure on test gauge at instant valve opens and discharge air through open line.

e. Adjust valve if pressure varies 5 psi from the original setting (65 psi).

2. Leakage Test

With air line still disconnected at bottom of valve, build up air pressure to a point just below valve setting (65 psi). Coat opening with soap suds to check for leakage. Also apply soap suds to vent opening in valve cover.

No leakage is permissible at vent opening in valve cover. Leakage at this point indicates a ruptured diaphragm. Replace ruptured diaphragm with new part.

Leakage amounting to a 3-inch bubble in 3 seconds at outlet port is permissible. Excessive leakage is an indication of a dirty or worn valve or valve seat.

ADJUSTING PRESSURE SETTING (Fig. 25)

The adjusting screw (1) controls the pressure at which the valve is unseated. Setting may be increased or decreased by turning screw.

1. Back off lock nut (2). Turn screw clockwise to increase pressure, or counterclockwise to decrease pressure.

2. Tighten lock nut (2) when correct adjustment is obtained.

DISASSEMBLY

Remove four screws (9) attaching cover (3) to body (11) and remove cover. Remove spring seat (4) and dampener (7) from cover. Lift diaphragm and valve assembly (8) off body.

INSPECTION

Clean all parts thoroughly, using a suitable cleaning solvent. Examine diaphragm for cracks or wear. If either the valve or the diaphragm is worn or damaged, a new valve and diaphragm assembly (8) must be installed. Inspect valve seat (10) in body. If seat is pitted, scratched, or chipped, it should be replaced.

ASSEMBLY (Fig. 25)

Place diaphragm and valve assembly (8) on body, with valve seated in valve seat in body. Install spring seat (4), spring (5) and dampener (7) in cover (3) and position cover on body. Install four screws (9) through cover and diaphragm into body, and tighten firmly. Connect air pressure source to valve inlet and adjust set pressure.

HEIGHT CONTROL VALVE

DESCRIPTION

Height control valves operate automatically. Valves control the flow of compressed air into or out of bellows. Body of each height control valve contains intake valve, exhaust valve, and delay piston. Overtravel control body contains a spring-loaded nylon piston. Piston protects valve parts when overtravel lever is moved beyond normal operating range, and also provides a delay in the action of the valve so air is not used during momentary bumps, but only on load changes.

Three height control valves are used in coach air suspension system; one at front axle and two at rear axle. The valve at center of front axle has two air supply outlets, one for left-hand set and one for right-hand set of bellows. Each rear valve has a single outlet to supply air to bellows on that side (see fig. 5).

Except for valve body and overtravel shaft, parts in all three valves are similar. Front valve also contains a ball check valve in each inlet port and in each outlet port to prevent passage of air pressure from one side of the vehicle to the other. Each check valve consists of a small nylon ball.

HEIGHT CONTROL VALVE OPERATION

Figure 26 shows cross-section of a front valve assembly in the three phases of operation. Operation of a rear valve would be identical. Valve operation is illustrated as coach is unloaded, at normal ride height, and as coach is loaded. Each valve adjusts independently for the following conditions:

LOADING (Fig. 26)

When coach is loaded, coach body settles. Since valve is linked to suspension, and valve is bolted to body, valve moves downward with body as body is loaded. As overtravel lever and control shaft turns, inlet valve lever moves over against pin of valve core. As pin is pushed in, air pressure flows through height control valve into bellows. Increased air pressure expands bellows and raises body.

Inlet valve is "protected" by check valve (18, figs. 34 and 35) in inlet adapter. Light spring in core freely admits tank air, but return flow of air is blocked.

NEUTRAL POSITION (Fig. 26)

As increased air pressure expands bellows and lifts body, the height control valve moves up-

AIR SUSPENSION

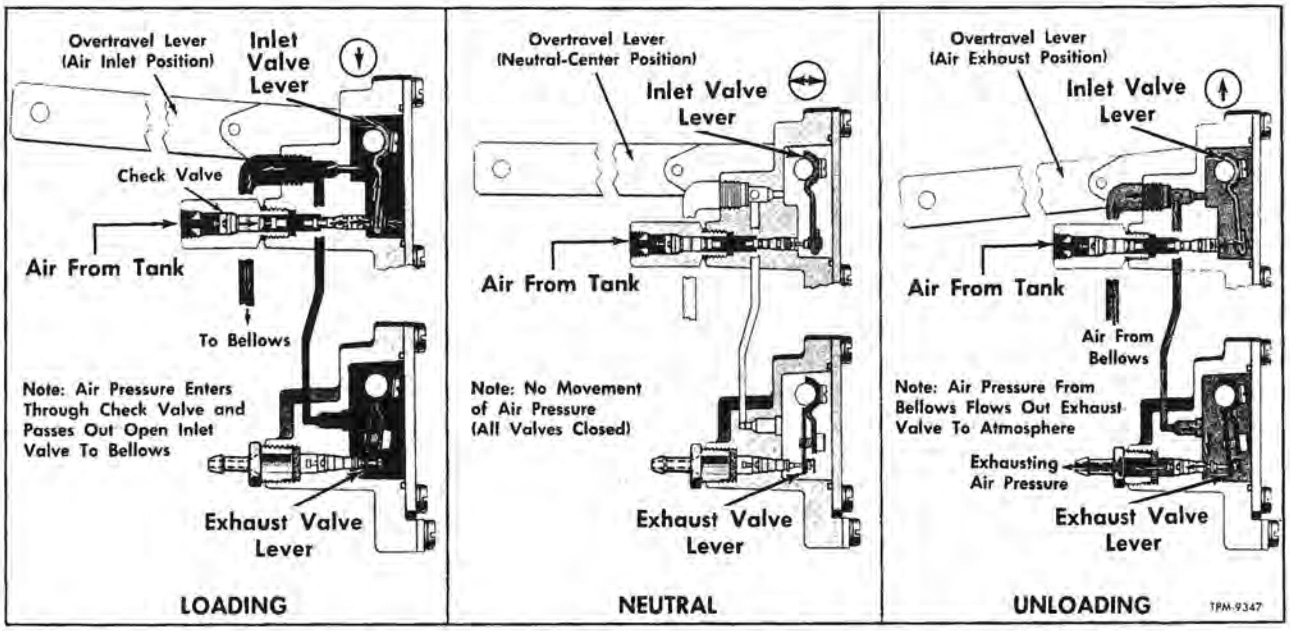


Figure 26—Operation of Height Control Valve (Front Shown)

ward with body. As body is returning to normal ride height, overtravel arm and shaft return to a neutral position. Inlet valve lever also moves away from inlet valve core and inlet valve closes. This stops the flow of air into the bellows. The exhaust valve remains closed. Since the exhaust valve is closed, and the check valve in the inlet adapter prevents compressed air from returning to tank, air is trapped in bellows and in valve. No further valve action or air pressure change takes place until load is increased or decreased, moving overtravel lever out of neutral position for one second or more to actuate intake valve or exhaust valve.

UNLOADING (Fig. 26)

When part of load is removed, air pressure in bellows lifts body. Overtravel lever, linked to suspension in rear and to axle in front, is pulled downward from neutral position. This applies a force on the delay piston which moves it slowly. The exhaust valve lever moves with the delay piston. The outer end of exhaust valve lever fits around stem of exhaust valve core. As soon as lever moves beyond free-travel range, lever pulls on stem and opens exhaust valve. Inlet valve remains closed. Compressed air from bellows then flows through the open exhaust valve and out exhaust fitting to atmosphere. As the compressed air is exhausted from bellows, the body lowers until overtravel lever and shaft are again in normal (neutral) position.

OVERTRAVEL LEVER FREE TRAVEL

With vehicle in motion and body at normal ride height, control valve overtravel lever and shaft are in neutral position as shown in figure 26. Small irregularities in road cause slight up and down movement of overtravel lever. Clearances are provided between operating levers and cores of inlet and exhaust valves to permit 3/16" up or down movement of overtravel lever from neutral position without causing valve action. This compensates for small road bumps. The bumps are absorbed by tires and bellows without causing movement of compressed air either into or out of suspension system.

HYDRAULIC DELAYING ACTION

Operation of a delay piston (5, figs. 34 and 35) in height control valve prevents change of bellows air pressure as result of momentary road shocks, conserves air pressure, and adds life to valve. The nylon piston moves inside cylinder containing a silicone type fluid. A flapper valve on either end of piston allows displacement of fluid or acts as a check valve, depending on direction piston moves. Delay piston is moved by piston pin (11, figs. 34 and 35) that is threaded into overtravel shaft. A one to six second delay results from the closing of one valve to the cracking of other valve. Intake and exhaust valves close from full open position within one second.

Overtravel piston (26, figs. 34 and 35) is held against flat side of overtravel shaft by two springs inside piston. Piston keeps overtravel shaft in proper position relative to overtravel lever. Piston also allows overtravel lever to rotate through a complete circle, if necessary, without damaging parts inside valve.

TROUBLESHOOTING HEIGHT CONTROL VALVE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE MEASURE
1. Bellows deflate overnight.	a. Defective check valve assembly.	a. Replace check valve assembly.
	b. Defective exhaust valve assembly.	b. Replace exhaust valve assembly.
	c. Leak in air line and/or bellows.	c. Replace air line or bellows.
	d. Defective valve cover rubber O-rings or gasket.	d. Replace valve cover O-rings or gasket.
2. Bellows raise to full height and fail to exhaust air pressure.	a. A clogged exhaust screen (15, fig. 34) in height control valve assembly.	a. Remove, then clean screen.
	b. A combination clogged exhaust screen and a defective air inlet valve assembly.	b. Clean exhaust screen and replace air inlet valve assembly
3. Intermittent hissing noise at height control valve during operation.	a. Loss of time delay action fluid in height control valve assembly.	a. Add fluid, then install new cover and delay piston plug gasket O-rings.
4. Erratic valve action.	a. Dirt or foreign matter in the air valve lever chamber.	a. Remove valve cover and blow out dirt. Install cover using new rubber O-rings.
	b. Defective valves.	b. Overhaul height control valve assembly.
5. Vehicle body fails to level out.	a. Improper height control valve overtravel lever adjustment.	a. Make proper adjustments as directed previously under "Ride Height Check and Adjustment."

HEIGHT CONTROL VALVE REMOVAL

Before disconnecting any height control valve air lines, securely support body by placing blocks under coach at jack pads. Exhaust air from air supply system by opening drain cock in suspension air tank. After the above precautions have been taken, remove height control valve as follows:

1. Disconnect height control valve overtravel lever from valve link. Pull lever downward to release compressed air from bellows.

2. Disconnect air supply line and bellows air line from height control valve. Tape ends of all lines closed.

3. Remove two bolts, lock washers, and nuts attaching height control valve to mounting bracket and remove valve assembly.

HEIGHT CONTROL VALVE INSTALLATION

Before installing height control valve assembly, see that air line fittings are clean and undamaged. Replace line connector rubber sleeves if deteriorated or damaged.

DO NOT USE SEALING COMPOUND ON THREADS. Sealer is unnecessary, and if used, may cause valve cores to stick.

IMPORTANT: Absolute cleanliness is essential when installing height control valves. Dirt and sealing compound must be kept out of valves. Even minute particles of foreign matter may become lodged in valve cores or flapper valves and may seriously affect operation of suspension system.

The difference in height control valves is explained previously in "Description." Install valves as follows:

1. Position height control valve at mounting bracket. Attach with two bolts, nuts, and lock washers and tighten to torque listed in "Specifications" at end of this section.

2. Connect air supply line to intake check valve adapter. Connect bellows air line (two at front valve) to outlet adapter. Tighten air line connector nuts firmly.

3. Connect height control valve overtravel lever to valve link. Build up air pressure in system and test for leaks. Check ride height dimensions. Make adjustments as directed following:

HEIGHT CONTROL VALVE AIR LEAKAGE CHECK

NOTE: Air leakage check can be made when valve is installed on vehicle only for bellows mountings and air line connection leaks. The following instructions explain procedure for making air leakage check when valve assembly is removed from vehicle.

1. Clean exterior of valve assembly.

2. Connect air pressure line to air inlet port (fig. 27), then open the air pressure (80-110) psi).

3. Submerge valve assembly in a container of water, then watch for air bubbles when the overtravel lever is in the center position. No air should escape from any point of valve assembly.

4. If bubbles appear from the bellows port, this is an indication that the air inlet valve assembly is defective and must be replaced.

5. Remove air pressure line from air inlet fitting and connect it to the bellows port (fig. 27). If bubbles appear at the air inlet check valve port, this is an indication that check valve unit is defective and must be replaced.

6. If bubbles appear at the exhaust port (fig. 27), it is an indication that the exhaust valve assembly is defective and must be replaced.

7. If bubbles appear around edge of valve cover plate, the cover plate rubber O-rings (or gasket) must be replaced.

8. If no leaks are detected, remove valve assembly from the water, then with air pressure still connected to the bellows port, actuate overtravel lever to expel any excessive amount of water which may have entered exhaust valve chamber. Remove air line and connect it to the air inlet port and repeat operation here to remove water from air inlet valve chamber.

HEIGHT CONTROL VALVE ADJUSTMENTS

To properly adjust the height control valve, it is ESSENTIAL that the following procedures be followed and in the sequence mentioned.

Three main adjustments are required:

1. Overtravel lever center position adjustment.

2. Air intake and exhaust valve lever gap adjustments.

3. Time delay check.

NOTE: The height control valve assembly must be removed from vehicle to make the above adjustments.

Instructions for checking the ride height dimension are explained previously under "Ride Height Check and Adjustment."

IMPORTANT: The Silicone fluid should be drained from valve assembly before making the first two adjustments mentioned above.

NOTE: The following tools should be used when making valve adjustments.

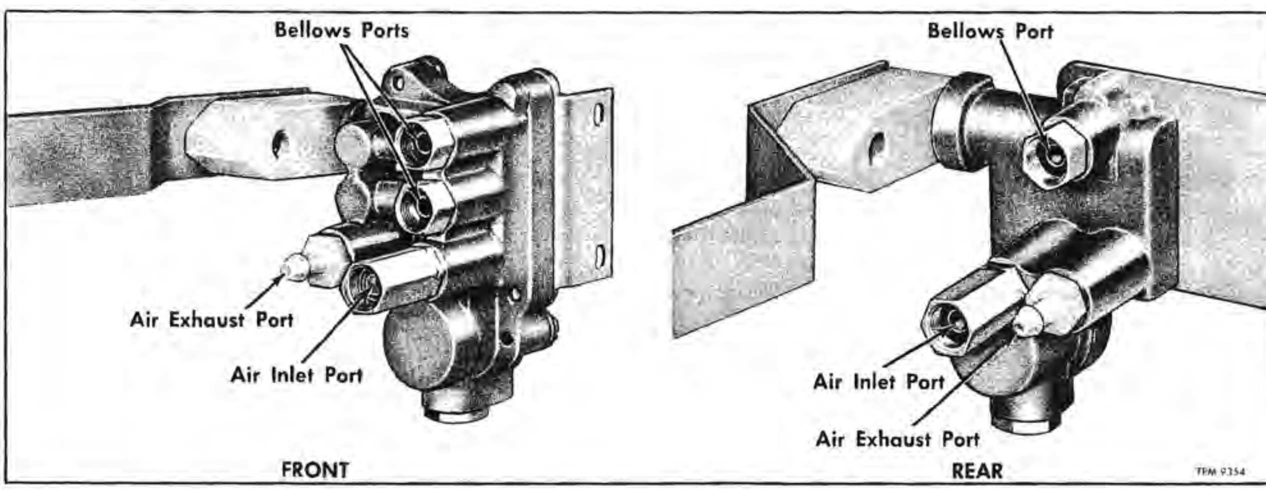


Figure 27—Identification of Valve Air Ports

REQUIRED TOOLS

Tool	Tool Number
Valve Core Replacer	J-6888
Overtravel Lever Piston Compressor	J-8424
Allen Wrenches (Sizes 3/32-inch and 1/8-inch)	Procure locally
Stop Watch	Procure locally
Dial Indicator Set (Having minimum range of 0.200 inch)	Procure locally
Air Line Fitting Assembly Consists of:	
(1) 2-Inch length of 1/4 H-9 hose	Procure locally
(1) Weatherhead pipe fitting	00904-104
(1) Weatherhead inverted fitting	00904-B04
Vacuum Line Fitting	Sun Tester #115-3
Depth Gauge and Straightedge	Procure locally
Conventional Type Eye Dropper	Procure locally

OVERTRAVEL LEVER CENTER POSITION ADJUSTMENT

1. Clean exterior of valve assembly.
2. Remove covers and rubber O-rings from valve assembly, then drain off the Silicone fluid.
3. Remove exhaust fitting (16, figs. 34 and 35) and exhaust screen (15, figs. 34 and 35) from valve.
4. Referring to figure 28, scribe a line 1-3/8 inch from plug end of overtravel lever control body.
5. Place valve assembly in vise as shown in figure 28.
6. If vacuum source is available, attach supply hose to valve exhaust port (fig. 27) using Sun Tester fitting #115-3 or equivalent. Do not apply vacuum at this time.
7. Attach air pressure supply hose to air inlet port (fig. 27). Do not apply pressure at this time.
8. Locate dial indicator in position as shown in figure 28. Move overtravel lever to full air exhaust position - TOP OF DELAY PISTON FLUSH WITH TOP OF BORE - without overtraveling (position "C," fig. 29). Relocate indicator push rod to just contact 1-3/8 inch mark on control body and reset indicator dial to zero (0) at this point (position "C," fig. 29).
9. Move overtravel lever to full air intake position without overtraveling (position "A," fig. 29) (delay piston at bottom of bore). Take indicator reading which may vary from 0.160" to 0.190".
10. Repeat steps 8 and 9 above to recheck this reading.
11. Divide the total travel dimension by two (example: 0.170" ÷ 2 = 0.085"), then move overtravel lever back this amount (0.085") to the center (position "B," fig. 29).

IMPORTANT: Without disturbing lever center position, reset indicator dial to zero (0), which actually is 0.100" on indicator of type registering 0.100" for each revolution of indicator needle, then proceed with valve lever gap adjustments following:

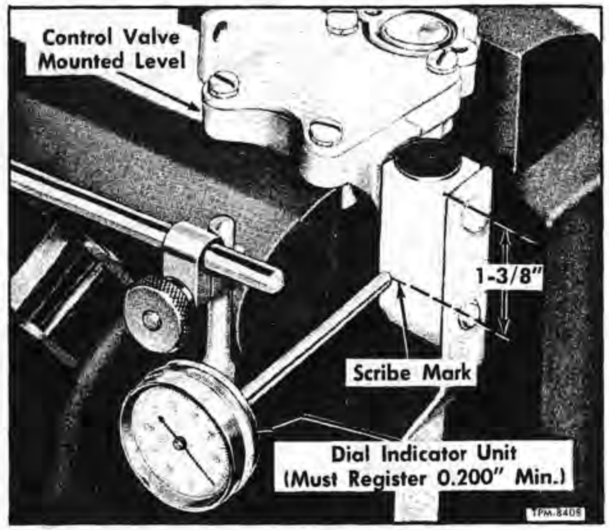


Figure 28—Dial Indicator Properly Installed

AIR INTAKE AND EXHAUST VALVE LEVER ADJUSTMENTS

IMPORTANT: Before making these adjustments the overtravel lever must be centered as explained previously.

Two methods of adjustment are available:

1. Using Both Air Pressure and Vacuum.

NOTE: If vacuum source is available, this method will take less time to perform adjustment. Vacuum source is used to make the exhaust valve lever gap check only.

2. Using Air Pressure Only.

NOTE: When this method is used, it will take longer to perform adjustments as the valve cover must be in place each time air pressure is applied and then removed to permit turning of exhaust valve lever adjustment screw.

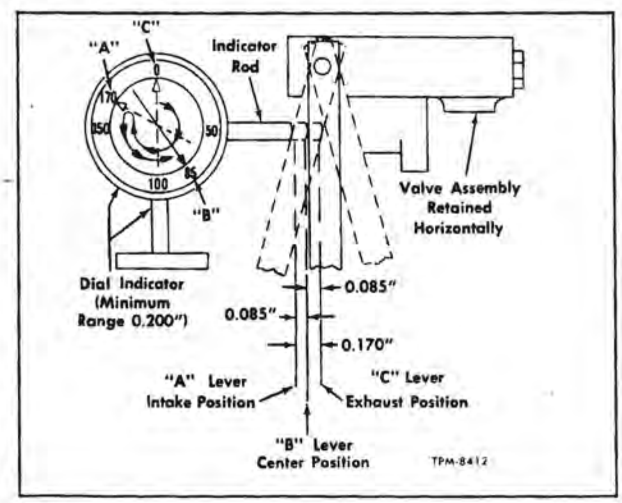


Figure 29—Locating Valve Overtravel Lever Center Position

AIR SUSPENSION

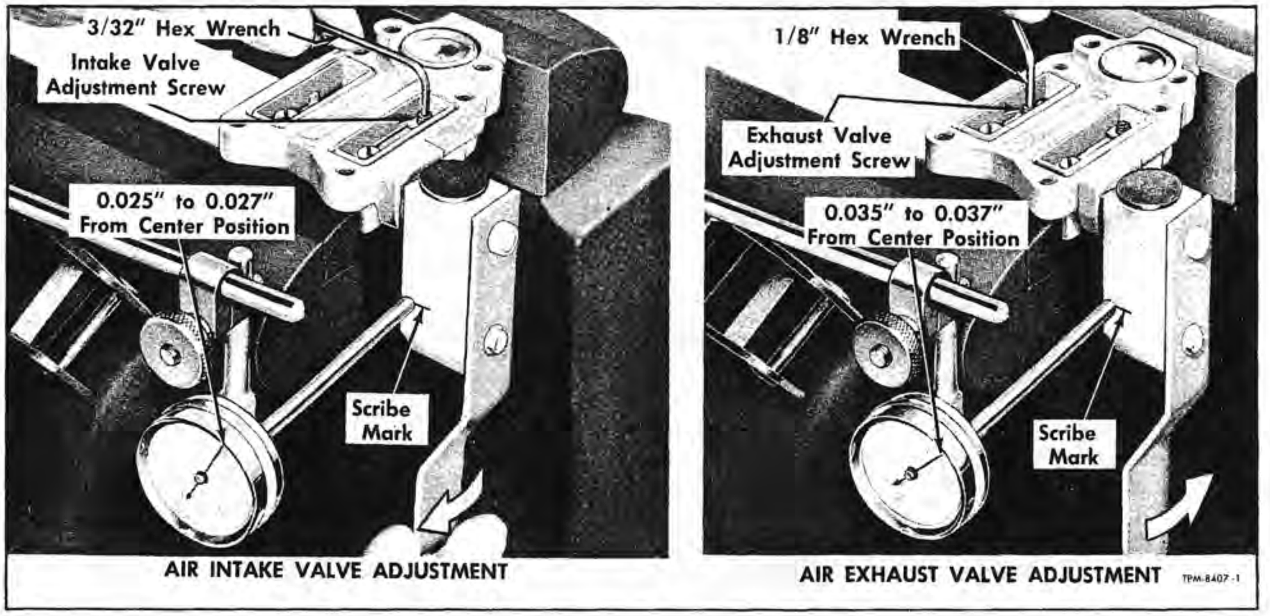


Figure 30—Method of Adjusting Air Valve Lever Gaps (Front Shown)

Instructions covering lever adjustments are identical for front and rear valves, except that portion which describes the actual setting of the levers. Front valve levers are set by screw adjustments but rear valve levers must be bent to proper setting. In rear valve, both exhaust and intake levers are part of one unit which contains "score" marks to permit easy bending. Mechanics may accomplish this operation with lever in the valve body, or lever may be removed and bent on the bench.

METHOD USING AIR PRESSURE AND VACUUM

1. If air supply and vacuum lines were not connected to valve assembly as directed previously when centering valve overtravel lever, connect lines.

2. Apply air pressure and regulate it to 80 to 110 psi. Apply vacuum and regulate it at approximately 15 inches.

3. Move overtravel lever fore and aft several times and then back to true center position.

4. Starting at true center position, slowly move lever to where air intake valve just begins to open. Listen for escaping air. Note reading on dial at this point. Reading should be 0.025" to 0.027" from lever center position. On front valves, using a 3/32" hex wrench, adjust screw on intake valve lever (left view, fig. 30) until correct setting is obtained. On rear valves, bend lever to correct setting.

5. Return overtravel lever to center position. Slowly move lever to exhaust side and at same time note the vacuum gauge reading. When vacuum just begins to fall off, the exhaust valve has opened. Valve should open when overtravel lever is moved 0.035" to 0.037" from center position. On front valves, using a 1/8-inch hex wrench, adjust exhaust valve lever adjustment screw as shown in right view, figure 30 as required. On rear valves, bend lever to correct setting.

NOTE: On front valves, if the adjustment screw is turned in too tight it must be backed off, and the two arms of exhaust lever spread apart as lever arms are not of the spring-back type. If this action was performed, repeat adjustment procedure above.

6. Recheck intake and exhaust valve lever gaps, then proceed with "Time Delay Check" explained later.

METHOD USING AIR PRESSURE ONLY

NOTE: This method may be performed when a vacuum source is not available.

1. Connect air supply hose (80 to 110 psi) to air inlet port (fig. 27).

2. To adjust air intake valve lever gap:

a. Move the overtravel lever slowly from true center position to point where intake valve just begins to open. Listen for escaping air. Note reading on dial at this point which should register 0.025" to 0.027".

b. On front valves using a 3/32" hex wrench adjust screw on intake valve lever (left view, fig. 30) until specified adjustment is obtained. On rear valves, bend lever to correct setting.

3. To adjust air exhaust valve lever gap:

a. Install valve cover on the valve using the two rubber O-rings and four attaching screws.

b. Being careful not to disturb indicator set-

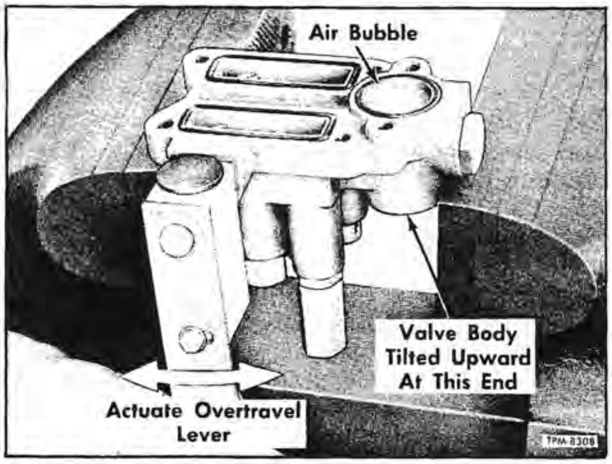


Figure 31—Venting Air From Silicone Fluid

ting, disconnect air supply from the air inlet port and connect it to the bellows port (fig. 27).

c. Move overtravel lever slowly to open exhaust port while observing the indicator dial. Air should start to escape from exhaust port when indicator registers 0.035" to 0.037". If adjustment is necessary, shut off air pressure supply and remove valve cover. On front valves, adjust screw setting; on rear valves, bend to correct setting, then install cover and recheck valve opening dimension.

NOTE: Turning adjustment screw clockwise reduces gap dimension and overtravel lever movement dimension. If the adjustment screw is turned in too tight, it must be backed off, and the two arms of exhaust lever spread apart. If this action was necessary repeat adjustment procedure above.

d. Recheck valve lever gaps, then proceed with "Time Delay Check" following:

TIME DELAY CHECK

PRELIMINARY PROCEDURES

After the valve lever gaps have been properly adjusted, the time delay check must be performed. A one to six seconds delay from the closing of one valve to the opening of the other is recommended. Also, valves should close from full-open position within one second.

1. Place new O-ring (12, figs. 34 and 35) over delay plug (13, figs. 34 and 35), then install plug into valve body. Tighten plug to 20-30 inch-pounds torque.

2. Pour 5.5 cc $\pm$ 0.25 cc of Silicone fluid (750 Centistokes viscosity at 25°C) into delay piston bore. With valve body tilted slightly as shown in figure 31 carefully operate overtravel lever fore and aft to vent air from fluid. When all air has been expelled from piston pin cavity, check fluid level using depth gauge as shown in figure 32.

IMPORTANT: With valve assembly level, take measurement from center of bore only. Add or remove fluid to bring fluid 1/8-inch from top of valve body on front valve, or 13/64 inch from top on rear valve. An eyedropper will serve for this purpose.

3. Place new delay piston cover O-ring in groove of valve body. Install cover with two attaching screws and tighten to 20-25 inch-pounds torque.

4. Place valve assembly vertically in holding vise (fig. 33).

5. Cycle arm up and down for approximately one minute.

AIR INLET TIME DELAY CHECK

1. Connect air pressure supply hose to valve air inlet port (fig. 27).

2. Move the overtravel lever upward (quickly) approximately two inches and simultaneously start

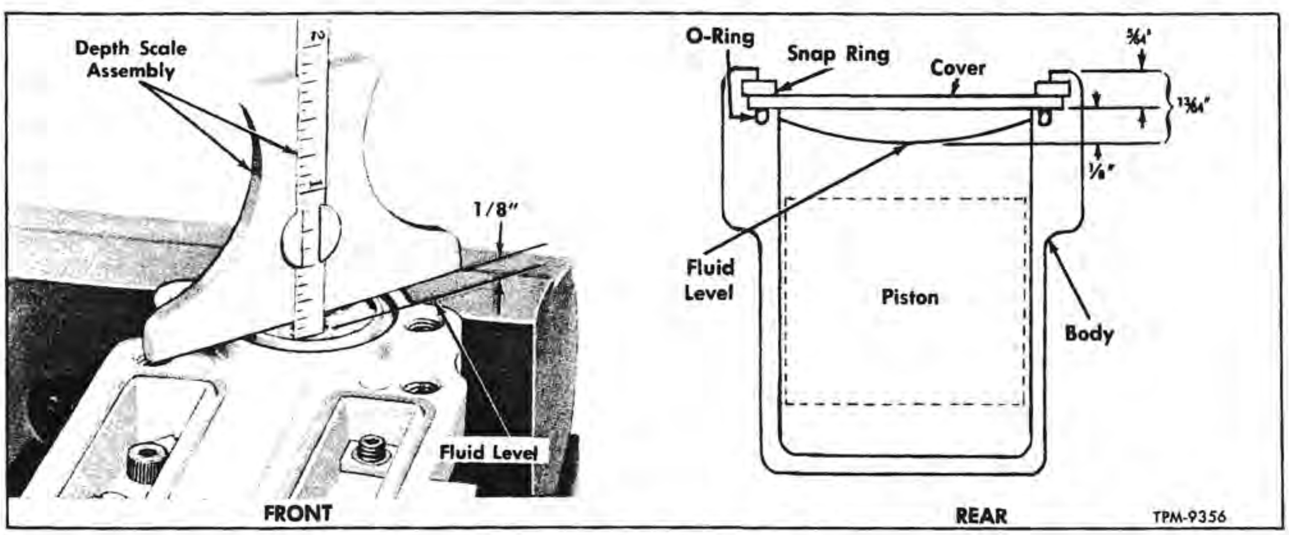


Figure 32—Measuring Fluid Level

counting the number of seconds before air starts to escape from bellows port. A delay of one to six seconds should exist. Repeat this check.

AIR EXHAUST TIME DELAY CHECK

To time the delay for exhaust, two methods can be used; one using vacuum source and one using air pressure.

1. Method Using Vacuum

a. Connect vacuum hose to air exhaust port (fig. 27). Adjust vacuum to 15 inches.

b. Move the overtravel lever downward (quickly) approximately two inches and simultaneously start counting the number of seconds before the vacuum gauge starts to drop off. A delay of one to six seconds should exist. Repeat this check.

2. Method Using Air Pressure

a. Install valve cover with rubber O-rings or gasket on valve assembly.

b. Connect air pressure supply hose to bellows port (fig. 27).

c. Move overtravel lever downward (quickly) approximately two inches and simultaneously start counting the seconds before air starts to escape from the exhaust port. A delay of one to six seconds should exist.

IMPORTANT: A time delay over six seconds could mean too large a valve lever gap adjustment and a time delay under one second would mean too small a valve lever gap adjustment. If the time delay is not within one to six seconds, first recheck the fluid level. If fluid level is satisfactory, the valve lever gap adjustment must be repeated, step by step.

NOTE: (Refer to figures 34 and 35.) After obtaining proper valve adjustments, install valve cover using new rubber O-rings or gasket (6). Install new screen (19), in bellows port, then using new O-ring (17), install outlet adapter (20) into bellows port. (NOTE: On front valves, two outlet adapters (20), screens (19), and nylon balls (40) are used.) If screen (15) was removed from exhaust port, install new screen and exhaust fitting (16).

NOTE: Place tape over ends of air line ports until such time valve assembly is installed on vehicle.

HEIGHT CONTROL VALVE OVERHAUL

Height control valves meter air into and out of the air suspension system. These valves are precision built and accurately adjusted. Parts must be carefully handled and assembled. Valves must also be accurately adjusted to insure proper operation after rebuild. Special tools mentioned previously should be used. Makeshift tools may break off chips that could lodge between valve and seats. Chips, dirt, and other foreign material could cause faulty valve operation.

NOTE: Repair parts kit is available which contains all parts usually requiring replacement in average overhaul. Parts in repair kit are indicated by asterisk (*) in figures 34 and 35.

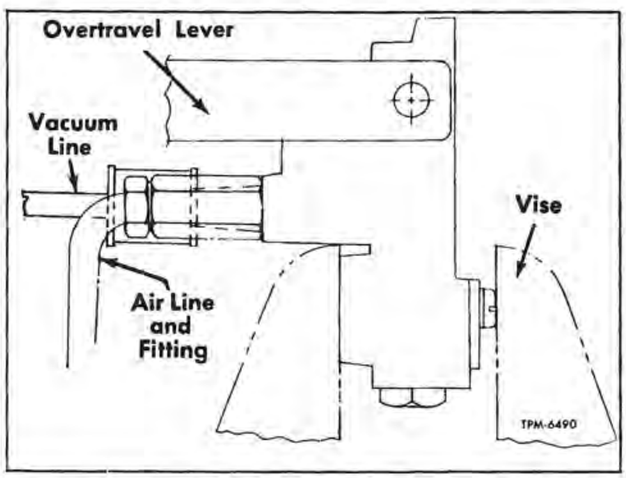


Figure 33—Valve Positioned For Time Delay Check

Key numbers shown in text refer to figures 34 (Front Valve) and 35 (Rear Valve). All parts common to both valves will have a common key number. Key numbers not common will be denoted by letter suffix "F" (Front) or "R" (Rear).

DISASSEMBLY

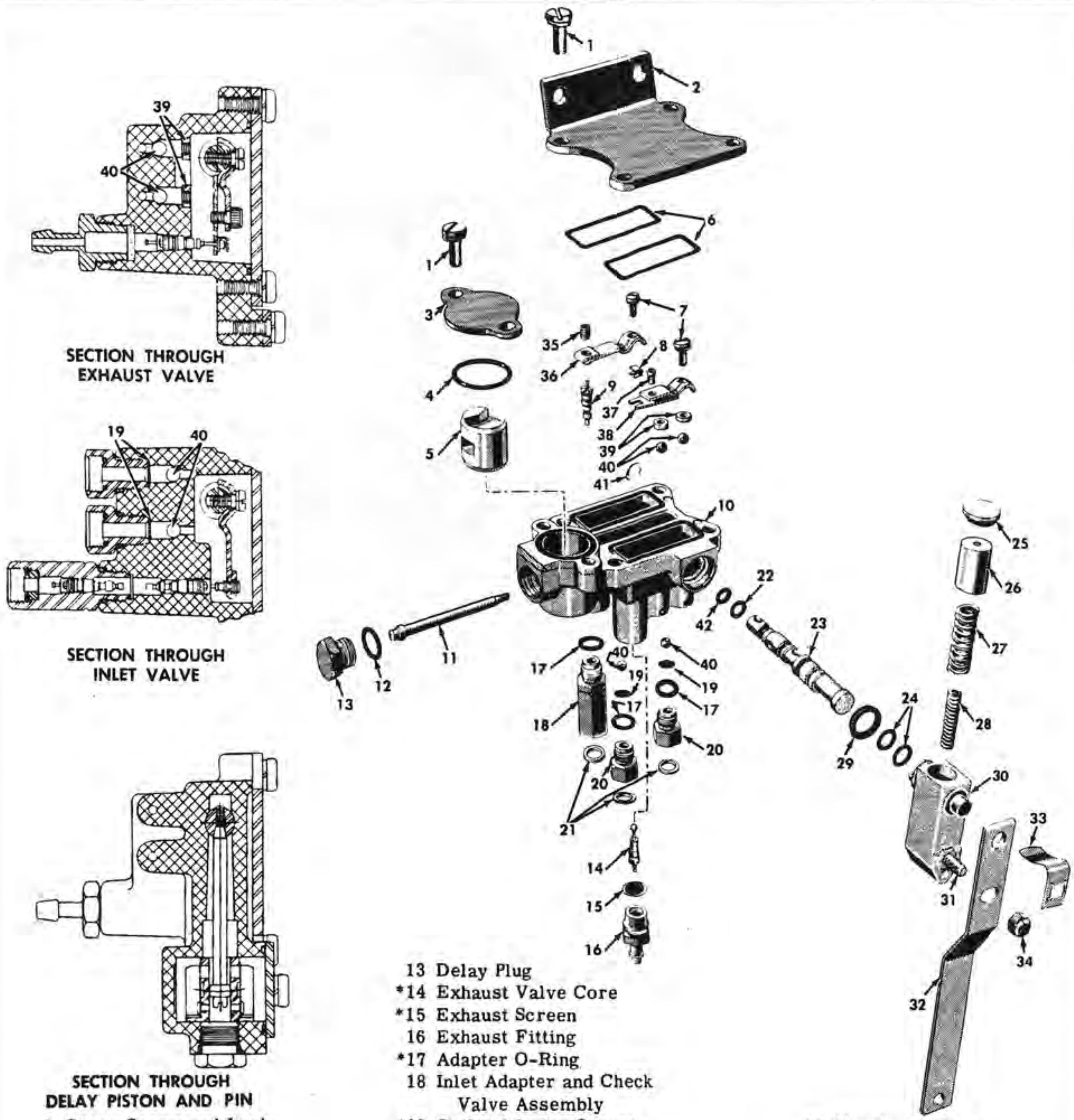
1. Remove inlet adapter and check valve assembly (18) from valve body (10). Remove outlet adapters (20) and nylon balls (40F). (Rear valves have only one outlet adapter (20) and no nylon balls are used.) Remove adapter O-rings (17). Remove air line fitting gasket (21) from adapters.

2. Remove four cover screws and lock washers (1) from cover and bracket (2). Remove cover and bracket and cover O-rings (6F) or gasket (6R).

3. Position valve with delay plug at top. Unscrew delay plug (13) from valve body. Drain silicone fluid from cavity. Remove plug O-ring (12). Unscrew piston pin (11) from control shaft.

4. On front valve remove two cover screws and lock washers (1) from cover (3). Remove cover and cover O-ring (4). Remove delay piston (5). Cover (3) on rear valve is retained by a snap ring (35R). Remove cover (3), O-ring and delay piston, accordingly.

5. Remove valve lever screw(s) and lock washer(s) (7) from valve lever(s). Remove exhaust valve lever (38F) and intake valve lever (36F) from valve body. Front valve has two separate levers while both levers (36R) are one unit in rear valve.

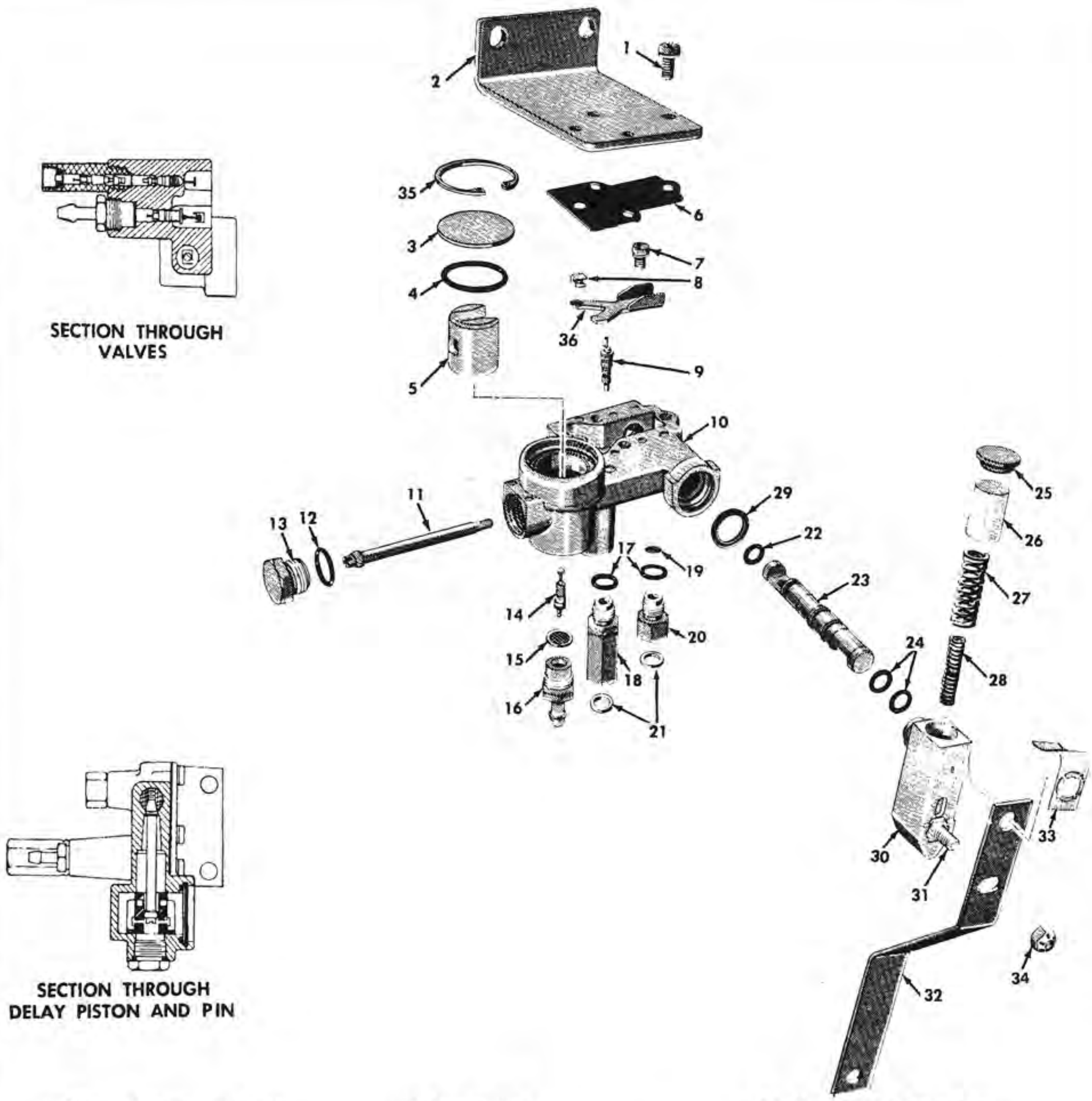


1 Cover Screw and Lock Washer
2 Cover and Bracket
3 Delay Cover
* 4 Delay Cover O-Ring
5 Delay Piston
* 6 Cover O-Ring
7 Valve Lever Screw
* 8 Valve Stem Lock Clip
* 9 Intake Valve Core
10 Valve Body
11 Piston Pin
*12 Plug O-Ring
13 Delay Plug
*14 Exhaust Valve Core
*15 Exhaust Screen
16 Exhaust Fitting
*17 Adapter O-Ring
18 Inlet Adapter and Check Valve Assembly
*19 Outlet Adapter Screen
20 Outlet Adapter
*21 Airline Fitting Gasket
*22 Shaft O-Ring (Medium)
23 Overtravel Control Shaft
*24 Shaft O-Ring (Large)
25 Overtravel Body Plug
26 Overtravel Piston
27 Overtravel Spring (Large)
28 Overtravel Spring (Small)
*29 Overtravel Control Body Seal
30 Overtravel Control Body
31 Overtravel Lever Stud
32 Overtravel Lever
*33 Plug Retainer
34 Lever Stud Nut
35 Intake Valve Lever Adjusting Screw
36 Intake Valve Lever
37 Exhaust Valve Lever Adjusting Screw
38 Exhaust Valve Lever
39 Nylon Ball Retainer
40 Nylon Ball
*41 Lever Retaining Ring
*42 Shaft O-Ring (Small)

TPM-9353

Figure 34—Height Control Valve and Components—Front

AIR SUSPENSION



1 Cover Screw and Lock Washer
2 Cover and Bracket
3 Delay Cover
* 4 Delay Cover O-Ring
5 Delay Piston
6 Cover Gasket
7 Valve Lever Screw
* 8 Valve Stem Lock Clip
* 9 Intake Valve Core
10 Valve Body
11 Piston Pin
*12 Plug O-Ring
13 Delay Plug
*14 Exhaust Valve Core
*15 Exhaust Screen
16 Exhaust Fitting
*17 Adapter O-Ring
18 Inlet Adapter and Check Valve Assembly
*19 Outlet Adapter Screen
20 Outlet Adapter
*21 Airline Fitting Gasket
*22 Shaft O-Ring (Medium)
23 Overtravel Control Shaft
*24 Shaft O-Ring (Large)
25 Overtravel Body Plug
26 Overtravel Piston
27 Overtravel Spring (Large)
28 Overtravel Spring (Small)
*29 Overtravel Control Body Seal
30 Overtravel Control Body
31 Overtravel Lever Stud
32 Overtravel Lever
*33 Plug Retainer
34 Lever Stud Nut
35 Delay Cover Retainer
36 Intake and Exhaust Valve Lever

TPM-9349

Figure 35—Height Control Valve and Components—Rear

6. Remove valve stem lock clip (8) from stem of exhaust valve core. Spread locking arms and slide clip from around stem.

7. Remove retaining ring (41F - Front only) from overtravel control shaft. Pull overtravel assembly and shaft from valve body.

8. Remove intake valve core (9) with tool J-6888 as shown in figure 36. Remove inlet adapter screen.

9. Remove exhaust fitting (16) and screen (15), then remove exhaust valve core (14) with tool J-6888 as shown in figure 36.

10. On front valve only, remove two retainers (39F) and nylon balls (40F) from exhaust valve lever cavity in body. Threaded end of piston pin (11) can be used to lift ball retainers out of body.

11. Remove plug retainer (33) from overtravel control body (30). Retainer must be cut off. Use caution to avoid damage to nylon body. Remove overtravel body plug (25).

12. Place forked end of tool J-8424 around shaft in overtravel control body, then tighten clamp screw. See figure 37. CAUTION: TIGHTEN TOOL UNTIL OVERTRAVEL CONTROL SHAFT (23) CAN BE TURNED 90° TO ALLOW NOTCH IN SHAFT TO PASS FREE OF OVERTRAVEL PISTON (26). DO NOT APPLY MORE PRESSURE THAN IS REQUIRED. Remove overtravel control shaft (23) and overtravel control body seal (29) from body. Remove shaft O-rings (22, 24, and 42F). Back off vise jaw and take body and tool from vise. Remove tool, overtravel piston (26), overtravel lever large spring (27), and overtravel lever small spring (28) from body. Remove lever screw nut (34) from overtravel lever screw or stud. Remove lever (32) from body.

CLEANING AND INSPECTION

1. The following parts should be discarded and replaced with new parts at each overhaul: Plug retainer (33), overtravel control body seal (29), and O-rings (4, 6F, 12, 17, 22, 24, and 42F).

2. Thoroughly clean all metallic parts in a suitable cleaning solvent. Blow parts dry with compressed air.

3. Inspect all bearing and rubbing surfaces for scoring, fractures, or noticeable wear. Discard all damaged or worn parts and replace with new parts.

ASSEMBLY

CAUTION: HEIGHT CONTROL VALVE PARTS MUST BE KEPT FREE FROM DIRT AND MOISTURE.

1. Install intake valve core (9) and exhaust valve core (14) in body with tool J-6888 in manner shown in figure 36. Tighten to 2-1/2 to 3 inch-pounds torque.

2. On front valves only, place two nylon balls (40F) in passages at bottom of exhaust valve lever cavity in body. Install ball retainers (39F).

3. Lubricate overtravel body with multi-purpose grease. Assemble overtravel components as follows:

a. Install overtravel lever (32) on body. Place lever stud nut (34) on stud and tighten to 70-80 inch-pounds torque.

b. Place overtravel lever large spring (27), and overtravel lever small spring (28) inside piston (26). Insert piston in body (30).

c. On front valve, place four new O-rings (22, 24 and 42F) on overtravel control shaft (23) as shown (on rear valve there are only three O-rings). Lubricate shaft and O-rings with multi-purpose grease.

d. Position fork of tool (J-8424) so that shaft can be inserted in body. Carefully apply pressure with clamp screw (fig. 37). Compress springs only

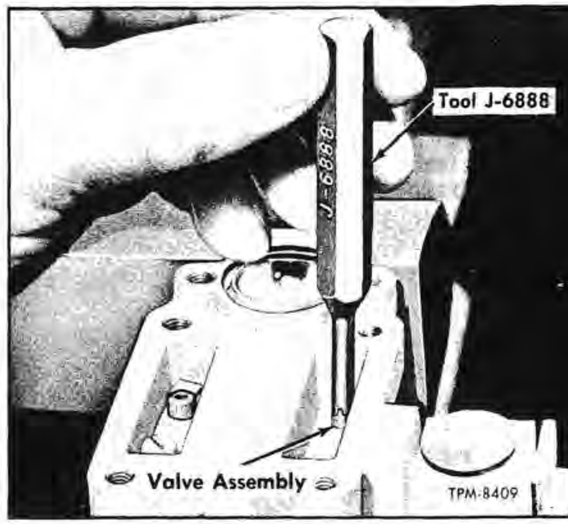


Figure 36—Replacing Valve Core Assemblies

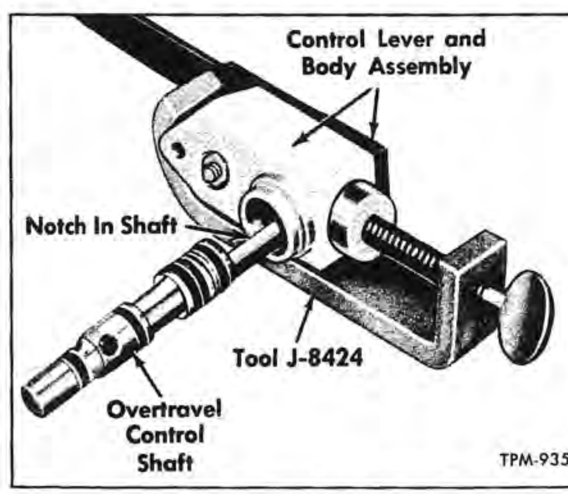


Figure 37—Replacing Overtravel Lever

enough to allow shaft to be inserted. Install overtravel control shaft (23). Rotate shaft so that flat is next to piston.

e. Insert overtravel body plug (25) in bore of body. Force new plug retainer (33) in position over nylon pivot and body plug.

f. Place new overtravel control body seal (29) on shoulder of body. Slide overtravel assembly into valve body (10). Insert carefully to avoid O-ring damage. On front valve secure shaft by installing retaining ring (41F).

4. Install delay assembly as follows:

a. Place delay piston (5) in valve body with open side of piston toward the overtravel shaft.

b. Align pin openings in piston and in shaft. Fit piston pin (11) in TAPERED SIDE of hole in shaft. Tighten pin to 8-10 inch-pounds torque.

5. Place intake valve lever (36F) and exhaust valve lever (38F) in position on overtravel shaft (combined in one piece - 36R - on rear valve). Place exhaust valve lever fork around stem of valve core. Fork should be high enough on stem so that stem will not be held open. Insert valve lever screws (7) and lock washers and tighten to 8-10 inch-pounds torque.

6. Spread ends of valve stem lock clip (8) slightly and place on exhaust valve stem around stem head. Use suitable tool to brace stem, and pinch ends of clip just enough to secure on stem. Clip must rotate freely on stem.

7. Using new O-ring (17), install air inlet adapter and check valve assembly (18) into valve body.

8. At this stage of assembly, make all of the valve assembly adjustments as explained previously under "Height Control Valve Adjustments."

SHOCK ABSORBERS

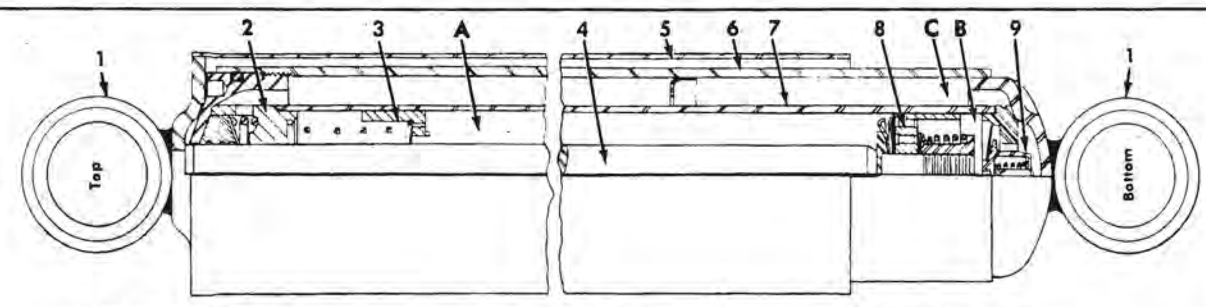
DESCRIPTION

Shock absorbers used at front and at rear axles are double-acting, telescoping type. The principal components of the shock absorber, illustrated in figure 38 are: Piston and valving assembly (8), piston rod (4), rod guide and seal assembly (2), cylinder tube (7), base valving assembly (9), reservoir tube (6), shield (5), and mounting eyes (1). The cylinder tube (7), is completely filled with special hydraulic fluid, with an additional amount in the reservoir tube. Front and rear shock absorbers are identical.

SHOCK ABSORBER OPERATION

Starting with the shock absorber in closed position as illustrated in figure 38, the control of the opening or "rebound" stroke is as follows: As the piston assembly (8) travels upward, the fluid is compressed in the top portion (A) of the cylinder tube (7) and is forced through orifices in the piston and the rebound control valving located in the bottom of the piston. To replace fluid displaced by the piston rod (4) when in closed position, fluid is drawn from the reservoir section (C) in the reservoir tube (6) through the intake valve section of the base valve (9) into the lower portion (B) of the cylinder tube (7).

The spring and piston making up the rebound cut-off assembly (3) act as an additional cushion for the last inch of rebound stroke. When piston and valving assembly (8) reaches rebound cut-off assembly, the oil passage between piston and piston rod closes. All oil displaced during last inch of travel must flow through a small (0.073") hole in rebound cut-off piston. This restriction of oil flow results in greater dampening effect through last inch of "rebound" travel. At compression stroke, spring in rebound cut-off assembly returns piston to original position.



1 Mounting Eye
2 Rod Guide and Seal Assy.
3 Rebound Cut-off Assy.
4 Piston Rod
5 Shield
6 Reservoir Tube
7 Cylinder Tube
8 Piston and Valving Assy.
9 Base Valving Assy. TPM-7051

Figure 38—Sectional View of Shock Absorber

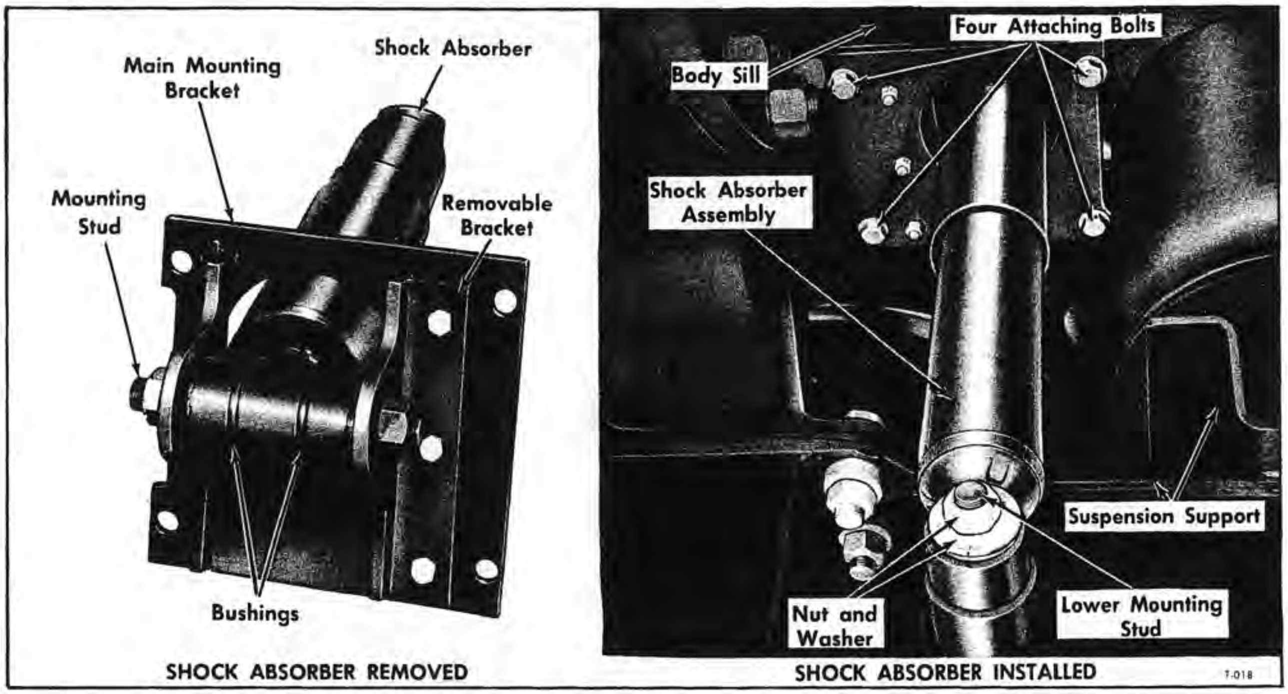


Figure 39—Rear Shock Absorber

The closing or "compression" stroke of the shock absorber is controlled as follows: Fluid pressure for control of the compression stroke is developed entirely by the displacement of the piston rod (4) as it enters the fluid-filled cylinder tube (7). The piston (8) does not function, (as a piston) during this cycle since fluid is by-passed from section (B) to section (A) of the cylinder tube (7) through the check valve located in top of piston. The check valve opens on the compression stroke and closes on the rebound stroke.

The fluid displaced by the piston rod (4) entering the cylinder tube (7) is expelled through an orifice in the base valve (9) into the reservoir (C). However, as the velocity of movement increases, the pressure will build up faster than the orifice can bleed it out. When this pressure overcomes the force of the spring in the relief valve section of the base valve, the relief valve lifts from its seat, permitting greater flow and maintaining the internal pressure at the predetermined limit.

SHOCK ABSORBER REPLACEMENT

REMOVAL - REAR (Refer to Fig. 39)

1. Remove four bolts and washers which attach the shock absorber upper mounting bracket to body sill.
2. At lower mounting stud, remove nut and washer retaining shock absorber to stud. Remove shock absorber with attached upper bracket. Left view in figure 39 shows assembly removed.
3. Remove nuts from each end of shock absorber eye stud, then remove three bolts and nuts which attach the removable side bracket to the main mounting bracket assembly. Remove bracket, then separate bushing components.

INSTALLATION - REAR (Refer to Fig. 39)

1. Assemble rubber bushings to the shock absorber upper eye, mounting stud, and main mounting bracket as shown in left view of figure 39.
2. Install removable side bracket to mounting stud, then attach bracket to the main mounting bracket with three bolts and nuts. Install nut at each end of mounting stud. Tighten all nuts firmly.
3. Locate shock absorber with assembled upper bracket into position, then install lower end of shock absorber with assembled bushings over mounting stud at suspension support. Install stud nut and washer. Tighten nut firmly.
4. Attach shock absorber upper mounting bracket to body sill with four bolts and washers.

REMOVAL - FRONT

Remove nuts and washers from shock absorber upper and lower anchor pins. Pull shock absorber and rubber bushings off anchor pins.

INSTALLATION - FRONT

Place one rubber bushing on each anchor pin, install shock absorber eyes over anchor pins, then install second rubber bushing, washer, and nut on each anchor pin. Tighten nuts to 60 to 70 foot-pounds torque.

AIR SUSPENSION

SPECIFICATIONS

AIR BELLOWS

Make (Optional)	The Goodyear Tire and Rubber Co.	
Make (Optional)	Firestone Industrial Products Co.	
	FRONT	**REAR**
Nominal Working Diameter	8″	10″
Nominal Working Height	11½″	11½″

HEIGHT CONTROL VALVES

Make	Delco Products
Part No. (Stamped on Overtravel Lever)	
Front	5544440
Right Rear	5549703
Left Rear	5549704

SHOCK ABSORBERS

Make	Delco Products
Type	Double-Acting, Telescoping
Identification	
Part Number	3178106
Model Number	DF 480X
Valve Code	3 (1) P10-10 J3
Collapsed Length*	16⅞″
Extended Length*	26⅛″
Travel	9¼″

*Length Measured from center to center of mounting eyes.

TORQUE SPECIFICATIONS

HEIGHT CONTROL VALVE

Valve Cores	2½-3 in.-lbs.
Intake and Exhaust Valve Lever Screws	8-10 in.-lbs.
Piston Pin	8-10 in.-lbs.
Exhaust Plug	20-30 in.-lbs.
Delay Plug	20-30 in.-lbs.
Cover Screw	15-20 in.-lbs.
Overtravel Lever Adjusting Nut	70-80 in.-lbs.

REAR AXLE SUSPENSION COMPONENTS

Bellows Support to Axle Bolt Nut	200-220 ft.-lbs.
Bellows to Bellows Support Stud Nut	8-10 ft.-lbs.
Bellows to Adapter Plate Stud Nut (Small)	8-10 ft.-lbs.
Bellows to Adapter Plate Stud Nut (Large)	15-20 ft.-lbs.
Lateral Radius Rod Cap Screw	90-100 ft.-lbs.
Lateral Radius Rod Anchor Bolt Nut	350-400 ft.-lbs.
Anchor Plate Radius Rod Bushing Bolt Nut	320-350 ft.-lbs.
Radius Rod Bolt Nut	490-520 ft.-lbs.
Leveling Valve to Bracket Bolt Nut	8-10 ft.-lbs.
Valve Link to Link Arm Stud Nut	8-10 ft.-lbs.
Axle Bumper Stud Nut	20-30 ft.-lbs.
Anchor Plate Stud Nut	200-210 ft.-lbs.

FRONT AXLE SUSPENSION COMPONENTS

Radius Rod Bracket to Bellows Support Stud Nut	190-210 ft.-lbs.
Mounting Plate to Bellows Beam Angle Bolt Nut	15-20 ft.-lbs.
Bellows to Bellows Beam Stud Nut (Large)	15-20 ft.-lbs.
Bellows to Bellows Beam Stud Nut (Small)	8-10 ft.-lbs.
Bellows to Bellows Support Stud Nut	8-10 ft.-lbs.
Support Bracket U-Bolt Nut	90-110 ft.-lbs.
Anchor Angle to Upper Radius Rod Bracket Bolt Nut	80-90 ft.-lbs.
Radius Rod Bolt Nut	490-520 ft.-lbs.
Lateral Radius Rod Cap Screw	90-100 ft.-lbs.
Axle Bumper Stud Nut	20-30 ft.-lbs.
Leveling Valve Bracket to Crossmember Angle Bolt Nut	15-20 ft.-lbs.
Leveling Valve to Bracket Bolt Nut	8-10 ft.-lbs.
Valve Link to Link Arm Stud Nut	8-10 ft.-lbs.
Bellows Support to Axle Bolt Nut	190-210 ft.-lbs.

STABILIZER BAR (FRONT AND REAR)

Stabilizer Bar Support Bracket Bolt Nut	20-30 ft.-lbs.
Stabilizer Bar Bushing Retainer Clamp Bolt Nut	20-30 ft.-lbs.
Stabilizer Bar Link Stud Nut	175 ft.-lbs. min.

Steering System

This group of the manual includes service information on both mechanical and power steering on coaches covered by this manual. The power units used in conjunction with the conventional steering gear units are covered under "Power Steering" later in this group. All other information applies to both systems with exceptions noted in text. This group is divided into two separate sections as shown in the following Index:

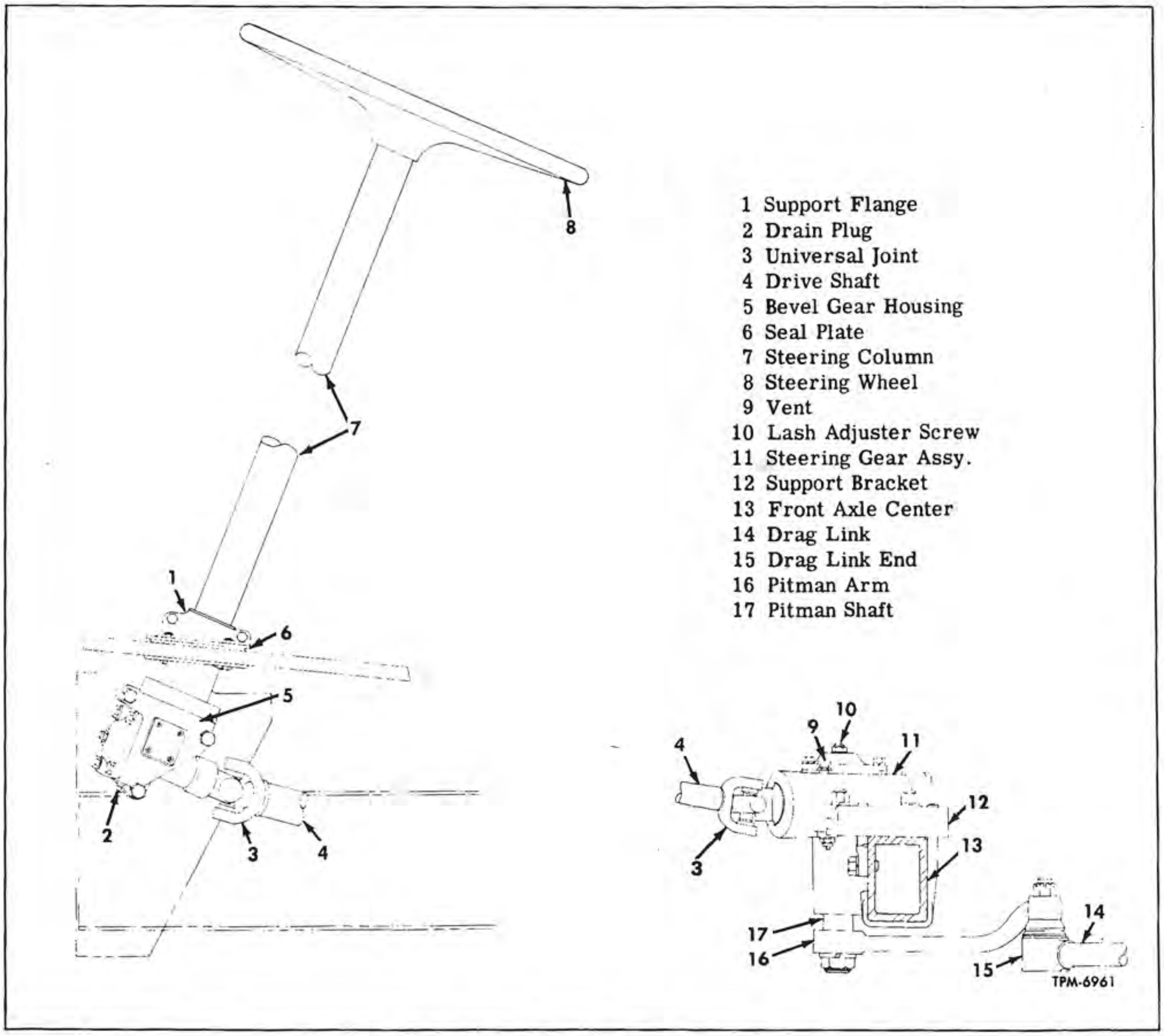


Figure 1—Steering System Installation (Typical)

Mechanical Steering

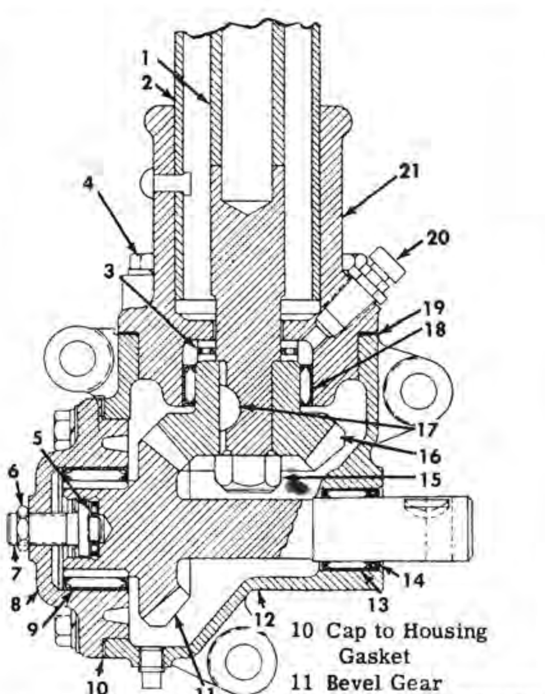
GENERAL

The steering system is comprised of steering column and bevel gear assembly, drive shaft, steering gear assembly, drag link, and allied parts of front axle (fig. 1).

The steering gear is a conventional recirculating ball bearing and sector nut type, mounted on the front axle center and connected to the steering column bevel gear unit by a drive shaft as shown in figure 1.

Related front end assemblies which may affect steering operations: Air Suspension, Brakes, Wheel Bearings, Front Axle, and Front End Alignment are covered in their respective groups in this manual.

Specifications and other pertinent steering system information is given in "Specifications" at the end of each section.



10 Cap to Housing Gasket
11 Bevel Gear
12 Bevel Gear Housing
13 Housing Bearing
14 Retainer
15 Pinion Gear to Shaft Nut
16 Steering Shaft Pinion Gear
17 Woodruff Key
18 Housing Upper Cover Bearing
19 Shim Pack
20 Housing Vent Assy.
21 Housing Upper Cover

1 Steering Shaft
2 Steering Column Tube
3 Steering Shaft Lower Bearing
4 Tube to Housing Bolt
5 Bevel Gear Bearing
6 Lock Nut
7 Bevel Gear Screw
8 Housing Cap Assy.
9 Housing Cap Bearing

TPM-6964-1

Figure 2—Steering Column and Bevel Gear

CONSTRUCTION AND OPERATION

MOUNTING (Fig. 1)

Steering system installation is illustrated in figure 1. Steering column and bevel gear housing assembly is bolted to a bracket on left-hand frame longitudinal member, with steering column extending upward through floor. Steering column support flange and seal plate are attached to floor with four bolts.

Steering gear assembly is mounted on support brackets on front axle center. Position of gear on axle center is maintained by two bolts through the gear housing flange into the front of the axle center. Support brackets are attached to axle center with U-bolts. Steering gear is mounted with Pitman shaft pointing down. Pitman arm extends rearward under axle and is connected to the drag link. Drag link is connected to steering arm at left front wheel.

STEERING COLUMN AND BEVEL GEAR
(Refer to Figure 2)

Bevel gear housing upper cover is pressed onto and riveted to steering column tube. Steering shaft pinion gear is pressed onto steering shaft and secured with Woodruff key and lock nut. The upper pinion gear is mounted in roller needle bearings in bevel gear housing upper cover. Upper pinion gear is adjustable toward lower bevel gear by means of shims used between gear housing upper cover and bevel gear housing.

Lower bevel gear is mounted in needle bearings in bevel gear housing and housing cap assembly and is adjustable toward steering shaft pinion gear by means of a thrust screw. Steering drive shaft flange is keyed to lower bevel gear and is secured by bolt, nut, and lock washer.

Upper end of steering shaft is supported by a ball bearing assembly which is pressed into steering column tube. Horn cable guard is attached to steering column tube with three screws. Steering wheel is keyed to upper end of steering shaft and secured with a nut. Horn contact, spring, button, and components are mounted on upper end of shaft and in center of steering wheel as shown in figure 3.

STEERING DRIVE SHAFT (Fig. 8)

Steering drive shaft, connecting lower bevel gear to steering gear worm, is a tubular type drive shaft equipped with needle bearing type universal joints. Splined slip joint at steering gear end of drive shaft compensates for changing length due to movement of front axle in relation to coach body. Universal joint flanges are connected to flanges on lower bevel gear and steering gear worm shaft.

WORM SHAFT AND NUT (Refer to Figure 9)

The steering worm, which is welded to worm shaft, is mounted in steering gear housing between two tapered roller bearings. Bearings are adjusted to control worm end play by means of shims used between the housing upper cover and gear housing. Helical cut groove in worm is precision finished to serve as a race for balls between worm and worm nut. Bore of worm nut is threaded with a precision finished helical groove corresponding to groove in worm. Worm nut balls are inserted in helical grooves between worm and worm nut in two separate circuits. Two tubular ball guides fit into worm nut and are clamped in place. These guides deflect worm nut balls from end of circuit in worm nut, returning them to helical path at start of circuit. Worm nut balls are the only contact between worm and nut. When worm is turned, worm ball nut moves along worm and at the same time, worm nut balls roll freely between worm and nut, circulating within their separate circuits. This arrangement provides a rolling instead of a sliding contact between parts.

Rack teeth on one side of worm nut mesh with teeth on Pitman shaft; thus, endwise movement of worm nut causes Pitman shaft to rotate.

Shaft yoke is keyed to drive shaft end of worm and secured with a pinch bolt. Oil seal is pressed into gear housing. Seal wipes on shaft yoke hub.

PITMAN SHAFT (Fig. 9)

Teeth on Pitman shaft are not ordinary spur gear type, but are specially designed to provide true rack and sector gear action when worm nut is positioned at a slight angle. This construction permits simple lash adjustment by shifting the Pitman shaft along its axis by means of the lash adjuster screw. With Pitman shaft adjusted to eliminate all lash at straight-ahead position, sector teeth design provides a slight lash when wheels are turned far to right or left. This design permits adjustment for wear of sector teeth in straight-ahead position without causing binding of teeth in less used portion of sector (extreme left or right position).

Pitman shaft is mounted on three needle type roller bearing assemblies, two in gear housing and one in housing side cover. An oil seal is pressed into housing at Pitman arm end of Pitman shaft.

MAINTENANCE

The following light maintenance operations include inspection and adjustment items which may be accomplished without removing the steering gear from the vehicle.

1. At regular intervals, check and if necessary, tighten all steering gear mounting bolts, bevel gear housing mounting bolts, drive shaft yoke bolts, Pitman arm retaining nut, drag link to Pitman arm and steering arm retaining nuts, tie rod to steering arm retaining nuts, and all assembly bolts on steering gear and bevel gear housing.

2. Check steering gear adjustments and adjust if necessary. Refer to "Steering Gear Adjustments" later in this section.

3. Check front end alignment: Refer to "FRONT END ALIGNMENT" (SEC. 1) of this manual.

4. Lubricate steering gear and allied units at regular intervals, as indicated in LUBRICATION (SEC. 13) of this manual.

STEERING GEAR ADJUSTMENTS

Before an attempt is made to remedy steering difficulties by adjusting the steering gear, other factors which might cause hard or otherwise unsatisfactory steering should be checked. Particular attention should be given to tire inflation, lubrication, wheel bearings, brakes, air suspension alignment, front end alignment, and worn, bent, or broken front axle parts.

It is important that the steering gear be properly adjusted to assure satisfactory steering and to prevent excessive wear of parts. Adjustments are provided for worm bearing end play and Pitman shaft lash.

Always check worm bearing adjustment, and adjust if necessary, prior to making Pitman shaft lash adjustment.

Before making adjustments, the following preliminary operations are necessary:

1. Disconnect steering drag link from Pitman arm by removing nut from end stud and driving end stud out of arm. Drag link should remain disconnected until all adjustments are completed.

2. Disconnect drive shaft universal joint yoke from yoke on worm shaft by removing U-bolts and lock nuts. Obtain a bar which can be bolted to worm yoke, with a hole in bar 10 inches from center of worm.

WORM BEARING CHECK AND ADJUSTMENT

Key numbers in text refer to figure 9.

1. Loosen lash adjuster lock nut (2) and turn lash adjuster screw (1) counterclockwise a few turns. This relieves load imposed on worm bearings by close meshing of teeth on worm nut and Pitman shaft sector.

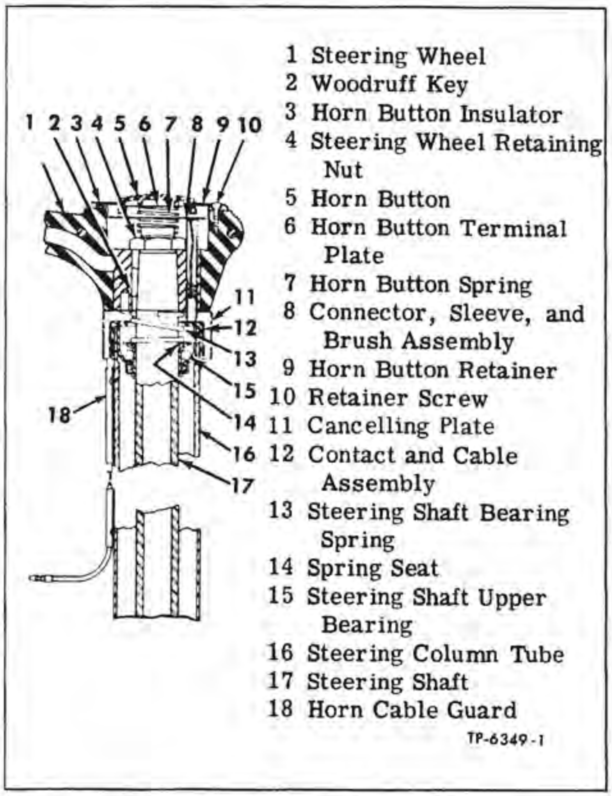


Figure 3—Steering Wheel and Horn Contact Installation

2. Gently turn worm to either extreme left or right position; then back away about one turn.

IMPORTANT: Do not turn worm hard to end of travel with linkage disconnected or ball guides on worm nut may be damaged.

3. Bolt bar previously obtained, to worm shaft yoke (35) and attach spring scale (J-544-01) to bar 10 inches from center of worm. Pulling on spring scale, at right angle to bar, measure pull required to keep worm in motion. Pull required must be within 1-1/2 to 2 pounds, otherwise worm bearing adjustment is required.

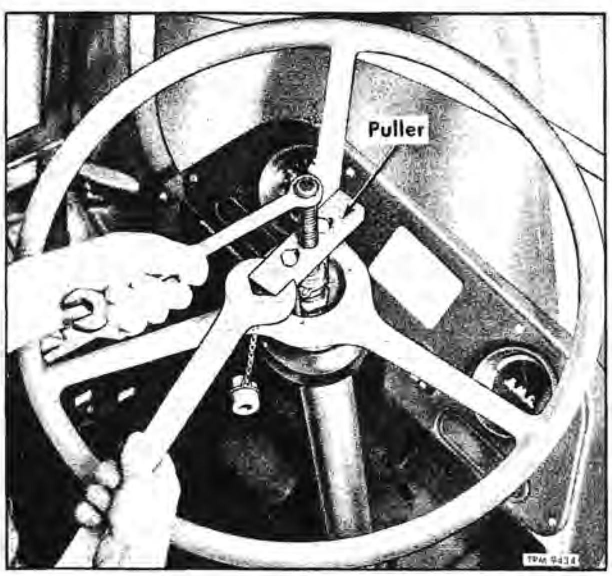


Figure 4—Removing Steering Wheel

NOTE: If any "rough" or "lumpy" action is noted during check, worm bearings are damaged. Steering gear should then be removed, disassembled, and bearings replaced as described later under "Steering Gear Overhaul."

4. Remove upper cover bolts and remove housing upper cover (25). Remove as many shims (26) from between upper cover and housing as required to eliminate all worm end play, when cover is reinstalled and bolts fully tightened. Shims used are 0.002", 0.005", 0.010", and 0.030" thick. A minimum of three 0.002" thick and two 0.005" thick shims should be used.

5. Again check pull, as in Step 3 above, and readjust, if necessary, to obtain proper pull. If adjustment is correct, adjust Pitman shaft lash as described in the following:

PITMAN SHAFT LASH ADJUSTMENT (Fig. 9)

NOTE: Worm bearing adjustment must be completed before making Pitman shaft lash adjustment.

1. Center steering gear by turning worm from extreme right to extreme left position, counting exact number of turns; then rotate worm back exactly half way. Mark worm yoke in some manner to indicate center position.

2. Tighten side cover bolts (3). Turn lash adjuster screw (1) clockwise sufficiently to remove all lash between worm nut teeth and teeth on Pitman shaft sector. Amount of lash may be felt by pushing Pitman arm back and forth. When all lash has been removed, tighten lash adjuster lock nut (2) to 25-35 foot-pounds torque.

3. Check with spring scale as in step 3 under "Worm Bearing Check and Adjustment," except measure greatest pull at CENTER position. If necessary, readjust to obtain pull within 2-3/4 to 3-1/4 pounds.

4. Connect drag link to Pitman shaft, adjusting drag link length, if necessary, as directed under "Drag Link," later in this section.

5. Connect drive shaft universal joint yoke to yoke on worm shaft.

STEERING WHEEL REPLACEMENT

REMOVAL (Figs. 3 and 4)

Key numbers in text refer to figure 3.

1. Remove three screws (10) which attach horn button retainer to steering wheel. Remove retainer, insulator, horn button, terminal plate, and spring from wheel. Lift connector assembly

(8), consisting of contact plate, sleeve, springs, and brush, out of wheel.

2. Remove steering wheel retaining nut (4).

3. Puller screw holes are provided in wheel hub. Using steering wheel puller similar to that illustrated in figure 4, pull steering wheel off shaft.

INSTALLATION

1. Tap Woodruff key (2) into keyseat in shaft. Make sure direction signal cancelling plate (11) is in place on bottom of wheel hub. Position wheel on shaft, with Woodruff key engaging keyway in wheel hub. Install steering wheel retaining nut on shaft. Tighten nut to 40-50 foot-pounds torque.

2. Install contact plate, sleeve, spring, and brush assembly in steering wheel hub, making sure sleeve enters hole in contact shield.

3. Install spring, terminal plate, horn button insulator, and button retainer on wheel and attach with three screws.

STEERING COLUMN AND BEVEL GEAR

REPLACEMENT

REMOVAL (Fig. 1)

1. Remove steering wheel as previously directed under "Steering Wheel Replacement."

2. Refer to LIGHTING (SEC. 7) of this manual for removal of the direction signal housing.

3. Disconnect horn wire. Remove four bolts attaching steering column support flange and seal plate to floor. Lift seal and plate off steering column.

4. Disconnect steering drive shaft universal joint yoke from yoke on lower bevel gear.

5. Remove three bolts attaching steering column bevel gear housing to bracket on frame longitudinal member. Lower bevel gear unit and remove from under vehicle, withdrawing steering column through opening in floor.

INSTALLATION (Fig. 1)

1. Position steering column assembly under vehicle, inserting column up through opening in floor. Attach bevel gear housing to bracket on frame longitudinal member with three bolts, three flat washers, and three lock washers. Use flat washers under bolt heads. Tighten bolts to 90-110 foot-pounds torque.

2. Connect steering drive shaft universal joint yoke to yoke on lower bevel gear. Tighten pinch bolt to torque listed in "Specifications" at end of this section.

3. Install steering column support flange and seal plate over steering column and attach to floor with four bolts. Tighten bolts to torque listed in "Specifications" at end of this section.

4. Install directional signal housing as directed in LIGHTING (SEC. 7) of this manual.

5. Install steering wheel as previously directed under "Steering Wheel Installation."

6. Lubricate bevel gear unit as instructed in LUBRICATION (SEC. 13) of this manual.

STEERING COLUMN AND BEVEL GEAR OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 5.

1. Remove steering wheel as previously described. Remove Woodruff key (48) from slot in steering shaft; then remove bearing spring (46) from shaft and steering column tube.

2. Remove screws attaching horn cable guard to steering column tube. Lift contact and cable assembly off tube.

3. Remove four bolts and lock washers attaching steering column tube and bevel gear housing upper cover assembly (1) to bevel gear housing (15). Lift tube and cover assembly from bevel gear housing. Save shims (6, 7, and 8) used between cover and housing for reuse at assembly.

4. While holding steering shaft (38) in a vise with soft jaws, remove pinion gear retaining nut (30) from end of steering shaft (38).

5. Using a brass drift and hammer, tap steering shaft (38) out of pinion gear (31). Remove gear, lower bearing (33), and two bearing races (32 and 34).

6. Remove steering shaft (38) from steering column tube (1).

NOTE: It may be necessary to remove steering shaft upper bearing (15, fig. 3) and spring seat (45) before shaft can be removed.

7. If not previously removed in step 7 above, remove steering shaft upper bearing from tube (1), using puller (J-489) (fig. 6).

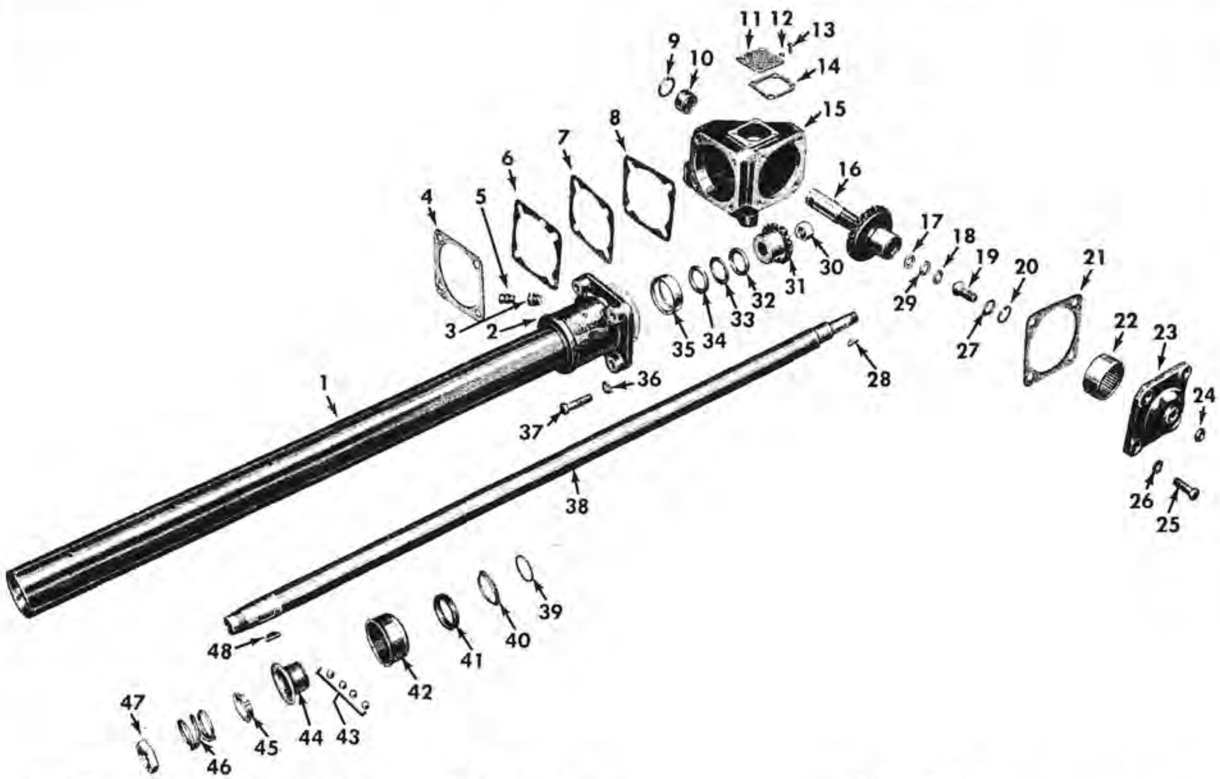
8. Disassemble upper bearing by removing retainer ring (39); then remove washer (40), packing (41), outer race (42), 14 balls (43), and the inner race (44).

9. With a suitable puller and slide hammer, remove the bearing assembly (35) from bevel gear upper cover (1) (fig. 7).

10. Remove housing vent assembly (5) and reducing bushing (3) from upper cover (1).

11. Remove four bolts and lock washers; then

MECHANICAL STEERING



1 Column Tube and Bevel Gear Housing Upper Cover Assy.
2 Upper Cover
3 Vent to Housing Bushing
4 Gasket
5 Steering Column Housing Vent
6 Thick Shim
7 Thin Shim
8 Thick Shim
9 Retainer
10 Bearing
11 Cover Plate
12 Lock Washer
13 Screws
14 Gasket
15 Bevel Gear Housing
16 Bevel Gear
17 Bearing Race
18 Bearing Race
19 Bevel Gear Screw
20 Bearing Retaining Ring
21 Cap to Housing Gasket
22 Housing Cap Bearing Assy.
23 Bevel Gear Housing Cap
24 Bevel Gear Nut
25 Cap to Housing Bolt
26 Lock Washer
27 Washer
28 Woodruff Key
29 Bevel Gear Bearing
30 Pinion Gear to Shaft Nut
31 Steering Shaft Pinion Gear
32 Bearing Race
33 Steering Shaft Lower Bearing
34 Bearing Race
35 Housing Upper Cover Bearing Assy.
36 Lock Washer
37 Upper Cover to Housing Bolt
38 Steering Shaft
39 Retaining Ring
40 Washer
41 Packing
42 Outer Race
43 Balls (14)
44 Inner Race
45 Spring Seat
46 Bearing Spring
47 Steering Wheel Retaining Nut
48 Woodruff Key

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Figure 5—Steering Column and Bevel Gear Components

remove housing cap (23) and bevel gear assembly (16) from bevel gear housing (15). Remove and discard gasket (21).

12. Remove lock nut (24); then using an Allen end wrench, remove adjusting screw (19) and bevel gear assembly (16) from housing cap (23).

13. Remove snap ring (20) from bevel gear shaft (16).

14. Remove thrust screw (19), washer (27), outer and inner race (17 and 18), and bearing (29) from bevel gear shaft (16).

15. Remove bearing race from bevel gear (16) only if inspection shows necessity.

16. Using an arbor press and suitable remover tool, remove retainer seal (9) and bearing (10) from bevel gear housing (15).

17. Remove four screws (13) and lock washers; then remove cover plate (11) and gasket (14) from bevel gear housing (15). Discard gasket.

18. Remove drain plug from bevel gear housing (15).

19. Do not remove bearing (22) from housing

cap (23) unless inspection shows necessity for removal.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in cleaning solvent. Wipe or blow parts dry.
2. Scrape all particles of old gasket off housing upper cover, housing cap, cover plate, and bevel gear housing.
3. Examine steering shaft for bent or twisted condition. Check steering shaft pinion gear for worn or broken teeth.
4. Examine lower bevel gear for worn or broken teeth.
5. Inspect all bearing assemblies for worn or damaged condition. Check bearing races for wear.
6. Replace all parts that are not in first class condition.

ASSEMBLY

Key numbers in text refer to figure 5.

1. Using an arbor press and suitable sleeve, press bearing assembly (22) into bore of bevel gear housing cap (23) if bearing was previously removed.
2. With press and suitable sleeve, press bearing assembly (10) and retainer seal (9) into bore of bevel gear housing (15).
3. Install drain plug in bore of bevel gear housing (15).
4. If bearing race was removed from bevel gear shaft (16) during inspection procedures, press new race on shaft.
5. Position bevel gear in vise with soft jaws and install inner race (17), bearing (29), outer race (18), adjusting screw (19), washer (27), and snap ring (20) in bore of bevel gear shaft (16).
6. Position housing cap assembly (23) on end of bevel gear (16); then using an Allen end wrench, turn cap on shaft. Install lock nut (24) on bevel gear adjusting screw (19) loosely. Nut is to be tightened later in step 18.
7. Place new gasket (21) over bevel gear (16) and against housing cap (23); then install bevel gear and cap assembly in bevel gear housing attaching with four bolts and lock washers. Tighten bolts to 20-25 foot-pounds torque. NOTE: Side of cap with corners cut off goes toward bottom of housing.
8. Install Woodruff key (28) in slot in lower end of steering shaft (38).
9. With suitable sleeve and hammer, tap bearing assembly (35) into housing upper cover (1).
10. Insert steering shaft (38) through top of column tube (1) and install bearing race (34), bearing (33), and second race (32) over steering shaft and into bore of housing upper cover.
11. Using a plastic hammer, tap steering shaft pinion gear (31) on lower end of steering shaft.

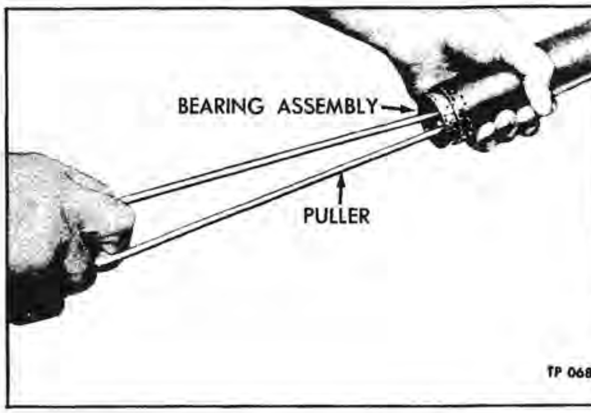


Figure 6—Removing Steering Shaft Upper Bearing

Install retaining nut (30) on shaft, tighten nut to 40-50 foot-pounds torque.

12. Install reducing bushing (3) and vent assembly (5) in bore of housing upper cover.
13. Assemble steering shaft upper bearing as follows: Place inner race (44) in palm of hand and lubricate inner race to hold bearing balls. Line fourteen balls (43) around the race; then install race and balls in outer race (42). Position packing (41) and retainer washer (40) on end of outer race; then install the retaining snap ring (39).
14. Press or tap upper bearing assembly into steering column tube over steering shaft.
15. Install spring seat (45) and spring (46) in tube over shaft and install Woodruff key (48) in slot of steering shaft. Retain parts with steering wheel nut (47).
16. Position original pack of shims (6, 7 and 8) against the cover.

NOTE: Approximately two thick shims and one thin shim are required to maintain proper adjust-

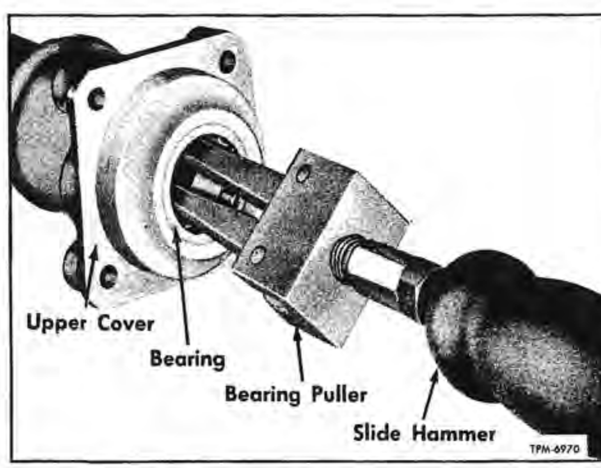


Figure 7—Removing Bearing from Upper Cover

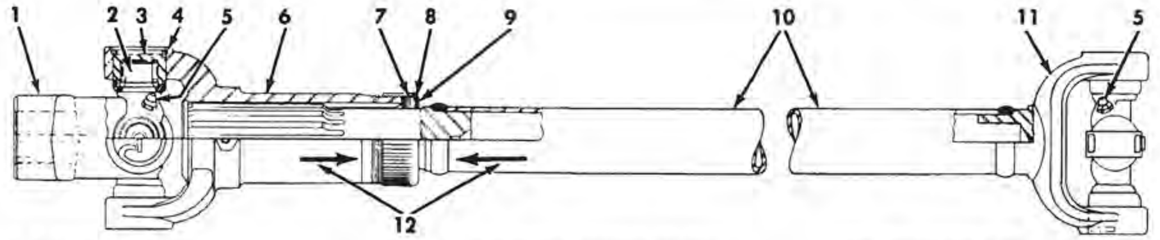


Figure 8—Steering Drive Shaft

ment. Thin shims must be placed between thick shims. Shims are 0.003" and 0.010" thick.

17. Install bevel gear housing assembly on steering column and upper cover assembly attaching with four bolts and lock washers. Tighten bolts alternately and evenly, to 25-30 foot-pounds torque.

18. Check back lash of bevel gears. Maximum allowable backlash is 0.002". Revolve gears to make sure there is no perceptible bind at any point. If gears are meshed too tight, hard steering will result. If gears are too loose, operation will be rough and noisy with excessive steering wheel play. To adjust gear lash, thread bevel gear adjuster screw (19) in or out as necessary to obtain proper gear lash; then tighten lock nut (24) securely.

19. Install new gasket (14) and cover plate (11) on bevel gear housing attaching with four screws and lock washers. Tighten screws firmly.

STEERING DRIVE SHAFT

REPLACEMENT

REMOVAL (Refer to Fig. 1)

1. Remove lock nuts and U-bolts attaching the drive shaft to yoke on steering gear worm shaft. Remove drive shaft from steering gear.

2. Remove bolt and lock nut attaching drive shaft to steering column bevel gear shaft.

3. Tap drive shaft loose from bevel gear shaft with a soft hammer. Remove drive shaft.

INSTALLATION (Refer to Fig. 1)

1. Position drive shaft yoke on bevel gear shaft making sure Woodruff key is installed in slot of bevel gear shaft.

2. Install bolt and lock nut. Tighten to torque listed in "Specifications" at end of this section.

3. Align drive shaft yoke with yoke on steering gear worm shaft; then install U-bolts and lock nuts. Tighten nuts to torque listed in "Specifications" at end of this section.

DRIVE SHAFT OVERHAUL

DISASSEMBLY (Fig. 8)

1. Before disassembly of drive shaft, look for alignment arrows (12) on shaft and slip joint sleeve. If arrows are not readily discernible, mark both parts so they can be reassembled in exactly the same relative positions.

2. Unscrew dust cap (9) from slip joint sleeve and pull slip joint assembly (6) off tube (10). Slide dust cap off tube. Remove cork (7) and steel washer (8) from dust cap.

Succeeding steps cover disassembly of universal joint at either the slip joint or fixed end of shaft.

3. Remove snap rings (4) from ends of yokes

4. Strike hub of yoke in line with bearings (3) to force bearing out of yoke far enough to be withdrawn by hand. Turn assembly over and force out opposite bearing. Repeat procedures until all four bearings are removed.

5. Slide journal cross (2) sideways until it clears one side of yoke, tilt at extreme angle, and withdraw from opposite side of yoke. Remove journal from other yoke in same manner.

6. Remove lubrication fitting from journal.

CLEANING AND INSPECTION

1. Clean all parts in a suitable cleaning solvent. Make sure lubricant passages in journal are

clean. Soak needle bearing assemblies in cleaning solvent to loosen old lubricant, clean with stiff bristled brush, and blow out with compressed air.

2. Inspect bearing surfaces of journals for roughness. If journals will not clean up with moderate honing, journal should be replaced. When new journal is used, new bearings should also be used. Carefully inspect each bearing assembly for damage or missing rollers. Excessive wear is indicated if rollers drop out of retainer, or if journal bearing surfaces show marks of rollers.

3. After bearings are clean, pack with lubricant recommended in LUBRICATION (SEC. 13). Place bearings on journal and check for wear (looseness). If excessive clearance is indicated, replace journal or bearings, or both.

ASSEMBLY

1. Install lubrication fittings (5) in journals if previously removed.

2. Insert one end of journal into yoke as far as possible from inside; then tilt journal until opposite side of journal will drop into other side of yoke. Install journal in other yoke in same manner.

3. Install bearings (3) in yokes over ends of journal, tapping bearings into place with a rawhide or plastic hammer if necessary. Install new snap rings (4) to secure bearings in yokes. Make sure snap rings are fully seated in grooves.

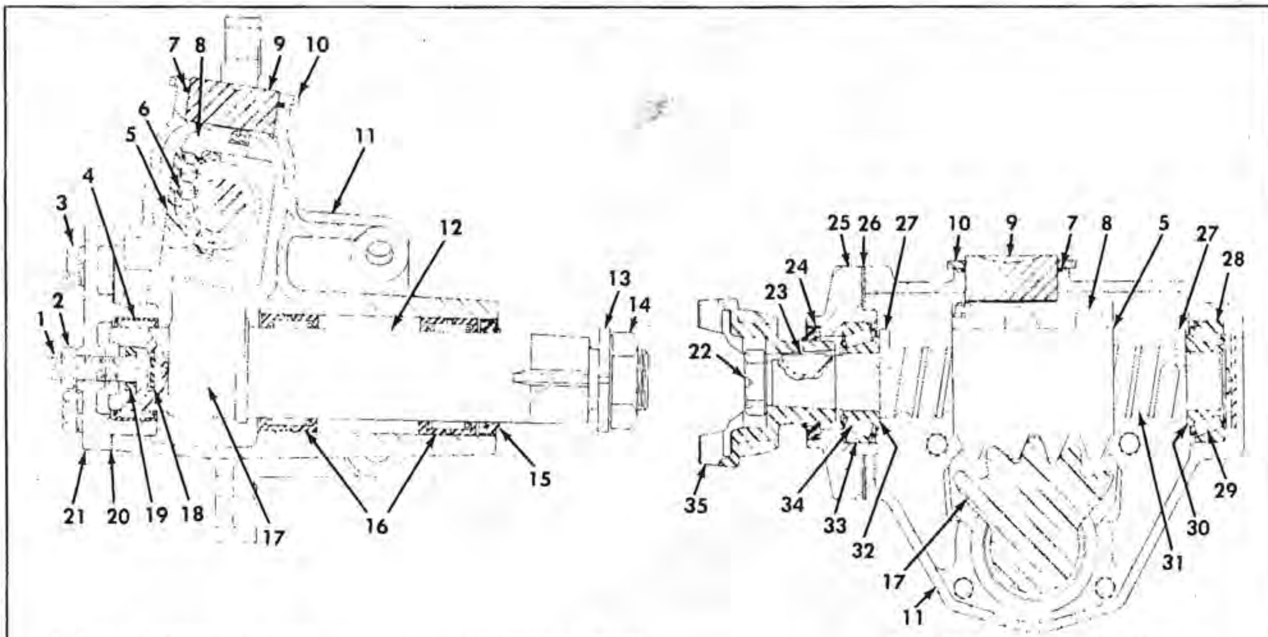
4. Repeat these procedures to install journal and bearings at opposite end of drive shaft.

5. Install steel washer (8) and new cork washer (7) in dust cap (9); then position dust cap and washers on drive shaft tube (10).

6. Insert tube (10) into slip joint sleeve, making sure arrows (12) or marks made prior to disassembly are aligned.

7. Thread dust cap onto slip joint sleeve and tighten by hand.

STEERING GEAR ASSEMBLY



1 Lash Adjuster Screw
2 Lock Nut
3 Side Cover Bolt
4 Pitman Shaft Side Cover Bearing
5 Worm Ball Nut
6 Worm Balls
7 Back-up Adjuster Packing
8 Ball Guide
9 Back-up Adjuster
10 Back-up Adjuster Lock Nut
11 Steering Gear Housing
12 Pitman Shaft
13 Lock Washer
14 Pitman Arm Nut
15 Pitman Shaft Oil Seal
16 Pitman Shaft Housing Bearings
17 Pitman Shaft Sector Gear
18 Lash Adjuster Thrust Washer
19 Lash Adjuster Retainer
20 Side Cover Gasket
21 Housing Side Cover
22 End Yoke Nut
23 End Yoke Key
24 Steering Shaft Oil Seal
25 Housing Upper Cover
26 Bearing Adjusting Shims
27 Ball Nut Stops
28 Worm Bearing Cup - Lower
29 Worm Bearing - Lower
30 Worm Bearing Cone - Lower
31 Steering Shaft Worm
32 Worm Bearing Cone - Upper
33 Worm Bearing Cup - Upper
34 Worm Bearing - Upper
35 Steering Shaft End Yoke

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Figure 9—Steering Gear Assembly

MECHANICAL STEERING

STEERING GEAR REPLACEMENT

REMOVAL (Fig. 1)

1. Disconnect propeller shaft universal joint yoke from yoke on steering gear worm shaft.

2. Disconnect the drag link from Pitman arm; then remove Pitman arm retaining nut and lock washer. Pull Pitman arm off shaft, using puller (J-21143) or other suitable puller.

3. Remove forward nut and lock washer from right-hand support U-bolt. Remove nuts and lock washers from two left-hand support studs. Remove two bolts and lock washers located in gear housing flange at forward side of the axle center.

4. Lift steering gear assembly up off studs and move forward off axle.

INSTALLATION (Fig. 1)

NOTE: Be sure front wheels and steering wheel are in the straight-ahead position, and that key slot in steering gear worm shaft is in 12 o'clock position before installing the steering gear.

1. Position steering gear assembly on front axle, with two left-hand support studs and front end of right-hand support U-bolt engaging holes in steering gear housing flanges.

2. Install nuts and lock washers on studs. Tighten nuts to torque listed in "Specifications" at end of this section.

3. Install nut and lock washer on front right-hand U-bolt. Tighten nut to torque listed in "Specifications" at end of this section.

4. Install two gear housing to front axle beam bolts in gear housing flange at front side of axle. Tighten bolts on all coaches to 170-180 foot-pounds torque.

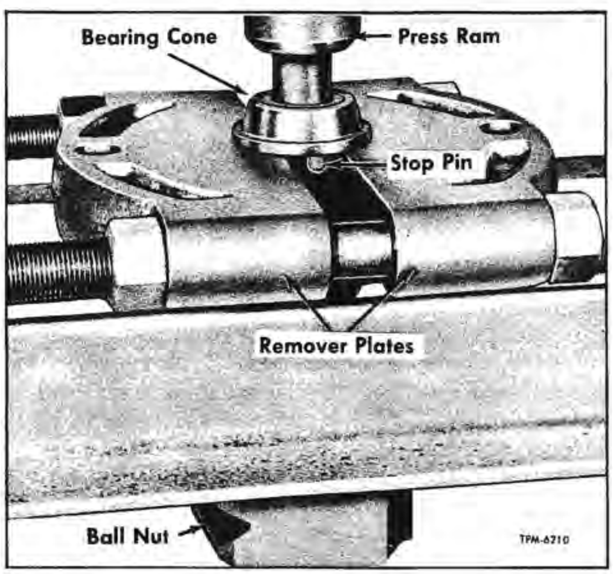


Figure 10—Removing Lower Worm Thrust Bearing Cone

5. Position Pitman arm on steering gear Pitman shaft. Install lock washer and nut securing arm to shaft. Tighten nut to torque listed in "Specifications" at end of this section.

6. With front wheels and steering wheel in straight-ahead position, move Pitman arm to a position where centerline of hole at drag link end of arm is 1.74" to left of centerline of coach on TDH/TDM-4518 and TDH/TDM-5303 coaches. On TDH/TDM-4519, SDH/SDM-4502, TDH/TDM-5304, and SDH/SDM-5302 coaches, position centerline of hole at drag link end of arm 1.26" to right of centerline of coach.

NOTE: Centerline of coach can be identified by prick punch marks on rear side of front axle beam.

7. With front wheels, steering wheel, and Pitman arm positioned as described in step 6 above, install end stud on drag link in hole in Pitman arm. Install stud nut and tighten to 150 foot-pounds torque minimum and advance to next cotter pin slot. Install new cotter pin.

8. Connect propeller shaft universal joint yoke to yoke on steering gear worm, using two U-bolts and lock nuts. Tighten lock nuts to torque listed in "Specifications" at end of this section.

9. Lubricate all points in steering system as instructed in LUBRICATION (SEC. 13).

STEERING GEAR OVERHAUL

DISASSEMBLY

NOTE: Key numbers in text refer to figure 9. Steering gear parts must be kept free from dirt or other foreign matter during overhaul procedures.

1. Remove plugs and drain as much lubricant as possible from the housing.

2. Mount steering gear assembly in a vise or holding fixture with the worm shaft horizontal. Do not grip the housing too tightly in vise.

3. Loosen lock nut (10); then remove back-up adjuster (9), packing, and lock nut. Discard packing (7).

4. Remove vent assembly from housing. Remove cotter pin and nut (22) attaching propeller shaft yoke (35) to steering gear worm (31); pull yoke off worm.

5. Remove lock nut (2) from lash adjuster screw (1). Remove four bolts and lock washers attaching side cover (21) to housing. Remove side cover and bearing assembly (4), using a screwdriver to thread lash adjuster screw out of cover as cover is withdrawn. Remove and discard side cover gasket (20).

6. Make sure the worm shaft (31) is horizontal and rotate shaft as necessary to position sector gear (17) on Pitman shaft (12) so it will pass through opening in gear housing; then withdraw Pitman shaft (12) from gear housing.

NOTE: Horizontal position of the worm shaft is necessary to prevent ball nut (5) from running down to end of worm as Pitman shaft (12) is withdrawn, thereby damaging the ball return guides.

7. Remove four bolts and lockwashers attaching top cover (25) to housing (11); then carefully withdraw top cover, worm, and ball nut assembly as a unit. Remove lower worm thrust bearing (29).

8. Remove top cover (25) from worm shaft (31). Remove upper thrust bearing (34) from top cover (25). Retain shim pack (26) for reassembly of steering gear.

IMPORTANT: Do not hold worm shaft (31) in a vertical position as ball nut (5) will travel by its own weight to end of shaft. If ball nut sharply strikes either end of shaft worm, ball guides (8) will be damaged.

9. Try action of ball nut (5) on shaft worm (31). Ball nut must rotate smoothly with no evidence of binding or roughness. Tape shaft worm at both ends of ball nut to keep nut from running up or down; then lay the assembly flat on work bench until ready to disassemble.

10. Remove lower thrust bearing cone (30) from worm shaft (31), using bearing remover plates (J-8176) (fig. 10).

11. Remove lower ball nut pin stop (27).

12. Remove screws attaching ball guide clamp to ball nut (5). Remove clamp. Pull ball guides out of ball nut as shown in figure 11. Remove balls (6) from guides by separating guides.

13. Remove tape from shaft worm; then turn ball nut upside down over a clean pan and rotate worm shaft back and forth until all balls have been removed. Pull ball nut endwise from worm shaft.

14. Remove upper thrust bearing cone (32) from worm shaft (31), using bearing remover plates (J-8176). Refer to figure 10. Remove upper ball nut stop pin (27) from worm shaft.

15. Remove Pitman shaft oil seal (15) from gear housing (11) and discard.

16. Remove worm shaft oil seal (24) from top cover (25) and discard. New oil seals should be used when reassembling the steering gear.

17. Removal of lower worm thrust bearing cup (28) from housing, upper thrust bearing cup (33) from top cover, needle bearing (4) from side cover, and needle bearings (16) from housing should be deferred until inspection of parts indicate necessity for further disassembly.

CLEANING AND INSPECTION

1. Wash all parts thoroughly in suitable cleaning solvent and wipe or blow parts dry prior to inspection, repair, and reassembly of the steering gear. Procedures should not be attempted in dirty surroundings. Parts must be absolutely clean.

2. Inspect steering gear housing and side cover for cracks, distortion, and condition of threads in tapped holes. Replace parts if damaged.

3. Examine needle roller bearings in housing and side cover for cracked, chipped, or worn rollers. If worn or damaged, bearing assemblies must be replaced as directed later under "Pitman Shaft Bearing Replacement."

4. Inspect Pitman shaft sector teeth and mating worm nut teeth for wear or damage. Check Pitman shaft for wear at bearing surfaces. If excessive wear is evident, replace shaft. Check condition of threads on lash adjuster screw, and check amount of screw end play in shaft. Any damage will necessitate replacement of lash adjuster screw; however, if screw is only loose (more than 0.005" end play), an adjustment may be made. Replacement and adjustment instructions are given later under "Lash Adjuster Replacement and Adjustment."

5. Inspect worm tapered roller bearing assemblies for worn or damaged rollers; also inspect bearing cups in top cover and housing and upper and lower bearing cones for wear or damage. If either the bearing rollers, cups, or cones are damaged, replace with complete new bearing assemblies. Instructions for replacing bearing cups are given later under "Worm Thrust Bearing Cup Replacement."

6. Inspect steering worm shaft for scoring, distortion, or wear.

7. Examine ball nut for scuffing, scoring, or wear on rack teeth and on ball thread groove. Check all holes and passages for obstructions. Check worm balls for flat spots, checking, wear, or damage. Balls should all be the same size within 0.0001".

8. Check expansion plug in housing for looseness or signs of grease leakage. If apparent, replace plug as follows:

a. Remove plug from housing by pressing center of plug outward from housing. As curvature of plug is changed, it will become loose and can easily be removed without damage to housing.

b. While expansion plug is removed, check condition of lower worm thrust bearing cup. Re-

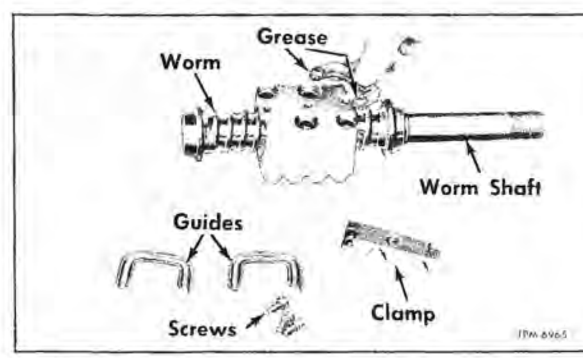


Figure 11—Ball Guide Removal and Installation

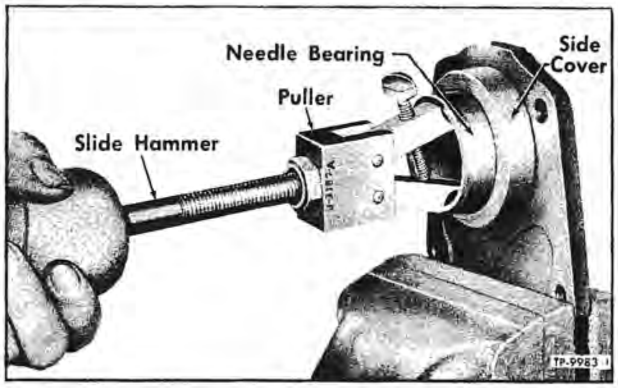


Figure 12—Removing Side Cover Needle Bearing

place if necessary, as described later under "Worm Thrust Bearing Cup Replacement."

c. Position new expansion plug in gear housing with convex side facing out. Press on center of plug to deform it inward to secure in housing.

9. Inspect ball return guides for distortion or damage. Place two halves of a guide together and try action of balls in guide. Replace guides if any restriction exists. Check return guide clamp.

10. Check top cover for cracks or damage.

STEERING GEAR REPAIR

PITMAN SHAFT BEARING REPLACEMENT

NOTE: Key numbers in text refer to figure 9.

When inspection indicates the need of replacing Pitman shaft needle roller bearings (4 and 16) in housing and side cover, it is recommended that suitable tools be used to remove and replace bearings to avoid damage to the bearings and steering gear housing.

1. Pull needle bearing from side cover, using puller tool (J-3187-A) with slide hammer (J-2619) (fig. 12).

2. Press or drive needle bearings from steering gear housing, using remover and replacer tool (J-5529) (fig. 13).

3. Install bearings in both side cover and gear housing with remover and replacer tool (J-5529). During installation, press only against the stamped identification side of bearing. Press side cover bearing in flush with face of side cover.

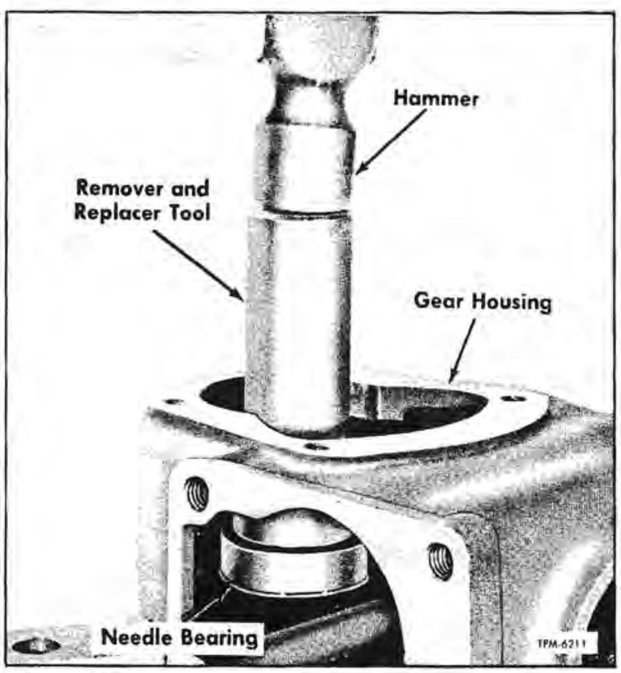


Figure 13—Removing or Installing Needle Bearing in Housing

WORM THRUST BEARING CUP REPLACEMENT

1. Using a suitable punch and hammer, drive bearing cup (28) from steering gear housing.

2. Position new bearing cup squarely over recess in gear housing and press cup in until it is firmly and evenly seated. Use old cup to press new cup into place.

3. Repeat these procedures for top cover bearing cup (33) replacement.

LASH ADJUSTER REPLACEMENT AND ADJUSTMENT

1. Lash adjuster retainer is tack-welded in end of Pitman shaft (fig. 14). Break tack-weld and withdraw retainer from shaft. Remove adjuster screw and thrust washer.

2. Install a new thrust washer and adjuster screw, lubricating end of adjuster screw with recommended steering gear lubricant.

3. Screw retainer in tight; then back off 30 degrees to obtain correct adjustment. Tack-weld retainer at points shown in figure 14.

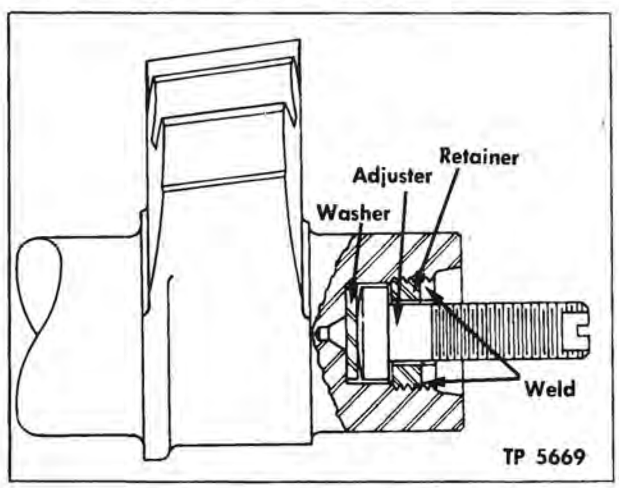


Figure 14—Installation of Lash Adjuster Screw

ASSEMBLY OF STEERING GEAR

(Key Numbers in Text Refer to Figure 9)

GENERAL

One of the most important phases when assembling the steering gear is cleanliness. All parts must be kept clean. Any bits of abrasive material which may get inside the housing during assembly procedures will quickly damage the gear mechanism. Grease and oil used at assembly must be free from dirt. When handling parts, make certain that hands are clean and that clean cloths are used. Pre-lubricate all bearings, oil seals, and moving parts at assembly with proper lubricant specified in LUBRICATION (SEC. 13) of this manual.

ASSEMBLING BALL NUT AND WORM

1. Install worm ball nut over shaft worm with return guide holes in ball nut up. Align grooves in worm and ball nut by sighting through bottom of ball return guide holes.

2. Divide total number of balls into two clean containers (42 balls for each circuit).

3. Drop balls into one of the return guide holes in upper circuit of nut. Gradually turn shaft away from that hole while inserting balls. Continue until the circuit is filled from bottom of one hole to bottom of the other, or until stopped by reaching end of the shaft worm (fig. 15).

4. In event balls are stopped by reaching end of shaft worm, hold down balls already installed with a rod or punch in return guide hole (fig. 15). Turn shaft in the reverse direction a few turns. Filling of the circuit can then be continued. It may be necessary to work shaft back and forth, holding balls down, first in one hole and then in the other. This will close up spaces between balls, filling the circuit completely and solidly.

5. Lay one-half of a ball guide on bench with groove up. Place the remaining balls for the first circuit into groove of the guide (fig. 16). Close this half of ball guide with other half. Hold the two halves together and plug each open end with heavy grease as shown in figure 11, to prevent balls from dropping out.

6. Push ball return guides, with balls, completely into return holes in ball nut. Tap guide lightly with screwdriver handle to seat if necessary. This completes one circuit of balls.

7. Fill lower ball circuit in ball nut in same manner as described for upper ball circuit.

8. Install ball return guide clamp on ball nut, using the three screw and lock washer assemblies. Tighten screws securely.

9. Thoroughly lubricate ball nut and balls; then test assembly by rotating ball nut on shaft worm. Do not rotate ball nut to end of worm threads as this may damage ball guides. If motion of worm nut is not free, cause of bind must be located and

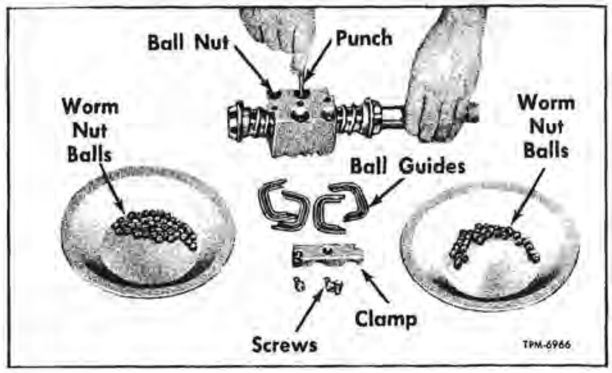


Figure 15—Filling Ball Circuit in Nut

trouble corrected. Bent ball guides may restrict ball circuit travel.

10. Temporarily tape shaft worm at both ends of ball nut to keep nut from running up or down; then until ready to install in gear housing, lay the assembly flat on work bench.

INSTALLATION OF WORM, BALL NUT, AND TOP COVER ASSEMBLY

1. Lubricate new worm oil seal (24) and press in base of top cover. Seal should be positioned so that lip of seal faces toward steering gear housing.

2. Install ball nut upper stop pin (27) in worm shaft slot.

3. Press upper thrust bearing cone (32) on worm shaft, using bearing installer plates (J-8176).

4. Install ball nut lower stop pin (27) in slot in worm shaft.

5. Press lower thrust bearing cone (30) on worm shaft, using bearing installer plates (J-8176).

6. Mount steering gear housing in holding fixture or vise so that top cover opening is up. Do not grip too tightly.

7. Lubricate worm thrust roller bearing (29) and position in cup (28) in lower end of gear housing.

Figure 16—Filling Ball Guides

MECHANICAL STEERING

8. Place original pack of shims (26) on top cover (25). Shims are available in 0.002", 0.005", 0.010", and 0.030" thickness. A minimum of three 0.002" and two 0.005" shims must be used for initial adjustment.

9. Lubricate upper worm thrust bearing (34); then position bearing on upper end of worm shaft over upper cone (32). Place top cover (25) over shaft and on bearing.

10. Remove tape from shaft worm at both ends of the ball nut; then gently rotate ball nut assembly so that it contacts stop pin (27) in lower end of the worm.

11. Lift top cover, worm, and ball nut assembly by grasping top cover and worm. Turn the shaft into a vertical position so that ball nut is on the bottom. Carefully guide the assembly into gear housing until bearing cone (30) on worm shaft contacts lower worm thrust bearing (29). In so doing, rotate the worm so ball nut return guide clamp faces the back-up adjuster opening in the housing. Bolt top cover to gear housing. Tighten bolts to 35-45 foot-pounds torque.

12. Accomplish all procedures described in steps 1 through 10 under "Installation of Pitman Shaft and Side Cover" following:

INSTALLATION OF PITMAN SHAFT AND SIDE COVER

1. With gear housing positioned in vise or holding fixture so that worm shaft (31) is horizontal, proceed as follows:

2. While holding worm nut (5), turn worm shaft to move nut to center of worm, This is necessary so that worm nut and Pitman shaft will mesh properly when the shaft is installed. Center tooth on Pitman shaft sector (17) must enter center space in worm nut (5).

3. Apply proper lubricant to shaft bearings (16) in gear housing. Position Pitman shaft in gear housing, being careful not to damage bearings with serrated end of the shaft.

4. Position a new gasket (20) on gear housing side cover opening.

5. Apply proper lubricant to side cover bearing (4). Place side cover on lash adjuster screw (1) in Pitman shaft. With screwdriver through hole in side cover, thread lash adjuster screw through cover until cover is pulled against housing. Back off lash adjuster screw a few additional turns to provide backlash between sector gear (17) on shaft and ball nut (5).

6. Install side cover to housing attaching bolts (3) and lock washers. Tighten bolts to 25-35 foot-pounds torque. Install adjuster screw lock nut (2) loosely.

7. Install new Pitman shaft oil seal (15) carefully over Pitman shaft so that serrations on shaft do not damage seal. Lips of oil seal should face inside of gear housing. Be sure oil seal is well seated in housing. Tool used to install bearing in housing may be used to install oil seal.

8. Install back-up adjuster, new packing, and lock nut loosely in the gear housing. Do not make adjustment until all other adjustments have been made.

9. Tap Woodruff key (23) into key slot in worm shaft and install drive shaft yoke (35). Secure yoke on worm shaft with nut and cotter pin.

10. Install bushing and lubrication fitting in tapped boss in bottom of gear housing. Fill gear housing with proper lubricant as described in LUBRICATION (SEC. 13) of this manual.

11. Install the steering gear assembly in coach as described earlier in this section under "Steering Gear Replacement."

12. Adjust worm bearings, and make Pitman shaft lash adjustment as previously directed in this section under "Steering Gear Adjustments."

13. Tighten back-up adjuster (9) until adjuster bottoms against ball nut return guide clamp. Back off adjuster 1/4 turn and secure in place with adjuster lock nut. Tighten lock nut to 30-50 foot-pounds torque. Purpose of the back-up adjuster is to keep the worm shaft from flexing up and down.

STEERING DRAG LINK

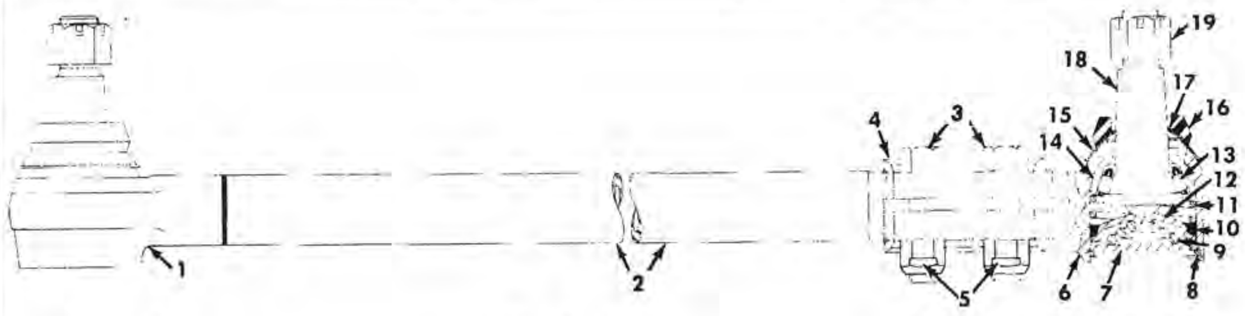
DESCRIPTION

Steering drag link assembly is a two piece type, comprised of drag link and end socket, and an end socket assembly. As shown in figure 17, drag link end sockets are roller bearing type and incorporate an adjustment feature which automatically compensates for wear on bearing surfaces. Both end socket assemblies are identical, except that end socket at Pitman arm screws onto drag link to provide for length adjustment, while end socket at steering arm is integral with link. Drag link end socket at Pitman arm is retained on drag link with clamp bolts. Drag link installation is shown in figure 1.

MAINTENANCE

Linkage between steering gear and front axle definitely affects steering action if parts are out of adjustment, bent, or twisted. Check steering geometry and front wheel alignment as directed in FRONT AXLE (SEC. 1) when steering linkage is repaired or replaced.

Drag link end stud nuts must be kept tight or stud holes in steering arm and Pitman arm may



1 End Socket
2 Drag Link Tube
3 Socket Clamp-Bolt
4 Clamp
5 Lock Nuts
6 End Socket
7 Plug
8 Plug Lock
9 Seat Spring
10 Grease Retainer
11 Socket Centering Spring
12 Stud Seat
13 Stud Bearing
14 Bearing Race
15 Inner Dust Cover Washer
16 Dust Seal
17 Outer Dust Cover Washer
18 End Stud
19 Stud Nut

TPM-6945-1

Figure 17—Steering Drag Link Assembly

become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs into arms so far that dust cover parts may be damaged during sharp turns.

Drag link end sockets are equipped with lubrication fittings and should be lubricated as directed in LUBRICATION (SEC. 13).

LENGTH ADJUSTMENT

It should not be necessary to alter length of drag link except when new link is installed or when removable end socket has been removed for overhaul. If necessary to adjust drag link length, proceed as follows:

1. Position front wheels in straight-ahead position.

2. Remove drag link ends from Pitman arm and steering arm.

3. Locate center of steering movement by turning steering wheel from extreme right to extreme left, counting the number of turns; then back up exactly half way.

4. Check position of Pitman arm. Refer to "FRONT END ALIGNMENT" (SEC. 1) of this manual.

5. Connect fixed drag link end to steering arm.

6. Stud at adjustable end of drag link should fit in Pitman arm without changing position of Pitman arm or front wheels.

7. If parts do not assemble correctly, first check all linkage for bends or distortion. If none of the drag link parts are found to be bent or twisted, loosen clamp bolts; then turn drag link end socket enough to obtain length to permit installation of end stud in Pitman arm without twist or bind.

8. Tighten clamp bolts to 45-55 foot-pounds torque; then test adjustment. Front wheels should turn from right to left extremes without noticeable binding at drag link ends.

REMOVAL AND DISASSEMBLY

Key numbers in text refer to figure 17.

Normal wear on bearing surfaces in drag link end socket will result in increased overall height of the assembly. If excessive play is noted, drag link end sockets must be disassembled for replacement of worn parts.

1. Disconnect drag link ends from steering arm and Pitman arm by removing cotter pins and nuts from end studs and driving studs out of arms.

2. Loosen clamp bolt nuts and unscrew drag link end from drag link at Pitman arm end.

3. Remove dust seal (16), dust cover washer (17), inner dust cover washer (15) from stud end (18).

4. Pry end plug lock wire (8) out of drag link end socket (6); then remove end plug (7), end stud seat spring (9), end stud seat (12), grease retainer (10), socket centering spring (11), end stud (18), end stud bearing (13), and end stud bearing race (14) from drag link end socket.

CLEANING AND INSPECTION (Fig. 17)

1. Immerse all parts, except dust seal in a suitable cleaning solvent. Use a stiff bristle brush, as required, and clean parts thoroughly.

2. Check all parts for wear or corrosion and discard parts that are badly damaged.

3. Check tension of end stud seat spring (9) and centering socket spring (11). Discard springs if tension is not within limits. Refer to "Specifications" at end of this section.

4. Carefully inspect rollers in end stud bearing assembly (13) for roughness or flaking. If roll-

ers will not rotate freely in bearing race (14), bearing assembly should be replaced.

ASSEMBLY AND INSTALLATION (Fig. 17)

Keep all parts clean when performing assembly operations. If dirt or grit is allowed to get into drag link end socket when assembling, premature and excessive parts wear will result.

1. Lubricate all parts with lubricant specified in LUBRICATION (SEC. 13); then place end stud bearing (13) and end stud bearing race (14) on end stud (18).

2. Insert stud and bearing assembly into drag link end socket (6); then press grease retainer (10) over stud seat (12). Place centering socket spring (11) and stud seat (12) in drag link end; then install end stud seat spring (9) and end plug (7). Secure parts in drag link end socket (6) with end plug lock wire (8).

3. Install on threaded end of stud, in following order, inner dust cover washer (15), outer dust cover washer (17), and dust seal (16).

4. Install drag link end assembly on drag link, but do not tighten clamp bolt nuts.

5. Install drag link and adjust length as previously directed under "Length Adjustment" in this section; then lubricate as directed in LUBRICATION (SEC. 13).

STEERING TIE ROD

DESCRIPTION

Tie rod assembly is a three-piece type comprised of tube and two socket end assemblies. Tube is threaded into socket ends and locked with clamp bolts. Right- and left-hand threads are provided to facilitate toe-in adjustment.

Tie rod end sockets (fig. 18) are so constructed as to automatically compensate for wear at bearing surfaces. Tie rod end parts are replaceable. Snap ring and plug can be removed from tie rod end socket to permit removal of stud, bearing, and bearing seat.

TIE ROD REMOVAL AND DISASSEMBLY

Key numbers in text refer to figure 18.

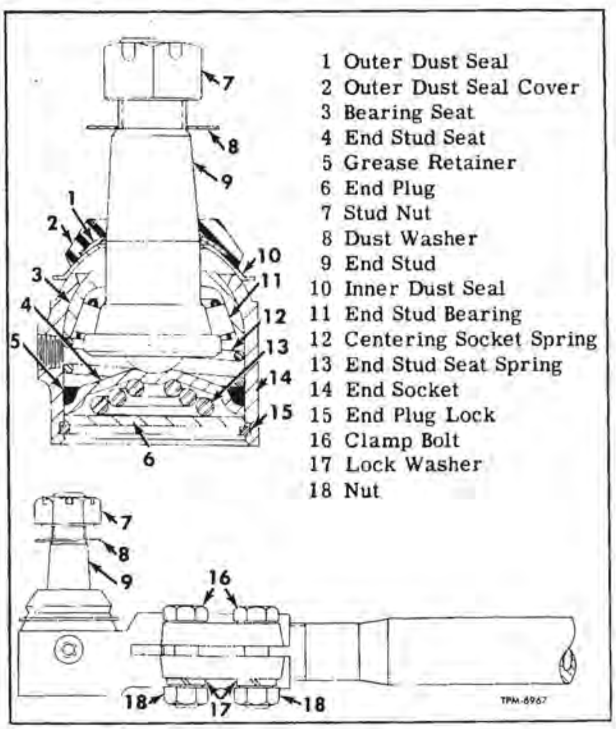


Figure 18—Tie Rod Construction

1. Remove cotter pins and nuts from tie rod ends, support steering arm to prevent bending; then drive tie rod end tapered studs out of steering arms. Remove dust washer (8), outer dust seal cover (2), outer dust seal (1), and inner dust seal (10) from stud.

2. Loosen clamp bolts; then remove each tie rod end socket assembly from tube.

3. Pry end plug lock (15) out of tie rod socket end; then remove plug (6), spring (13), stud seat (4), and grease retainer (5). Stud (9), bearing (11), centering spring (12), and bearing seat (3) can then be removed from the end socket (14).

TIE ROD INSPECTION

Clean all tie rod parts thoroughly; then inspect for wear and other damage. Discard worn parts and replace springs in tie rod ends if found to be weak or broken. Straighten or replace tie rod tube if bent.

TIE ROD ASSEMBLY AND INSTALLATION

Key numbers in text refer to figure 18.

1. Lubricate tie rod end parts with lubricant specified in LUBRICATION (SEC. 13) before assembling.

2. Place bearing seat (3) in tie rod socket (14); then place bearing (11) and stud (9) in socket. Follow with centering spring (12) and grease retainer (5).

3. Install stud seat (4) and seat spring (13); then secure parts in socket with plug (6) and lock (15).

4. Install tie rod end sockets on tube, threading each socket the same number of turns on tube; then install clamp bolts.

5. Assemble dust shield parts on end studs in the following order: inner dust seal (10), outer dust seal (1), outer dust seal cover (2), and dust washer (8).

6. Install tie rod assembly on steering arms with lubrication fittings toward the rear. Tighten

stud nuts to minimum torque; then tighten nuts as necessary to permit installation of new cotter pins.

NOTE: Final adjustment of the tie rod assembly for setting toe-in should be made after the front axle is installed on coach and is supporting weight of coach. Be sure to tighten clamp bolts on tie rod ends after toe-in adjustment is completed. Refer to "Toe-In Adjustment" in FRONT AXLE (SEC. 1) and make toe-in adjustment.

SPECIFICATIONS

MECHANICAL STEERING

STEERING GEAR

MAKE	Saginaw
TYPE	Recirculating Ball and Sector Nut
GEAR RATIO	25.6 to 1
MODEL	572-D-1
WORM NUT	
Type	Ball
Ball Diameter	⅜"
Number of Balls	84
BEARINGS	
Worm Thrust—Type	Tapered Roller
Pitman Shaft Needle Housing	
Width	1.245"-1.250"
Inside Diameter	1.8730"-1.8735"
Outside Diameter	2.4369"-2.4375"
Side Cover	
Width	0.990"-1.000"
Inside Diameter	1.7495"-1.7500"
Outside Diameter	2.1245"-2.1255"
ADJUSTMENTS	
Worm Bearings	
Adjustment Type	Shims
Shim Sizes Available	0.002", 0.005", 0.010" & 0.030"
NOTE: Use a Minimum of 3-0.002" & 2-0.005" Thick Shims	
End Play in Worm	None
Pull at Wheel to Keep Wheel Moving (9" radius)	1½ to 2 Lbs.
Pitman Shaft Lash Adjustment Type	Adjuster Screw
Pull Through Center (Includes Worm Bearing Load)	2¾ to 3¼ Lbs.
Back-up Adjuster	Screw in Until Stop Bottoms; Then Back Off ¼ Turn and Tighten Lock Nut

STEERING COLUMN AND BEVEL GEAR

STEERING BEVEL GEAR	
Ratio	1.5 to 1
Total Steering Ratio	38.4 to 1
Upper Bevel Pinion Number of Teeth	18
Lower Bevel Gear Number of Teeth	27
Backlash Between Gears Theoretical	Max. 0.002" Without Any Perceptible Bind In Gears
BEARINGS	
Steering Shaft—Upper	
Type	Special Ball
Number of Balls	14
Steering Shaft—Lower	
Type	Roller
Inside Diameter	1.002"-1.007"
Outside Diameter	1.542"-1.552"
Number of Rollers	30
Width	0.0779"-0.0781"
Bevel Gear Housing	
Type	Needle
Inside Diameter	1.0000"-0.9995"
Outside Diameter	1.2495"-1.2505"
Width	0.740"-0.750"
Housing Cap	
Type	Needle
Housing Cap (Cont.)	
Inside Diameter	1.4995"-1.5000"
Outside Diameter	1.8745"-1.8755"
Width	0.990"-1.000"
ADJUSTMENTS	
Upper Bevel Pinion	
Adjustment Type	Shims
Shim Thickness Available	0.003" & 0.010"
End Play	None
Lower Bevel Gear	
Adjustment Type	Adjuster Screw
End Play	None
SPRINGS	
Horn Cap	
Free Length	1.359"
Compressed Length Under 4 Lbs.	0.234"
Shaft Upper Bearing	
Free Length	1.0937"
Compressed Length Under 40-50 Lbs.	0.8125"

STEERING DRAG LINK

TYPE	Adjustable Length
LENGTH—Stud Centers	33.12" + or − $\frac{5}{32}$"
SPRINGS	
Stud Seat Spring	
Free Length	0.750"
Compressed Length Under 350-400 lbs.	0.500"
Socket Centering Spring	
Free Length	1.250"
Compressed Length Under 30 Lbs.	0.875"

STEERING DRIVE SHAFT

Universal Joint (Slip Joint End)	1281 Series
Universal Joint (Fixed Joint End)	1288 Series
Journal Diameter	0.5965"-0.5970"
Bearing Rollers—Quantity	23
Length—Centerline of Journal at One End to Centerline of Journal at Opposite End (Compressed Length)	63½"

TORQUE SPECIFICATIONS

Location	Torque Foot-Pounds
Lash Adjuster Lock Nut	25-35
Side Cover Bolt	25-35
Steering Gear Worm Shaft End Yoke Nut	50-75
Steering Drive Shaft To Steering Gear Worm Shaft U-Bolt Lock Nuts	
TDH/TDM-4518 and TDH/TDM-5303	15-20
TDH/TDM-4519, SDH/SDM-4502, TDH/TDM-5304 and SDH/SDM-5302	20-30
Steering Drive Shaft to Bevel Gear Pinch Bolt Lock Nut	
TDH/TDM-4518 and TDH/TDM-5303	15-20
TDH/TDM-4519, SDH/SDM-4502, TDH/TDM-5304 and SDH/SDM-5302	20-30
Steering Wheel Nut	40-50

MECHANICAL STEERING

MECHANICAL STEERING SYSTEM SPECIFICATIONS (CONT.)

TORQUE SPECIFICATIONS (Cont.)

Location	Torque Foot-Pounds
Top Cover Bolt	35-45
Back-up Adjuster Lock Nut	30-50
Drag Link End Socket Tube Clamp Bolt Nut	45-55
Steering Gear to Support Stud Lock Nut	45-55
Steering Gear Clip to Support Stud Lock Nut	
TDH/TDM-4518 and TDH/TDM-5303	90-110
TDH/TDM-4519, SDH/SDM-4502, TDH/TDM-5304, and SDH/SDM-5302	150-180
Steering Gear to Front Axle Beam Bolt	170-180
Steering Gear Support to Front Axle U-Bolt Lock Nut	90-110
Steering Column Housing to Bracket Bolt	90-110
Steering Column Support Flange Bolt Lock Nut	10-15
Steering Column Support Flange and Floor Plate to Floor Bolt Nut	10-15
Drag Link to Steering Arm Nut	150 Lbs. Minimum and Advance to Nearest Cotter Key Hole
Pitman Arm to Drag Link Nut	150 Lbs. Minimum and Advance to Nearest Cotter Key Hole
Drag Link End Socket Clamp Nuts	45-55
Upper Cover to Bevel Gear Housing Bolt	25-30
Cap to Bevel Gear Housing Bolt	20-25
Pinion Gear to Steering Shaft Nut	40-50
Tie Rod End Socket Clamp Nuts	100-120
Pitman Arm to Steering Gear Shaft Nut (All Models)	250-300

Power Steering

The power steering system, available as special equipment on coaches covered in this manual, provides automatic hydraulic assistance to the turning effort applied to the mechanical steering system. The power steering is adaptable to the standard mechanical steering described previously with a minimum amount of alterations.

The power steering system consists primarily of three units, used in conjunction with the conventional steering gear:

1. Control Valve.
2. Booster Cylinder.
3. Hydraulic Pump.

OPERATION

Power steering is accomplished through use of hydraulic pressure. This pressure is supplied by a vane-type oil pump mounted at left rear of the engine (fig. 1). The pump is driven through a coupling by engine blower drive shaft. Pressure created by the pump is circulated through flexible fluid lines to a self-contained actuating booster cylinder installed on the front axle (fig. 2). Movement of steering wheel is transmitted through conventional Pitman arm and drag link to a control valve located in booster cylinder. This control valve directs hydraulic fluid, under pressure created by the hydraulic pump, to either side of a piston in the booster cylinder, producing movement of piston and attached drag link of the coach steering linkage. Force applied by booster cylinder to drag link is automatically the amount of thrust necessary for all steering requirements.

MAINTENANCE

The power steering hydraulic system requires little maintenance. However, the system should be kept clean to insure maximum operating performance and trouble-free service. Periodic inspection to check for leaks should also be made.

At regular intervals the hydraulic fluid level in pump reservoir should be checked and fluid added when required. Refer to LUBRICATION (SEC. 13) of this manual for type fluid to be used, method, and intervals for filling. The fluid reservoir and filter assembly is mounted on the right-hand engine support rail (fig. 1). When the slightest evidence of dirt, sludge, or water is discovered in the system, drain and refill with clean recommended hydraulic fluid. Refer to LUBRICATION (SEC. 13) for procedures. To drain system, disconnect fluid lines at booster cylinder.

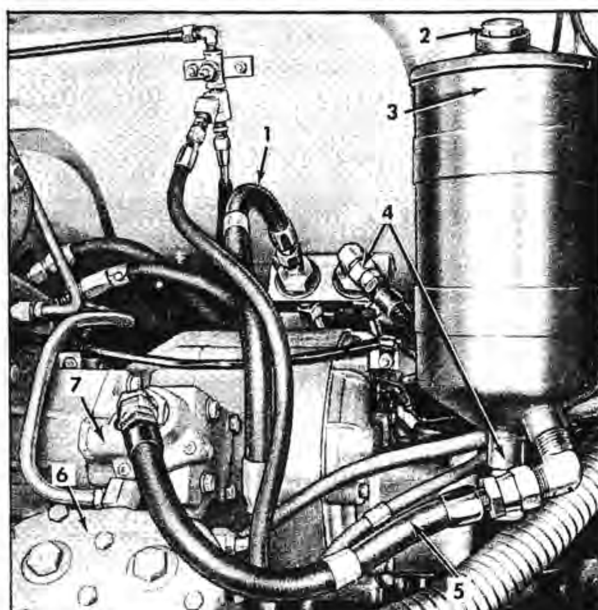
Power steering fluid filter (fig. 3) should be serviced at regular lubrication intervals. Refer to LUBRICATION (SEC. 13) for servicing fluid filter.

Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled after adding fluid. Bleed system as directed later in this section under "Bleeding Power Steering Hydraulic System." Should the power steering system become inoperative because of loss of hydraulic fluid, pump pressure line should be re-routed from pump outlet directly back to pump reservoir.

IMPORTANT: Do not operate pump without fluid in the pump reservoir.

If steering linkage between steering gear and front wheels is out of adjustment, bent, twisted, or worn, steering action of coach will be seriously affected. At any time steering linkage parts are repaired, replaced, or adjusted, steering geometry and front wheel alignment must be checked. Refer to FRONT AXLE (SEC. 1) of this manual for front end alignment information.

At regular lubrication intervals, the steering linkage should be checked completely for worn or



1 Pressure Line
2 Dipstick, Breather, and Filler Cap Assy.
3 Reservoir and Filter Assy.
4 Inlet Line
5 Outlet Line
6 Air Compressor
7 Hydraulic Pump

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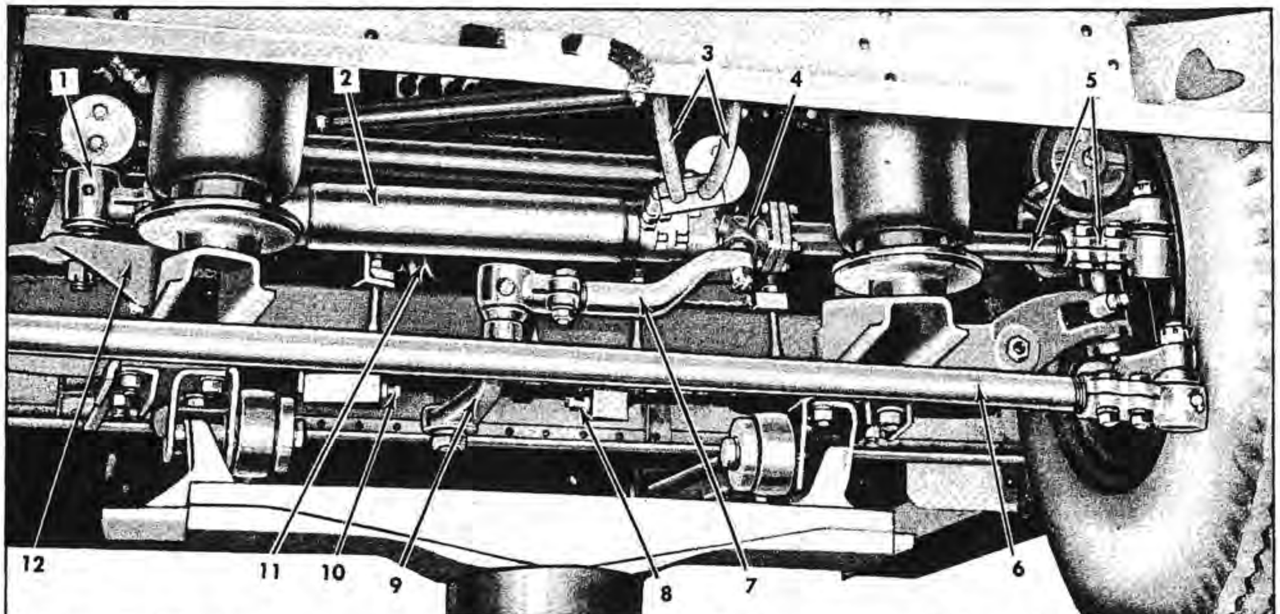
Figure 1—Power Steering Hydraulic Pump Installed



1 Piston Rod Socket Assy.
2 Booster Cylinder Assy.
3 Pressure and Return Line Hoses
4 Booster Cylinder Ball Stud
5 Extension and End Socket Assy.
6 Steering Tie Rod
7 Drag Link Assy.
8 Pitman Arm Right-Hand Stop
9 Pitman Arm
10 Pitman Arm Left-Hand Stop
11 Steering Gear Assy.
12 Piston Rod Socket End Support

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Figure 2—Power Steering Booster Cylinder Installed

loose ball stud end sockets.

If coach steering tends to wander in one direction, after making certain that front end is properly aligned, cause may be that the control valve in booster cylinder may not be centering properly.

BLEEDING POWER STEERING HYDRAULIC SYSTEM

When power steering hydraulic pump, booster cylinder assembly, or fluid reservoir and filter assembly has been removed for overhaul or replacement, or any hydraulic system lines disconnected, the hydraulic system must be bled before vehicle is again operated. Bleed power steering hydraulic system as follows:

NOTE: When hydraulic fluid is added to power steering system, fluid should be poured through a 200 mesh wire screen secured inside funnel. Use only the hydraulic fluid recommended in LUBRICATION (SEC. 13) of this manual in the power steering hydraulic system.

1. Fill power steering pump reservoir tank to "FULL" mark on dipstick. Let hydraulic fluid remain undisturbed for about two or three minutes.

2. Raise front end of coach until front wheels are well off floor.

3. Eliminate air pockets in booster cylinder and hydraulic system by turning front wheels to right and left Pitman arm stops. Continue this procedure, while maintaining fluid level in pump reservoir tank to "FULL" mark on dipstick, until fluid in pump tank stops bubbling.

4. Start engine and run at idle for two or three minutes. Turn front wheels to right and left as before. DO NOT HIT WHEEL STOPS. Maintain fluid level in pump reservoir tank to "FULL" mark on dipstick. Check system lines and connections for leaks. Continue these procedures until fluid in pump reservoir tank is clear and free of bubbles.

5. Increase engine speed to approximately half throttle and run engine at this speed until all signs of air bubbles cease to exist in pump reservoir tank. Turn wheels to right and left as before. DO NOT HIT PITMAN ARM STOPS.

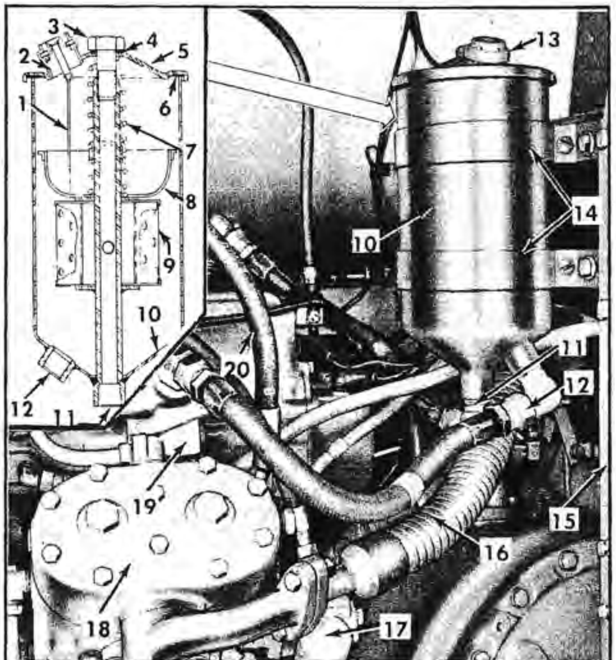
6. Lower coach to floor and turn wheels to right and left while rechecking for fluid leaks.

7. Recheck fluid level in pump reservoir tank and fill to "FULL" mark on dipstick.

HYDRAULIC PRESSURE TEST

1. Disconnect pressure hose from fitting at the hydraulic pump.

NOTE: Some hydraulic fluid will leak out when line is disconnected. Provision should be made to



1 Dipstick
2 Filler Tube
3 Cover Bolt
4 Gasket
5 Cover
6 Gasket
7 Hold Down Spring
8 Filter Screen and Washer Assembly
9 Element Cartridge
10 Shell Assembly
11 Inlet
12 Outlet
13 Filler Cap Assembly
14 Support Clamps
15 Engine Support Hanger
16 Air Compressor Discharge Line
17 Air Compressor Governor
18 Air Compressor
19 Hydraulic Pump
20 Pressure Line T-301

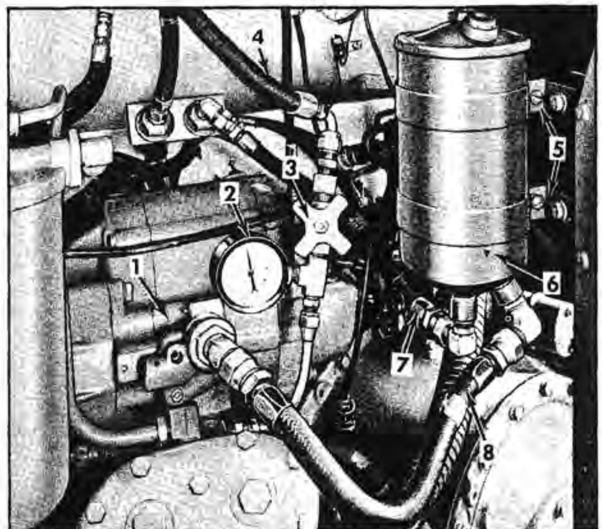
Figure 3—Power Steering Filter and Reservoir Installed

catch this fluid.

2. Connect 0 to 1000 psi pressure checking gauge (J-5631-01) (fig. 4) between the pump pressure port and pressure hose. Leave valve in pressure gauge open.

3. Bleed steering hydraulic system to remove all air from pressure line as directed previously under "Bleeding Hydraulic System."

4. Start engine and run at idle speed. Turn wheels through normal operating range several



1 Hydraulic Pump
2 Pressure Checking Gauge
3 Gauge Valve
4 Pressure Line
5 Support Clamps
6 Reservoir and Filter Assembly
7 Inlet Line
8 Outlet Line T-177

Figure 4—Checking Pump Hydraulic Pressure

times until the hydraulic fluid temperature reaches 170°F. When fluid temperature reaches 170°F., close valve in pressure gauge line and observe reading on pressure gauge. Pressure reading should be 950 to 1050 psi.

IMPORTANT: Do not leave valve closed for more than 15 seconds.

5. Open valve in pressure gauge line. Turn wheels to extreme right and left against "stops" (with wheels on ground). At extreme right or left position the maximum pressure reading should be within the amount specified in procedure 4 above.

6. If pump pressure is less than amount specified, make necessary repairs described under "Hydraulic Pump Overhaul" later in this section.

7. If pump pressure is satisfactory, shut off the engine and remove pressure checking gauge.

8. Reconnect pressure hose to pump port fitting; then bleed hydraulic system as described previously under "Bleeding Power Steering Hydraulic System."

POWER STEERING BOOSTER CYLINDER

GENERAL

The cutaway view in figure 5 illustrates the assembly and construction of the valve assembly with ball stud, the integral steering unit and the cylinder assembly. The control valve is bolted to the cylinder. Fluid flow from the pump is directed by the valve, through internal ports into the cylinder to operate the piston.

The rod end of the steering cylinder piston is anchored to the vehicle. The cylinder and valve body are connected to the wheels through the extension and end socket assembly and the valve is linked to the steering gear by the drag line assembly. Road shock forces on the wheels tend to move the cylinder, but this action also moves the valve body in relation to the spool, which is being held by the drag link. Movement of the valve body rela-

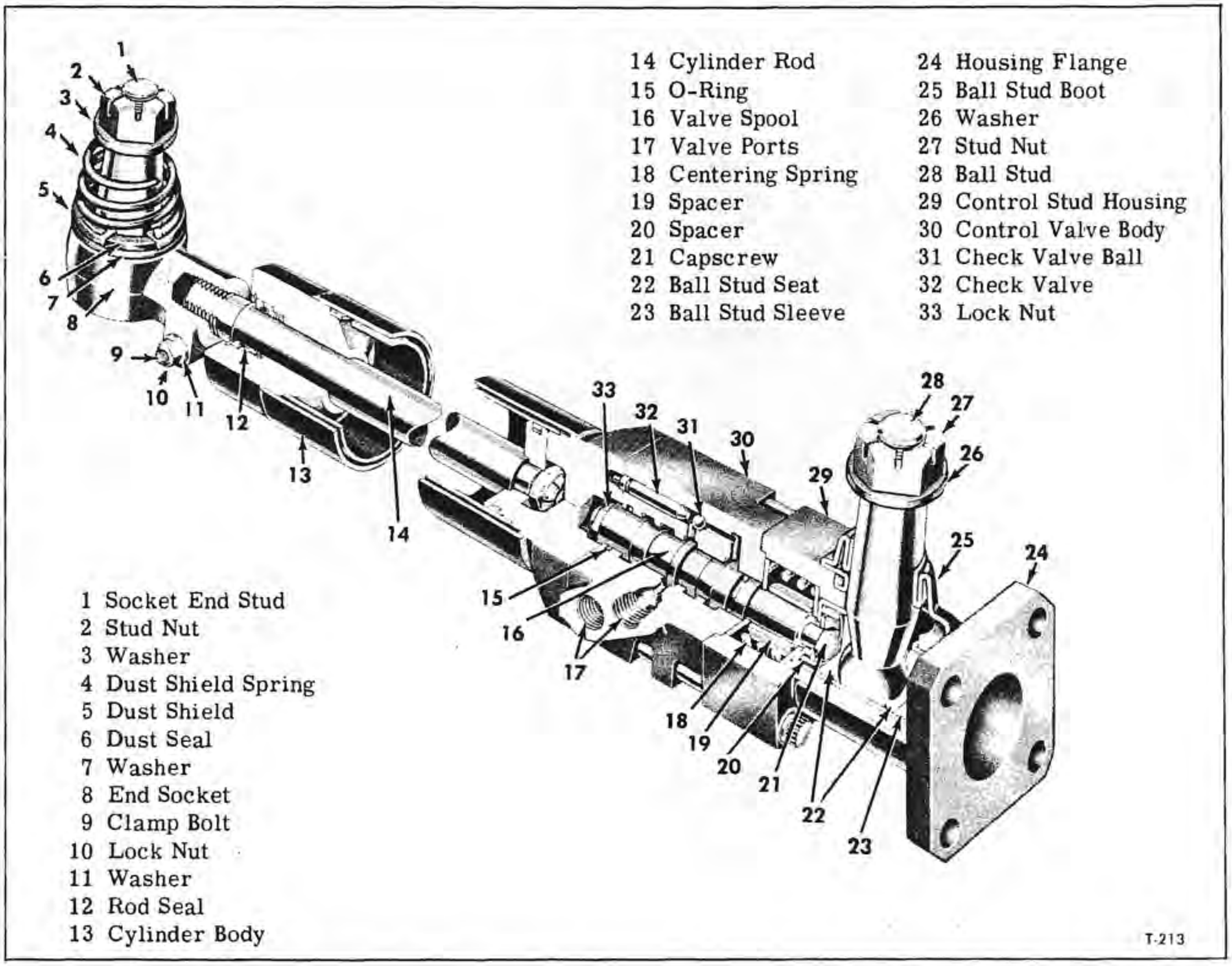


Figure 5—Power Steering Booster Cylinder Assembly

tive to the valve spool directs oil to the cylinder to compensate for the road shock loads and to maintain vehicle directional control at the steering wheel.

When the valve spool is moved in either direction by movement of the steering wheel and drag link, oil is directed to the cylinder. This causes the cylinder and valve body to move in the desired direction relative to the piston and rod which is anchored to the vehicle. Movement of the cylinder and valve body, which, through the extension and end socket assembly, are connected to the wheels, steers the vehicle.

OPERATION

(Refer to Figure 6)

Neutral Position - Neutral position is obtained when free hydraulic flow from the valve inlet to outlet is provided by the position of the control spool in relation to internal passages.

Extend or Retract - Movement of the steering wheel in either direction is transmitted through mechanical linkage to the control valve ball stud. Movement of the ball stud causes movement of the control spool. Pump oil flow is directed by spool position to either the head end or rod end of the cylinder, causing the cylinder to extend or retract. Movement of the cylinder will continue as long as the control spool is offset by continued turning of the steering wheel. When the steering wheel stops turning, the control spool stops and the cylinder and valve body move to center (neutral) position and stop. This is true in any position of the steering wheel if steering pitman arm stops are provided to prevent the cylinder from bottoming with the wheels against the wheel stops.

Pressure - In the event of power source failure, the ball check in the steering control valve body will permit free flow of oil throughout the steering unit. This permits the steering system to be operated manually.

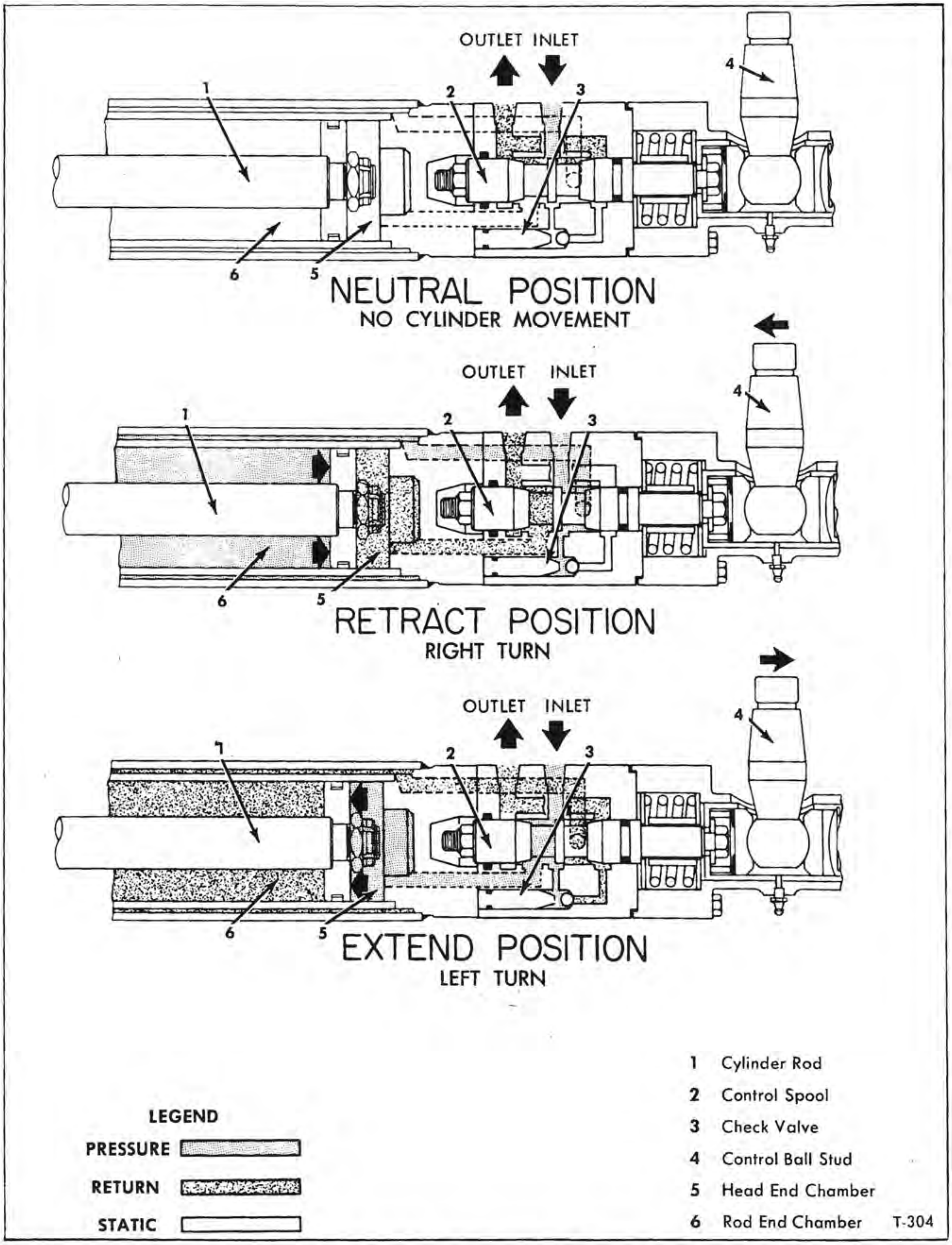


Figure 6—Operational Diagrams of Steering Booster Cylinder

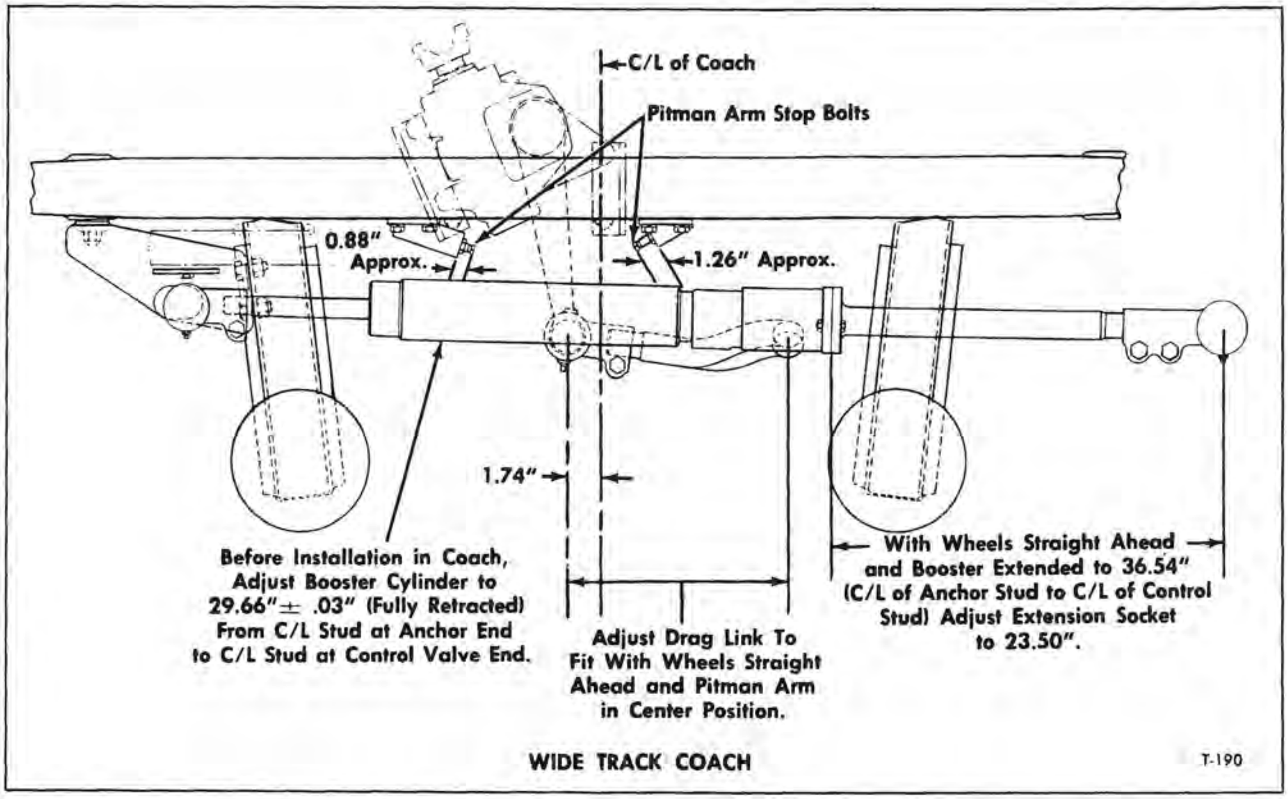


Figure 7—Power Steering Booster Cylinder Installation (Wide Track Coach)

Malfunction - For diagnosis and remedy of trouble relative to power steering booster assembly, see "Booster Cylinder Trouble Shooting Chart" in this section.

BOOSTER CYLINDER REPLACEMENT

Power steering booster cylinder assembly, installed as shown in figure 2, can be readily removed from coach at any time service is required that necessitates disassembly or partial disassembly of the unit. Remove booster cylinder assembly from coach as described in the following text. When reinstalling booster cylinder assembly, be sure to accomplish adjustment procedures outlined.

REMOVAL

Key numbers in text refer to figure 2.

1. Attach identification tags to flexible pressure and return hoses (3), then remove hoses and drain fluid from hoses and cylinder into a clean pan.
2. Remove cotter pin and stud nut attaching adjustable steering drag link (7) to booster cylinder ball stud (4). Discard cotter pin.
3. Remove cotter pin and stud nut attaching piston rod end socket tapered stud (1) to suspension support bracket (12). Discard cotter pin.
4. Remove four cotter pins, nuts, and bolts attaching flange of booster cylinder ball stud body (4) to flange of adjustable extension (5).
5. Remove booster cylinder assembly (2) from drag link end (7) and suspension support bracket (12). It may be necessary to use a suitable puller to aid in removal.
6. Remove dust cover spring and dust cover from booster cylinder ball stud (4).
7. Remove dust cover spring, shield, dust cover, and washer from piston rod end socket tapered stud (1).
8. If necessary, remove set screw and clamp bolt; then turn piston rod end socket (1) off piston rod.

INSTALLATION (Refer to Figs. 2, 7, and 8)

1. Before installing booster cylinder (2) assembly in coach, compress booster cylinder into fully retracted position; then thread piston rod end socket assembly (1) on booster cylinder piston rod to the dimension shown in figure 7 or 8, measured from centerline of socket end tapered stud (1) to centerline of booster cylinder ball stud (4).
2. Position dust cover and dust cover spring on booster cylinder ball stud (4).
3. Position washer, dust cover, shield, and dust cover spring on piston rod end socket tapered stud (1).

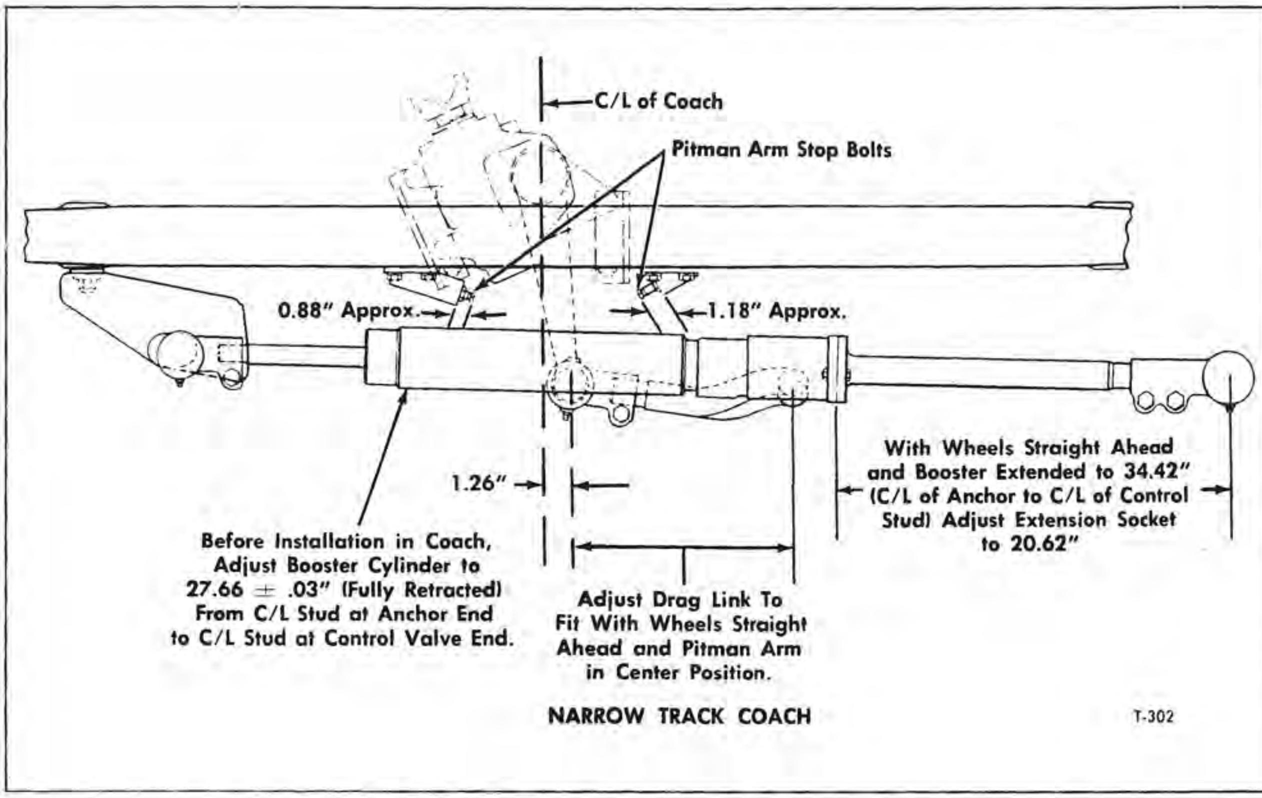


Figure 8—Power Steering Booster Cylinder Installation (Narrow Track Coach)

4. Check length of cylinder extension and end socket assembly (5), measuring from center of end socket ball stud to flange of extension (figs. 7 and 8). Distance should measure 23.50" on TDH/TDM-4518 and TDH/TDM5303 (wide track coach). Distance should measure 20.62" on TDH/TDM4519, TDH/TDM5304, SDH/SDM4502 and SDH/SDM5302 (narrow track coach). Adjust as necessary to obtain these dimensions.

5. Set wheels in straight ahead position and extend booster cylinder to applicable following dimension (measure from C/L of piston rod end socket stud (1) to C/L of cylinder ball stud (4).

a. On TDH/TDM4518 and TDH/TDM5303 (wide track coach) extend cylinder to 36.54".

b. On TDH/TDM4519, TDH/TDM5304, SDH/SDM4502 and SDH/SDM5302 (narrow track coach) extend cylinder to 34.42".

6. At this stage of installation the booster cylinder (2) should be suspended horizontally under coach and fluid lines (3) connected to unit.

7. Position booster cylinder ball stud body flange (4) to flange of end socket extension (5), at the same time inserting booster cylinder ball stud (4) in hole at end of drag link (7) and piston rod end socket tapered stud (1) into hole in suspension support bracket (12). NOTE: Cylinder ball stud to drag link must be positioned at bottom of cylinder. When booster cylinder and end socket extension are pre-set to above dimensions, the studs (1 and 4) should slip easily into the holes in drag link (7) and support bracket (12). Turn adjustable drag link for further adjustment if necessary.

> CAUTION: If excessive adjustment is necessary, after pre-setting to above dimensions, this is an indication that something else is wrong. Check for bent steering arm, misaligned front end or worn components of steering linkage.

8. Dip threads of extension bolts in special lubricant (S-17). Refer to LUBRICATION (SEC. 13) for description of special lubricant (S-17); then attach booster cylinder ball stud body flange (4) to flange of end socket extension (5) with four bolts and lock nuts. Tighten bolts to 40-50 foot-pounds torque; then advance lock nuts to nearest cotter pin holes and install new cotter pins.

9. With booster cylinder ball stud inserted through hole at end of drag link, install stud nut on ball stud. Tighten stud nut to 150 foot-pounds torque; then advance nut to nearest cotter pin hole and install new cotter pin.

10. With piston rod end socket tapered stud (1) inserted through hole in suspension support bracket (12), install stud nut on tapered stud. Tight-

en nut to 150 foot-pounds torque; then advance nut to nearest cotter pin hole and install new cotter pin to retain nut.

IMPORTANT: It is important that the following adjustments be checked.

11. Check position of Pitman arm as described previously under "Steering Gear Replacement" in "MECHANICAL STEERING." With front wheels and steering wheel in straight-ahead position, centerline of hole at drag link end of arm should be 1.74" to left of centerline of coach, when viewed from the rear, on TDH/TDM4518 and TDH/TDM-5303 (wide track coach - fig. 7). On TDH/TDM4519, TDH/TDM5304, SDH/SDM4502 and SDH/SDM5302 (narrow track coach - fig. 8) centerline of hole at drag link end of Pitman arm (9) should be 1.26" to the right of centerline of coach.

NOTE: Centerline of coach can be identified by prick punch marks on back of front axle beam.

12. If Pitman arm (9) is incorrectly positioned, disconnect drag link (7) from Pitman arm. Loosen clamp bolt securing end socket to drag link. With Pitman arm positioned as described in Step 11, and front wheels and steering wheel in straight-ahead position, turn end socket on drag link as required to align center of end stud with center of hole in Pitman arm. Attach end socket to Pitman arm. Tighten stud nut to 150 foot-pounds torque. Install new cotter pin.

IMPORTANT: Booster cylinder end of drag link must be tilted to same plane as flange of booster cylinder ball stud body before clamp bolt at Pitman arm end socket is tightened. Rotate link if necessary; then tighten bolt to 45-55 foot-pounds torque.

13. Refill power steering hydraulic system and bleed system as directed previously under "Bleeding Power Steering Hydraulic System."

BOOSTER CYLINDER OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 9.

NOTE: If ball stud housing (40), valve body (24) and cylinder tube (17) have not been scribed with alignment marks, use prick punch and mark these parts so they can be reassembled in same relative position.

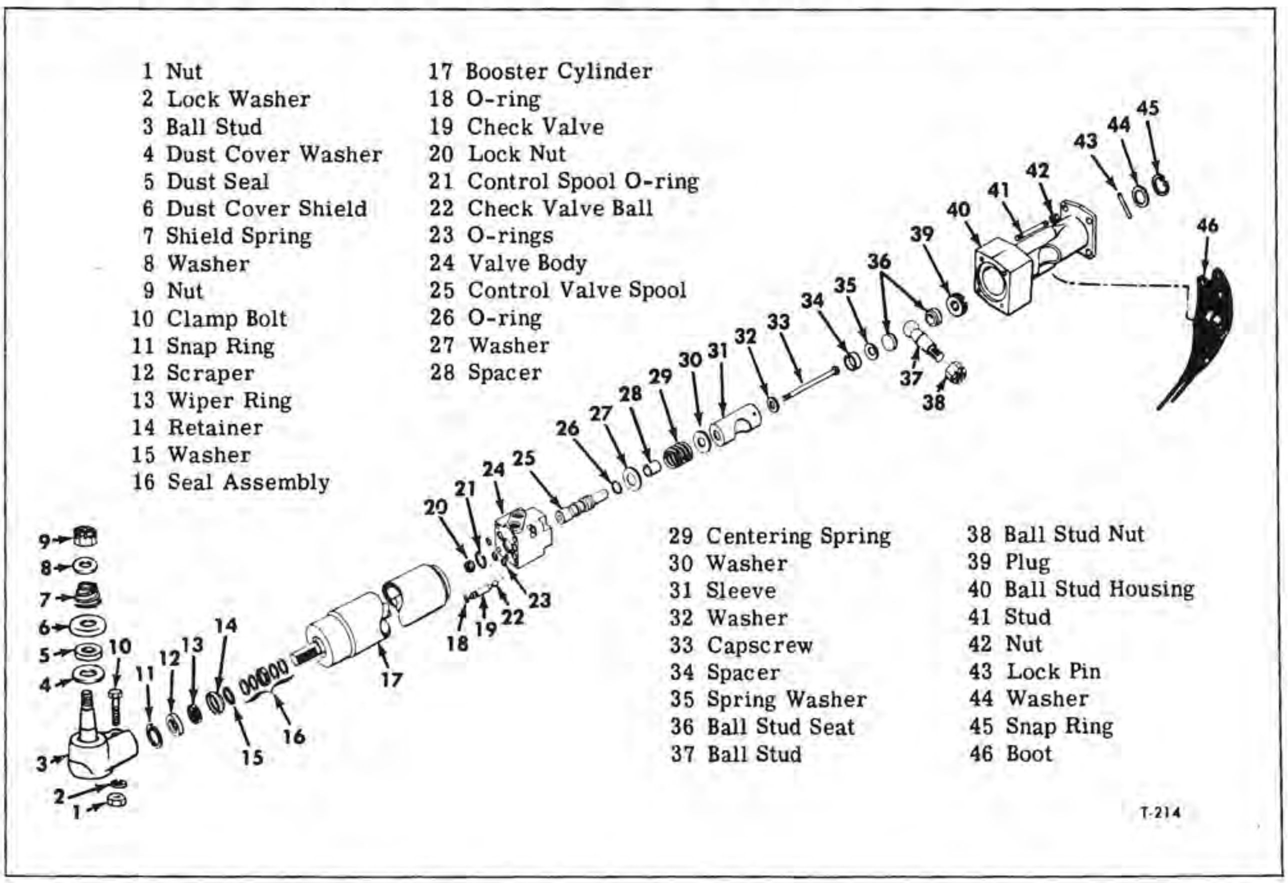


Figure 9—Power Steering Booster Cylinder Components

CAUTION

Before removing unit or parts of unit to be serviced be certain the unit is not subject to hydraulic pressure.

Do not disassemble a unit further than is necessary to correct a malfunction. During disassembly, special attention should be given to identification of parts for proper reassembly. Place all disassembled parts on a clean, lint-free surface for inspection. Carefully remove any burrs by light stoning. Clean all parts except O-rings and seals in a clean mineral oil solvent. After drying thoroughly, lay the parts on a clean, lint-free surface. All internal oil passages of the unit must be thoroughly cleaned.

CAUTION

Never use an air hose on or near the exposed parts because of the presence of water and dirt in the air system.

All O-rings and seals should be replaced for reassembly. Soak them in hydraulic fluid prior to being used.

Control Valve Disassembly

1. Loosen and remove four stud nuts (42) that secure the control ball stud housing (40) and valve assembly to the cylinder. Remove the control ball stud housing and valve assembly from the cylinder. Remove three O-rings (23) from recesses in the valve body (24). Care must be taken not to score or otherwise damage the cylinder or valve body mating surfaces.

2. Hold control ball stud housing and valve body assembly in a vise, by lightly clamping valve body (24). Use care not to distort spool bore in valve body. Remove the lock pin (43) which secures the control ball stud sleeve plug (39) and remove plug. Remove control ball stud (37), two ball stud seats (36), spring washer (35) and spacer (34).

3. Remove self-locking nut (20) from cap screw (33). Remove cap screw (33), washer (32) and control ball stud sleeve (31). Then lift the two centering spring retaining washers (30 and 27), centering spring (29) and spacer (28) from the valve body (24). Remove control spool (25) from the control ball stud end of valve body (24). Remove O-ring (26) from valve body and from spool to complete disassembly.

NOTE

The check valve retaining plug with integral valve body-cylinder locating pin should be removed for inspection of check valve (19) and ball (22).

Cylinder Disassembly

The cylinder assembly is a sealed unit. Overhaul procedures are restricted to replacing the sealing parts on the rod end.

1. Remove rod end ball stud (3) by removing nut (1), bolt (10), and lock washer (2) from the ball stud housing and unscrewing the ball stud (3).

2. Remove retainer snap ring (11) with snap ring pliers. Rotate the rod and withdraw it far enough from the cylinder to expose scraper (12), wiper ring (13), retainer (14) and washer (15). The shaft seal assembly (16) may be removed with a hooked scriber.

INSPECTION

1. Discard all seals, wipers, and scrapers and replace with new upon reassembly. Wash all parts in a good grade of mineral spirits.

2. Inspect all fluid passages in valve body and cylinder to be certain they are clean and free from obstructions.

3. Check each disassembled part for excessive wear, cracks or pitting that would render them unfit for continued use. Replace all defective parts.

4. Inspect valve spool for deep scoring and excessive wear. Check valve spool bore for similar scoring or pitting. Replace these parts if badly damaged or worn. Do not rework or attempt to "touch-up" the valve spool. This practice will only result in improper steering unit operation and performance.

5. Inspect cylinder shaft for damage and straightness to insure proper seating.

ASSEMBLY

NOTE: Immerse all parts in clean hydraulic fluid to facilitate reassembly.

Seals - Be sure that all old seals, wipers and scrapers are discarded and replaced with new parts for reassembly. Remember that a seal can only do its job when properly seated to prevent fluid leakage and entrance of air into the system. Coat all seals with liberal amounts of grease or petroleum jelly prior to assembly.

Control Valve Assembly.

1. Install new O-rings (21 and 23 - coated with grease or petroleum jelly) in cylinder end of valve body and on control ball stud end of valve spool. Install spool in bore from the control ball stud end to avoid O-ring interference during assembly.

2. Install washer (27), spacer (28), centering spring (29), washer (30), control ball stud sleeve (31), cap screw washer (32) and cap screw (33). Coat screw threads with a small amount of grade D "Loctite" or equivalent. Install a new self locking nut (20) and tighten until play between parts is removed. Be sure that the centering spring remains aligned between the two retaining washers. Back nut (20) off two flats (1/3 turn or 120^{o}).

3. Start control ball stud sleeve plug (39) in control ball stud sleeve (31).

4. Slide the control ball stud housing (40) over the ball stud sleeve (31).

5. Install three new O-rings (23) in recesses in the valve body (24). Mate surfaces of valve and cylinder. Install ball (22) and check valve (19). The locating pin on the check valve retaining plug must mate with a recessed hole on the cylinder mating face to insure proper port alignment between cylinder and valve.

6. Locate control ball stud housing (40) in desired position relative to control ball stud. Install four stud nuts (42) while holding valve and control assembly in place to prevent misalignment of O-rings. Tightening of the four stud nuts (42) should be done evenly and 180 degrees apart to prevent an out-of-square condition between the ball stud housing and valve body. The nuts should initially be tightened only snugly, and then tightened evenly to 30-40 foot-pounds after the control ball stud has been assembled. The ball stud then can be actuated to check if the spool is free. If the spool is not free, the nuts should be loosened and retightened.

7. Install control ball stud spacer (34). The spring washer (35) must be installed with its convex (raised inside diameter) face toward ball stud (37) to provide spring tension on ball stud. Next install ball stud seats (36) and control ball stud (37). Position the stud (37) and sleeve (31) so that the stud is centered in the sleeve opening.

8. Tighten control ball stud sleeve plug (39) snugly against seat (36). Back plug off until slot in plug lines with one of the lock pin anchor holes in sleeve which are spaced at 60° intervals in control ball stud sleeve. Install lock pin (43).

9. Grease control ball stud housing, under low pressure, through grease fitting. See LUBRICATION (SEC. 13) of this manual for grease recommendations.

Cylinder Reassembly.

1. Coat the rod seal assembly parts (16) with petroleum jelly. Install two back-up rings over the rod and in the cylinder cap bore. Be sure that the

BOOSTER CYLINDER TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
LOSS OF SYSTEM PRESSURE	SLIPPAGE OF PUMP DRIVE OTHER PUMP MALFUNCTION	Check pump according to manufacturer's recommendations.
CYLINDER PISTON ROD BINDING OR STICKING	CRAMPING OF LINKAGE	With hydraulic flow shut off from the unit and the rod end uncoupled the rod should slide freely in or out by hand with a maximum force of 30 pounds. If binding is apparent, replace the unit and readjust Pitman arm stops to prevent recurrence of damage.
CHATTER CONDITIONS	LOOSE MOUNTINGS OR LINKAGE	Make certain all ball stud mounting and other linkage is tight. Check Pitman arm stops to be certain the arm strikes the stops slightly before the steering knuckles contact the stops on the axle. Insufficient pump flow at idle speeds can be corrected by increasing engine idle rpm.
UNSATISFACTORY STEERING IN EITHER DIRECTION	AIR IN SYSTEM, EXCESSIVE WEAR IN STEERING CYLINDER. INCORRECT SYSTEM PRESSURE, WORN PUMP	Check for air in system. Excessive noise or foamy condition of oil indicates aeration. Check to be sure air is not entering system through poor threads, hoses, pump seals, O-rings, gaskets and loose connections. Excessively worn cylinders result in leakage past the piston. Correct by replacing cylinder. Repair or replace pump.

split ends are staggered. Install the seal ring and two outer back-up rings, again with split ends staggered. Install the washer (15), retainer (14), wiper (13) and scraper (12). Install the snap ring (11).

2. Screw the rod end ball stud sub-assembly (3) on to the end of the rod. Install bolt (10) washer (2) and nut (1). Torque to 45-55 foot-pounds.

BOOSTER CYLINDER EXTENSION AND END SOCKET

The booster cylinder extension assembly is two-piece type, composed of an extension and an end socket assembly. Extension is flanged at end which attaches to booster cylinder and threaded at opposite end for attachment of end socket assembly.

End socket stud is held against a tapered bearing by a seat and spring. An end plug and lock wire hold these parts in their correct relative position in end socket (fig. 10).

MAINTENANCE

Tapered stud nut must be kept tight, as any looseness of stud at steering arm will cause hole in arm to become enlarged and result in premature replacement of parts. Tightening stud nut after wear has occurred will result in damage to dust covers and springs, particularly when turning to extreme right and left.

Normal wear on bearing surfaces in end socket will cause increase in overall height of assembly. If excessive play is noted, it is evident that worn parts or complete end socket assembly must be replaced.

At intervals indicated, apply recommended lubricant as directed in LUBRICATION (SEC. 13) of this manual.

BOOSTER CYLINDER EXTENSION AND END SOCKET REPLACEMENT

REMOVAL

1. Remove cotter pin and nut attaching tapered end socket stud to right-hand steering arm. Strike steering arm a sharp blow with hammer as downward pressure is applied at end socket to remove stud from arm.

2. Remove four cotter pins, nuts, and bolts attaching extension to booster cylinder assembly. Discard cotter pins.

INSTALLATION

1. With the two clamp bolts loose, turn end socket onto extension until dimension from centerline of tapered stud to face of extension is 23.50" on TDH/TDM4518 and TDH/TDM5303 coaches. Distance should measure 20.62" on TDH/TDM4519, TDH/TDM5304, SDH/SDM4502, and SDH/SDM5302 coaches. DO NOT TIGHTEN CLAMP BOLTS UNTIL INSTALLATION IS COMPLETE.

2. Set wheels in straight ahead position and extend booster cylinder to applicable following dimension (measure from C/L of piston rod end socket stud to C/L of cylinder ball stud).

a. On TDH/TDM4518 and TDH/TDM5303 (wide track coach) extend cylinder to 36.54".

b. On TDH/TDM4519, TDH/TDM5304, SDH/SDM4502 and SDH/SDM5302 (narrow track coach) extend cylinder to 34.42".

3. Attach extension flange to booster cylinder flange using four bolts and nuts. Tighten nuts securely; then install new cotter pins to secure nuts.

4. Position dust cover washer, dust seal, dust cover seal, and spring over end socket tapered stud. Insert tapered stud in steering arm. When booster cylinder and end socket extension are preset to above dimensions, the stud should slip easily into hole in steering arm. Turn end socket on extension for further adjustment if necessary.

NOTE: If excessive adjustment is necessary, after pre-setting to above dimensions, this is an indication that something else is wrong. Check for bent steering arm, misaligned front end or worn components of steering linkage.

5. Attach tapered stud to steering arm with nut and new cotter pin. Tighten end socket clamp bolts to 45-55 foot-pounds torque.

BOOSTER CYLINDER EXTENSION AND END SOCKET OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 10.

1. Remove extension and end socket assembly as previously instructed. Loosen two clamp bolts

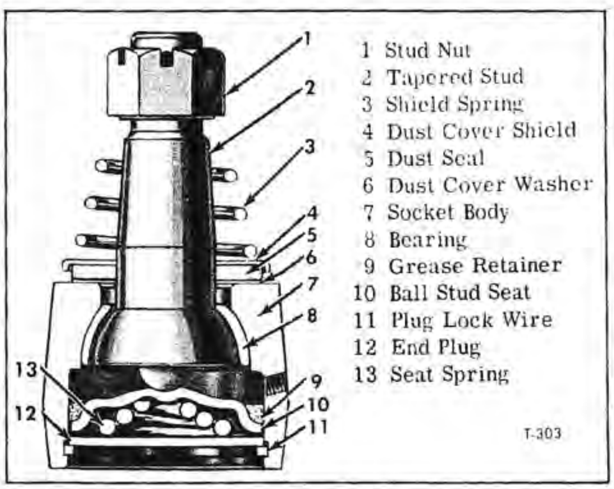


Figure 10—Booster Cylinder Extension End Socket

and nuts; then thread end socket assembly off extension.

NOTE: If end socket body is not being repaired or replaced, there is no need for removal from extension.

2. Remove shield spring (3), dust cover shield (4), dust seal (5), and dust cover washer (6) from tapered stud (2).

3. Remove end plug lock wire (11), end plug (12), seat spring (13), stud seat (10), and grease retainer (9). When these parts are removed, tapered stud (2), and bearing (8) can easily be removed from end socket.

CLEANING AND INSPECTION

Immerse all parts in suitable cleaning solvent to loosen and remove all accumulated dirt and grease. Use stiff bristle brush and repeat immersions until all parts are clean.

Inspect all parts for evidence of excessive wear or corrosion. Inspect springs for loss of tension and broken coils. Discard seal and grease retainer. Replace defective and excessively worn parts wherever necessary.

ASSEMBLY

Key numbers in text refer to figure 10.

1. During assembly procedures, lubricate parts with lubricant recommended in LUBRICATION (SEC. 13) of this manual.

2. Install bearing (8) into end socket. Install tapered stud (2).

3. In the order listed, install the following parts into end socket; grease retainer (9), stud seat (10), seat spring (13), end plug (12), and lock wire (11).

4. If removed, install lubrication fitting and fill with recommended lubricant.

5. Position dust cover washer (6), dust seal (5), dust cover shield (4), and shield spring (3) on tapered stud (2); then until ready to install the assembly on coach, install stud nut (1) to retain parts.

6. If socket end assembly was removed from extension, thread end socket on extension to a dimension of 23.50" on TDH/TDM4518 and TDH/TDM5303 coaches. Distance should measure 20.62" on TDH/TDM4519, TDH/TDM5304, SDH/SDM4502, and SDH/SDM5302 coaches. Distance is measured from centerline of tapered stud to face of extension flange (figs. 7 and 8).

BOOSTER CYLINDER PISTON ROD END SOCKET

Power steering booster cylinder piston rod end socket is similar to booster cylinder extension end socket (fig. 10). Piston rod end socket threads directly on piston rod installed in booster cylinder assembly. Refer to "Booster Cylinder Extension and End Socket" described earlier in this section for overhaul procedures.

BOOSTER CYLINDER PISTON ROD END SOCKET REPLACEMENT

REMOVAL

1. Remove cotter pin and stud nut attaching piston rod end socket stud to suspension support bracket. Using a puller, force socket stud from bracket.

2. Remove set screw; then loosen socket end clamp bolt. Thread socket end assembly off piston rod.

3. Procedures required to overhaul booster cylinder piston rod end socket are the same as described previously under "Booster Cylinder Extension and End Socket."

INSTALLATION

1. Compress booster cylinder assembly into fully retracted position; then thread booster cylinder piston rod end socket on piston rod to a dimension of 29.66" on TDH/TDM4518 and TDH/TDM5303 coaches. On TDH/TDM4519, TDH/TDM-5304, SDH/SDM4502, and SDH/SDM5302 dimension should be 27.66". NOTE: Dimension is measured from centerline of end socket tapered stud to centerline of booster cylinder ball stud.

2. When booster cylinder is correctly adjusted, install set screw and clamp bolt. Tighten clamp bolt to 45-55 foot-pounds torque. Stake set screw in three places.

3. Reinstall piston rod end socket to suspension support bracket. Tighten stud nut to 150 foot-pounds torque. Secure nut with new cotter pin.

POWER STEERING DRAG LINK

Adjustable steering drag link assembly used with power steering is composed of two parts, drag link and end socket assembly (fig. 11). Drag link end socket assembly is roller-bearing type incorporating adjustable features which automatically compensates for normal wear. End socket assembly at Pitman arm end of drag link assembly threads on drag link and provides for length adjustment. End socket assembly is secured to drag link by a clamp bolt, nut, and lock washer. Opposite end of drag link engages booster cylinder ball stud and is secured by a stud nut and cotter pin.

MAINTENANCE

If steering linkage between the steering gear and front axle is out adjustment, bent, twisted, or worn, steering action of coach will be seriously affected. At any time steering linkage parts are repaired, replaced, or adjusted, steering geometry and front wheel alignment must be checked. Refer to FRONT AXLE (SEC. 1) of this manual for procedures.

Stud nuts at socket end and booster cylinder ball stud end of drag link must be kept tight or hole at ball stud end of drag link and hole in Pitman arm may become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs into holes so far that dust cover parts may become damaged and result in premature replacement.

Drag link end socket is equipped with a lubrication fitting and should be lubricated at regular intervals as directed in LUBRICATION (SEC. 13) of this manual.

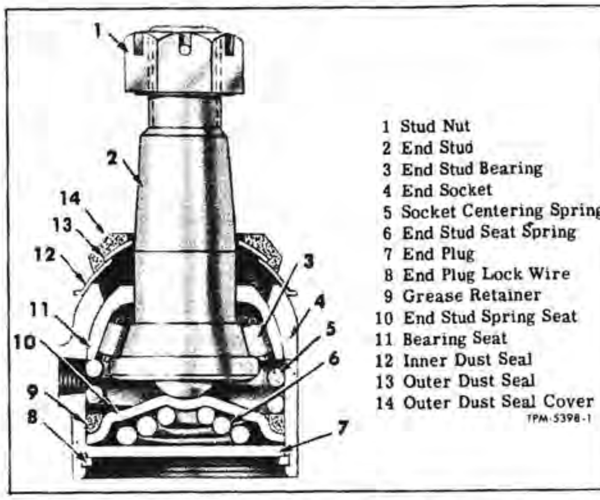


Figure 11—Power Steering Drag Link End Socket

DRAG LINK ADJUSTMENT

Drag link is adjusted properly when steering wheel is centered an equal number of turns between extreme right or left position, and the front wheels are positioned straight-ahead. In this position the centerline of hole at drag link end of the Pitman arm will be 1.74" to the left of centerline of coach when viewed from rear of front axle (fig. 7) on TDH/TDM-4518 and TDH/TDM5303 coaches. On TDH/TDM4519, TDH/TDM5304, SDH/SDM4502, and SDH/SDM5302 coaches, centerline of hole at drag link end of Pitman arm will be 1.26" to the right of centerline of coach (fig. 8). NOTE: Centerline of coach can be identified by prick punch marks on back of front axle beam.

1. If drag link needs adjustment, disconnect drag link at Pitman arm.

2. Loosen clamp bolt securing end socket to drag link. With Pitman arm positioned to dimension stated above (figs. 7 and 8), and front wheels straight ahead, turn end socket on drag link as required to align center of end stud with center of hole in Pitman arm. Attach end socket to Pitman arm. Tighten stud nut to 150 foot-pounds torque; then install new cotter pin.

IMPORTANT: Booster cylinder end of drag link must be tilted to same plane as flange of booster cylinder ball stud body before clamp bolt at Pitman arm end socket is tightened. Rotate link if necessary; then tighten clamp bolt to 45-55 foot-pounds torque.

DRAG LINK END SOCKET REPLACEMENT

Refer to "Steering Drag Link Adjustment" preceding for preliminary procedures which will apply for replacement of drag link end socket. In addition to adjustment procedures, remove end socket from drag link.

DRAG LINK END SOCKET OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 11.

1. Remove outer dust seal cover (14), outer dust seal (13), and inner dust seal (12) from end socket tapered stud.

2. Position end socket assembly in a vise and press end plug (7) in against spring pressure far enough to remove end plug lock wire (8), by using a screwdriver to pry lock wire out of groove in end socket (4).

3. Remove end plug (7), end stud seat spring (6), end stud spring seat (10), grease retainer (9), socket centering spring (5), tapered end stud (2), end stud bearing (3), and end stud bearing seat (11) from drag link socket end (4).

CLEANING AND INSPECTION

Key numbers in text refer to figure 11.

1. Clean all parts except outer dust seal cover (14) thoroughly in cleaning solvent. Wipe or blow parts dry.

2. Inspect all parts for corrosion and excessive wear. Discard all parts not in good condition.

3. Check socket centering spring (5) and end stud seat spring (6) for free length, compressed length, distortion, or collapsed coils.

4. Inspect bearing rollers in end stud bearing assembly (3) for roughness or flaking. If rollers will not rotate freely in retainer, replace bearing assembly.

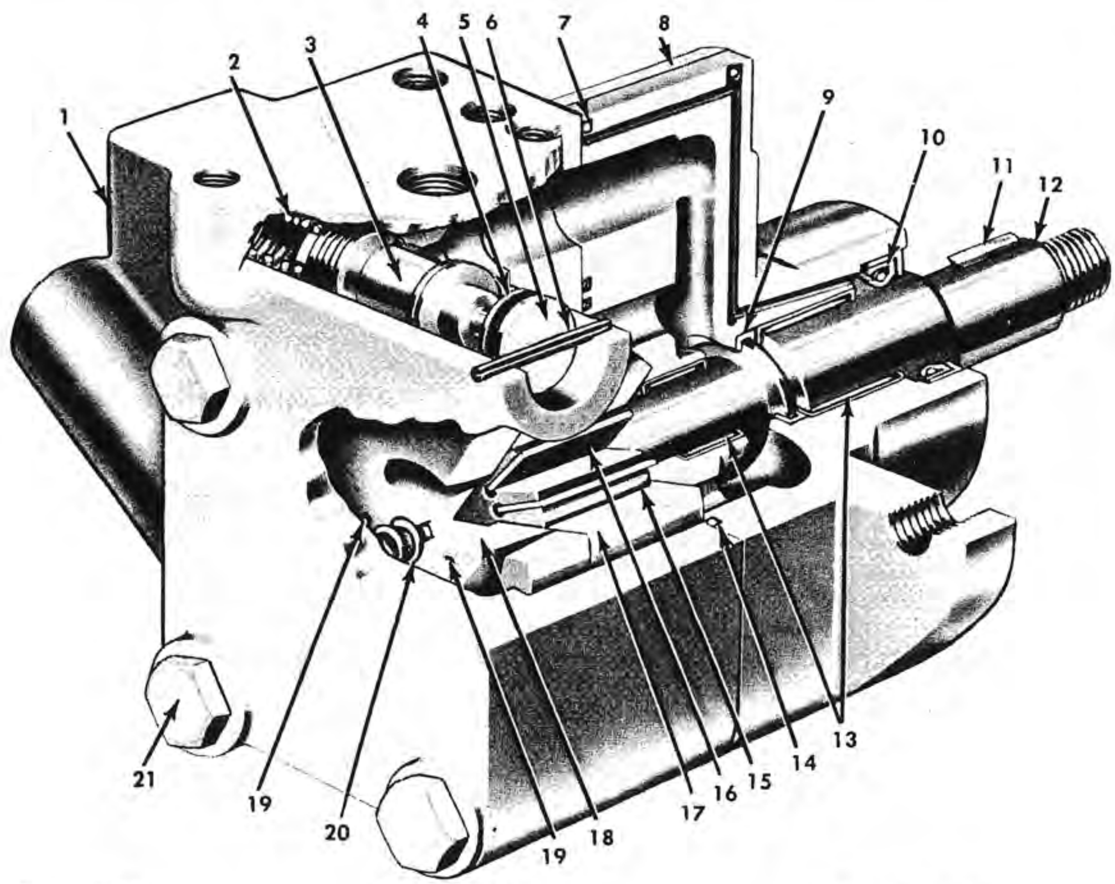
5. Discard dust seals, dust cover, and grease retainer.

ASSEMBLY

Key numbers in text refer to figure 11.

When assembling adjustable drag link end socket assembly, be sure all parts and working area are thoroughly clean. If dirt or foreign matter is allowed to get into drag link end socket assembly, excessive wear and premature replacement of parts will be the result. Lubricate each part with lubricant specified in LUBRICATION (SEC. 13) of this manual as part is installed.

1. Position end stud bearing seat (11) and stud bearing (3) on tapered end stud.
2. Insert stud and bearing assembly into drag link end socket (4).
3. Position socket centering spring (5) in end socket (4) against end stud bearing seat (11).
4. Press new grease retainer (9) over end stud spring seat (10); then position retainer and seat in end socket (4).
5. Install end stud seat spring (6), and end plug (7) in end socket (4).
6. With end socket assembly positioned in vise, apply pressure against end plug to compress springs; then install end plug lock wire (8) in groove of end socket (4).
7. Position inner dust seal (12), outer dust seal (13), and outer dust seal cover (14) over threaded end of tapered end stud.



1 Pump Cover Assy.
2 Control Valve Spring
3 Control Valve Assy.
4 Control Valve O-Ring
5 Control Valve Plug
6 Valve Retainer Pin
7 O-Ring
8 Pump Body
9 Spacer
10 Shaft Seal
11 Key
12 Rotor Shaft
13 Needle Bearing
14 O-Ring
15 Pump Rotor
16 Rotor Vane
17 Pump Ring
18 Pressure Plate
19 Locating Pins
20 Pressure Plate Spring
21 Pump Cover Cap Screw

T-211

Figure 12—Power Steering Hydraulic Pump

8. With drag link end socket assembly cleaned, inspected, and repaired, assemble to drag link and adjust as directed previously under "Drag Link Adjustment."

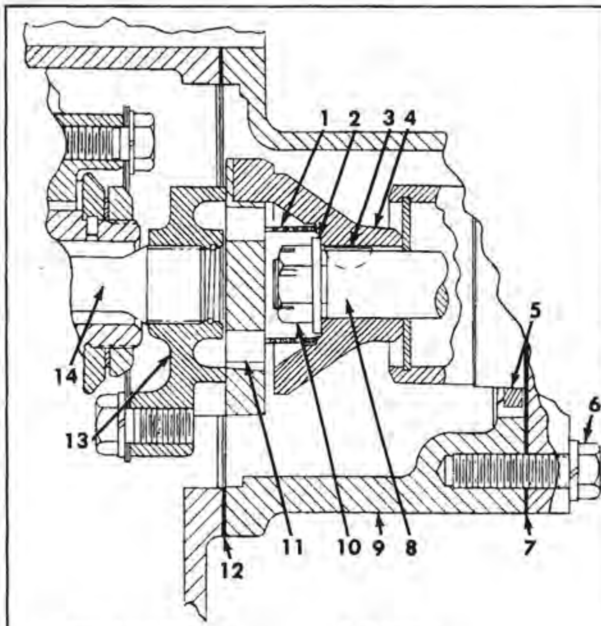
POWER STEERING HYDRAULIC PUMP

The power steering pump (fig. 12) is a vane type, hydraulic unit which supplies hydraulic power for operation of the steering booster cylinder at front axle. Pump is mounted at rear of engine (fig. 1), and is driven by the blower drive shaft through a coupling (fig. 13). The fluid reservoir and filter is remotely mounted and is connected to the hydraulic system by hoses (fig. 3).

OPERATION

PUMP OPERATION

Pumps are composed principally of a pressure plate, ring, rotor, vanes, and wear plate. (Refer to fig. 12.) The rotor is driven within the pump ring by a drive shaft, coupled to a power source. As the rotor speed increases, centrifugal action causes the vanes to follow the cam-shaped contour of the pump ring (fig. 14). System pressure, fed behind the vanes, assures sealing contact of vanes on ring contour during normal operation.



1 Coupling Spring
2 Plain Washer
3 Driven Hub Key
4 Power Steering Pump Driven Hub
5 Pump to Adapter Pilot Ring
6 Pump to Adapter Attaching Bolt
7 Gasket
8 Pump Drive Shaft
9 Adapter
10 Nut
11 Pump Drive Coupling
12 Gasket
13 Driving Hub
14 Blower Drive Shaft

TPM-7241

Figure 13—Power Steering Pump Drive

The ring is shaped so that two opposing pumping chambers are formed, thus cancelling any hydraulic loads on the bearings. Radial movement of the vanes, and rotation of the rotor, causes the chamber area between vanes to increase in size at the inlet (large diameter) section of the ring. This results in a low pressure, or vacuum in the chamber. This pressure differential causes oil to flow into the inlet, where it is trapped between the rotating vanes and is forced, through porting in the pressure plate to discharge into the system as the chamber size decreases at the pressure quadrant (small diameter) of the ring.

FLOW CONTROL AND RELIEF VALVE

Maximum pump delivery and maximum system pressure are determined by the integral flow control and relief valve in a special outlet cover used on pumps. This feature is illustrated schematically in figure 15. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to reservoir, thus limiting the system pressure to a prescribed maximum.

View "A" shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure in this chamber equalizes pressure at the other end of the relief valve spool and the light spring holds the spool closed. Pump delivery is blocked from the reservoir port by the spool land.

When pump delivery is more than the flow rate determined by the orifice plug, a pressure build-up forces the spool open against the light spring. Excess fluid is throttled past the spool to the reservoir port as shown in View "B."

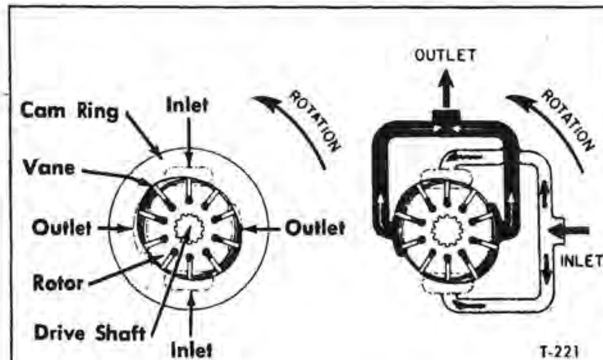


Figure 14-Checking Pump Hydraulic Pressure

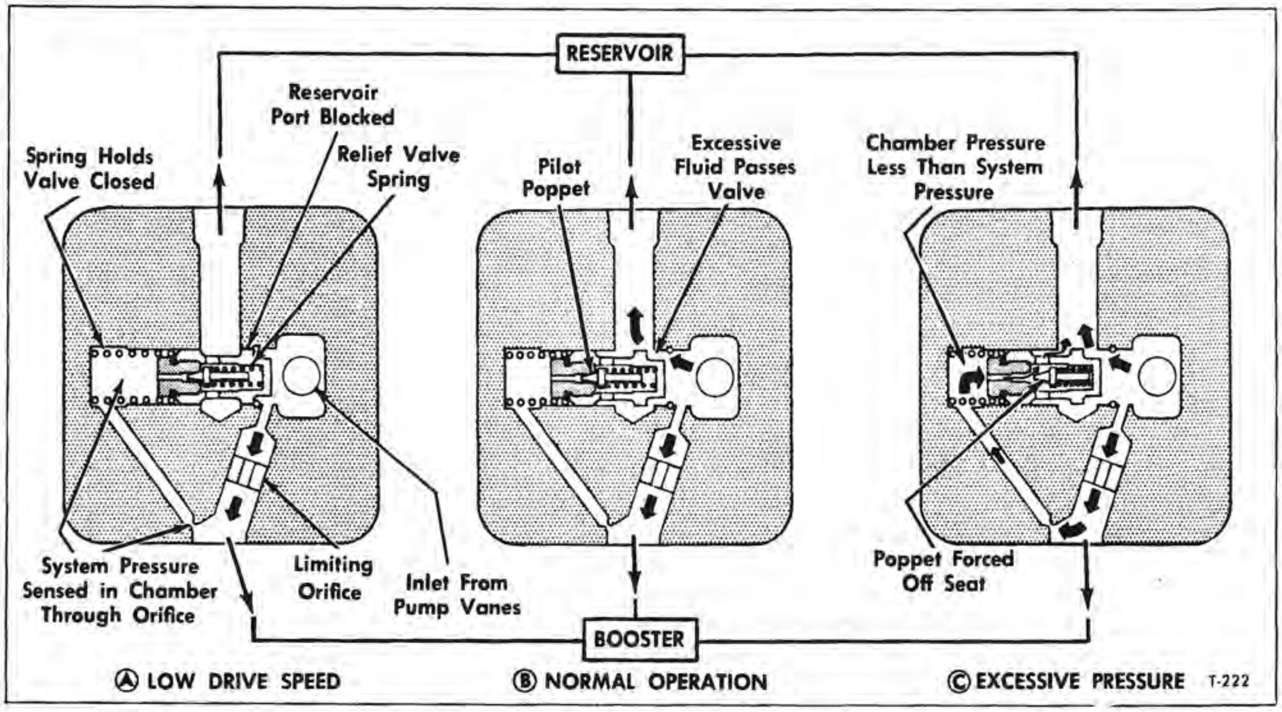


Figure 15—Hydraulic Pump Flow Control and Relief Valve Operation

If pressure in the system builds up to the relief valve setting (View "C"), the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to reservoir This flow causes a pressure differential on the spool, shifting it against the light spring. All pump delivery is thus permitted to flow to reservoir.

OPERATING INSTRUCTIONS

Normally, these pumps require no manual priming. However, it is essential that, after starting, a minimum drive speed of 600 RPM be held until the pump picks up its prime and pressure is built up in the system. Failure to observe the above precaution can result in scoring and possible seizure of the pump due to a lack of oil for lubrication.

HYDRAULIC FLUID RECOMMENDATIONS

Refer to LUBRICATION (SEC. 13) for type of fluid and intervals of service required for the power steering system.

MALFUNCTION

For diagnosis and remedy of trouble relative to power steering hydraulic pump see "Hydraulic Pump Trouble Shooting Chart" in this section.

HYDRAULIC PUMP REPLACEMENT

REMOVAL

Key numbers in text refer to figure 13.

1. Place a clean pan under power steering pump pressure and return flexible lines and pump parts to catch hydraulic fluid; then remove lines from pump by unscrewing fittings.
2. Remove bolts, nuts, and lock washers attaching power steering pump and adapter assembly to engine flywheel housing.
3. Using care to avoid dropping coupling ring (11) and coupling spring (1), remove pump and adapter assembly from engine.
4. Remove coupling ring (11) and coupling spring (1); then remove adapter to housing gasket (12). Discard gasket.
5. Remove lock nut (10) and plain washer (2) attaching driven hub (4) to pump drive shaft (8).
6. Remove two bolts (6) and lock washers attaching pump to adapter.
7. Remove adapter (9), adapter pilot ring (5), and gasket (7) from pump. Discard gasket.

INSTALLATION

1. If previously removed, install Woodruff key (3) in slot of pump drive shaft (8).
2. Position pump driven hub (4) on pump drive shaft (8), aligning Woodruff key in drive shaft with slot in hub (4).
3. Install plain washer (2) and lock nut (10) attaching pump driven hub (4) to pump drive shaft (8).
4. Position adapter pilot ring (5) in the adapter (9); then attach adapter and new gasket (7) to power steering pump with two bolts and washers.
5. Install coupling spring (1) and coupling ring (11) in pump adapter, engaging prongs of driven hub (4) with slots in coupling ring (11).

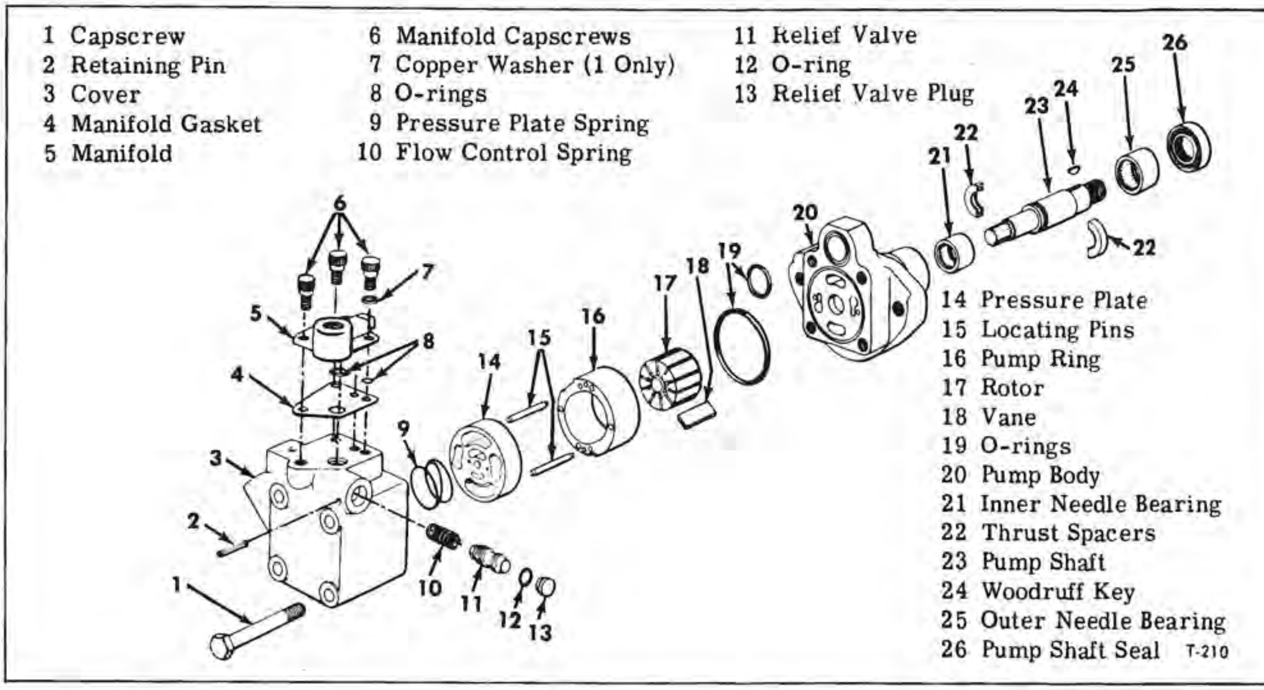


Figure 16—Power Steering Pump Components

6. Using new adapter to flywheel housing gasket (12), position pump and adapter assembly to flywheel housing, engaging prongs of driving hub (13) with slots in coupling ring (11).

7. Install adapter to flywheel housing attaching with bolts, nuts, and lock washers. Tighten securely.

8. Connect power steering pump pressure and return flexible lines to pump. Tighten fittings firmly

9. Refill power steering hydraulic system and bleed system as described previously under "Bleeding Power Steering Hydraulic System."

HYDRAULIC PUMP OVERHAUL

Overhaul of power steering hydraulic pump must be undertaken in clean working area with pump removed from coach engine. It is important that overhaul procedures described in the following text be carefully followed.

DISASSEMBLY

Key numbers in text refer to figure 16.

1. Using a suitable cleaning solvent, thoroughly clean the exterior of the hydraulic pump to prevent entry of dirt or other foreign matter into the pump during overhaul procedures.

2. Remove three manifold capscrews (6) and copper washer (7). Remove manifold (5). Remove and discard manifold gasket (4) and O-rings (8).

3. Remove cover mounting capscrews (1) and separate the cover (3) from the pump body (20).

4. Remove pressure plate spring (9) and pressure plate (14).

5. Remove pump ring (16), locating pins (15), rotor (17) and vanes (18), and the two O-rings (19).

6. Mount the cover (3) in a vise. Drive out retaining pin (2) with a suitable punch. Protect the relief valve plug and subassembly against falling from bore. Work the plug (13), relief valve (11) and spring (10) from the bore.

NOTE: Access to the relief valve plug and subassembly may be gained through the large chamfered hole which leads to relief valve bore from inside the cover.

7. Support the shaft end of the pump body (20) in a two inch straight pipe coupling and, using an arbor press, remove the shaft (23), shaft thrust spacers (22), outer needle bearing (25) and shaft seal (26). The shaft assembly should drop through a slot in the press table so the shaft will not be damaged. The outer needle bearing and shaft seal are a press-fit to the body. Use a pin punch and hammer to tap the inner needle bearing (21) from the body (20).

INSPECTION

NOTE: Wash all parts, except seals, in clear mineral solvent and lay them aside for inspection. Replace all old seals and O-rings at reassembly.

1. <u>Ring, Rotor, Vanes, Pressure Plate, Body</u> - Inspect the surfaces of all parts which are subject to wear. Light scoring may be removed from the faces of the body or wear plate with crocus cloth (by placing the cloth on a flat surface), medium stone or by lapping. Check the edges of vanes for

wear. Vanes must not have excessive play in slots or burrs on edges. Replace if necessary. Check each rotor slot for sticky vanes or wear. Vanes should drop in rotor slots by their own weight when both slot and vane are dry.

2. Relief Valve - Insert valve in its bore in pump cover. There should be no binding. Check valves and bore for excessive wear and scoring. Replace if necessary.

3. Bearings - Wash bearings thoroughly. Inspect and replace bearings if worn or damaged.

4. Shaft and Seal - Replace the shaft seal at each overhaul to prevent oil leakage. Check the drive shaft oil seal diameter for wear and scoring. Do not install a new seal on a shaft which is worn or damaged at the oil seal diameter. Replace the shaft if worn. Stone and polish the sharp edges on the shaft to prevent damage to the seal.

5. Body and Cover - Stone all mating surfaces with a medium stone to remove all burrs and sharp edges. Rewash all parts after stoning.

ASSEMBLY

NOTE: Immerse all parts in clean hydraulic oil to facilitate reassembly. Refer to figure 16.

1. Press inner needle bearing (21) in the body (20), using an arbor press.

2. Assemble the split-ring thrust spacer (22) on the shouldered portion of the shaft (23) and install shaft in the pump body (20).

3. Press outer needle bearing (25) onto shaft (23). The edge of the bearing must be 1/64" below the shaft seal shoulder when assembled. This provides for shaft end play of approximately .010" to .015".

4. Position the seal (26) on the shaft end of the body (20), being careful not to damage seal. Press seal in until it engages the shoulder in the body. This shoulder acts as a positive stop for the seal. Do not over-press as damage to the seal will result.

5. Install locating pins (15) in pump body (20). Install pump ring (16) over pins in correct direction of rotation.

6. Position rotor (17) in pump ring (16) with chamfered edge of splined hole "in" or toward pump body (20). The chamfer facilitates assembly.

7. Install vanes (18) with their radius edge toward the inner ring contour.

8. Oil the pump ring (16) and rotor (17) with clean hydraulic oil and install pressure plate (14).

9. Install O-rings (19). Install pressure plate spring (9) and cover (3). Tighten cover screws (1) to 25-30 foot-pounds torque.

10. Install pressure compensating spring (10) in relief valve bore. Insert valve assembly (11) with the hex toward the spring. Install plug (13) with O-ring (12) in bore and hold it in position while driving a new retaining pin (2).

11. Install O-rings (8) in pump cover (3), position new manifold gasket (4) and manifold (5) on pump cover and secure manifold to pump body with screws (6). Copper washer (7) is used on screw where tapped hole enters oil passage.

HYDRAULIC PUMP TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING OIL	DRIVEN IN WRONG DIRECTION OF ROTATION	Check direction of pump shaft rotation.
	PUMP DRIVE SHAFT DISENGAGED OR SHEARED. BELT SLIPPING OR BROKEN	Remove pump; determine damage to cartridge parts (see disassembly instructions) replace sheared shaft and needed parts.
	FLOW CONTROL VALVE STUCK OPEN	Disassemble pump and wash control valve in a clean solvent. Return valve to its bore and slide it back and forth. No stickiness in movement should occur. If a gritty feeling is noted on the valve O.D. it may be polished with crocus cloth. Avoid removal of excess material or rounding of valve edges during this operation. Do not attempt to polish the valve bore. Wash all parts before reassembly of pump. Flush entire system thoroughly and fill with clean oil.

HYDRAULIC PUMP TROUBLESHOOTING CHART (CONT'D.)

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING OIL (CONT'D.)	VANE OR VANES STUCK IN ROTOR SLOTS	Disassemble pump, examine rotor slots for dirt, grime or small metal chips. Clean rotor and vanes in a good grade solvent (mineral spirits or kerosene) reassemble parts and check for free vane movement.
	OIL VISCOSITY TOO HEAVY TO PICK UP PRIME	Use fluid of the proper viscosity as recommended.
	PUMP INTAKE PARTIALLY BLOCKED	Drain system completely; flush to clear pump passages. Flush and refill system with clean oil as per recommendations.
	AIR VENT FOR OIL TANK CLOGGED OR DIRTY STRAINER	Remove filler cap and clean air vent slot. Check filter or strainer in tank for clogged condition. Drain, flush and add clean oil to system if strainer was clogged.
PUMP MAKING NOISE	RESTRICTED OR PARTIALLY CLOGGED INTAKE LINE OR CLOGGED FILTER	Pump must receive intake oil freely or cavitation will result. Drain system, and clean intake line and strainers. Add new oil and strain by recommended procedures.
	AIR LEAK AT PUMP INTAKE PIPING JOINTS OR PUMP SHAFT SEAL.	Test by pouring oil on joints and around drive shaft. Listen for change in operation. Tighten joints affected and replace pump drive shaft seal according to service instructions as outlined.
	COUPLING MISALIGNMENT	Re-align and replace oil seal and bearings if damaged by shaft misalignment.
	RESERVOIR OR MANIFOLD SEAL LEAKAGE	Leakage between manifold or reservoir at replenishing hole due to O-ring damage. Reservoir inlet tube to pump cover O-ring should be carefully examined for damage such as cuts, nicks, or dirt.

POWER STEERING FLUID RESERVOIR AND FILTER

Power steering fluid reservoir and filter assembly is bracket mounted to right-hand engine support rail (fig. 3).

At regular lubrication intervals, fluid filter cover should be removed and element replaced. Any time power steering filter has been serviced, power steering hydraulic system should be bled.

Oil reservoir and filter assemblies used on coaches covered by this manual have two different type filler strainer screens. The early type is a cone-shaped screen (21) soldered to the filler neck in reservoir cover (5) as shown in figure 3. The late type is disc-shaped and is inserted inside reservoir shell (10) over center stand pipe. The disc shaped screen rests on top of the filter element cartridge hold-down washer (8) and is held in place by the element hold down spring (7). Either type may be removed for cleaning or replacement.

For complete details relative to method and interval of service required, see LUBRICATION (SEC. 13) of this manual.

POWER STEERING

SPECIFICATIONS

HYDRAULIC PUMP

Make	Vickers
Model	VTM27-50-40-10-ME-L1-10-S9
Type	Hydraulic Vane
Capacity	5 Gal. per Minute at 1200 R.P.M.
PUMP ROTOR	
Width	0.7693"-0.7695"
Outside Diameter	1.5930"-1.5980"
Number Vane Slots	10
Vane Slot Width	0.0780"-0.0785"
ROTOR VANES	
Quantity	10
Thickness	0.0775"
Width	0.3430"
Length	0.7692"
OUTER BEARING	
Type	Needle
Fits Housing Bore Diameter	1.1245"-1.1255"
Fits Shaft Diameter	0.8745"-0.8750"
Width	0.7400"-0.7500"
INNER BEARING	
Type	Needle
Fits Housing Bore Diameter	0.7495"-0.7505"
Fits Shaft Diameter	0.5620"-0.5625"
Width	0.6150"-0.6250"
FLOW CONTROL VALVE	
Opening Pressure	1000 psi (±100)
FLOW CONTROL VALVE SPRING	
Free Length	2.5470"
Compressed Length Under 6.25 lbs.	1.2970"
8.2 lbs.	0.9060"
PUMP SHAFT	
Diameter at Inner Bearing	0.5620"-0.5625"
Diameter at Outer Bearing	0.8745"-0.8750"
Length of Spline	0.6250"
Number of Splines	14

POWER STEERING BOOSTER CYLINDER

Make		Vickers
Model (Wide Coach)		S20B22-500-XNN14N-10-020
(Narrow Coach)		S20B22-500-XNN12N-10-020
Type		Hydraulic
Length	Retracted	Extended
(Wide Coach)	27.406"	41.500"
(Narrow Coach)	25.406"	37.500"
STROKE		
(Wide Coach)		$14\frac{3}{32}$"
(Narrow Coach)		$12\frac{3}{32}$"
Booster Cylinder Extension and End Socket Adjusted Length (Centerline of End Socket Tapered Stud to Outside Edge of Flange)		
(Wide Coach)		23.50"
(Narrow Coach)		20.62"
VALVE CENTERING SPRING		
Free Length		1.467"
Compressed Length Under 150 lbs.		1.062"
Compressed Length Under 196 lbs.		0.937"

STEERING DRAG LINK

Type	Adjustable Length
Length—Stud Centers (Approx.)	
(Wide Coach)	13.18"
(Narrow Coach)	9.98"
SPRINGS	
Stud Seat Spring	
Free Length	0.750"
Compressed Length Under 350-400 lbs.	0.500"
SOCKET CENTERING SPRING	
Free Length	1.250"
Compressed Length Under 30 lbs.	0.875"

RESERVOIR AND FILTER

Element	Disposable Cartridge
CARTRIDGE HOLD DOWN SPRING	
Free Length	5.50"
Compressed Length Under 16 lbs.	4.50"

TORQUE SPECIFICATIONS

Location	Ft.-Lbs.
Cover to Pump Body Bolt	25-30
Booster Cylinder Flange to Extension Flange Bolts	40-50
Drag Link to Booster Cylinder Ball Stud Nut and advance to nearest cotter pin hole.	150
Piston Rod End Socket Stud to Support Bracket Stud Nut and advance to nearest cotter pin hole.	150
Extension End Socket Stud to Steering Arm Nut and advance to nearest cotter pin hole.	150
Drag Link Stud to Pitman Arm Nut and advance to nearest cotter pin hole.	150
Piston Rod End Socket to Piston Rod Bolt—Nut	45-55
Extension End Socket Clamp Bolt—Nut	45-55
Drag Link Socket Bolt—Nut	45-55

Transmission
SPICER 4-SPEED MECHANICAL

DESCRIPTION

GENERAL

Mechanical transmission (fig. 1) is mounted directly to engine assembly. Power input is through 63-degree angle drive gears which are enclosed in a portion of the clutch housing. Clutch housing, transmission case, and cover are of cast aluminum alloy. Cast iron inserts are employed where additional strength is required. Angle drive gears are spiral bevel type. All mainshaft, countershaft and reverse idler gears are constant mesh type with helical teeth.

The transmission gears are shifted manually through use of gearshift lever located at right of driver's seat and connected to levers on transmission by rods and bell cranks (figs. 4, 5, and 6).

Shift forks in transmission cover (fig. 16) engage sliding clutches (fig. 13) and the clutches lock gears to respective shafts to provide the power train for each speed.

Transmission lubricant is contained in reservoir (sump) on bottom of transmission case. Lubricant is circulated to various points by a gear type pump mounted on engine and connected to transmission by flexible lines (fig. 3).

On vehicles with wet type clutch, the drive pinion has drilled passages (inset in figure 11) to carry lubricant to clutch components and pilot bearing (bushing) at engine flywheel.

Additional information on lubrication system and pump is included later under "Lubrication System."

The terms "Front" and "Rear" as used in this section do not refer to mounted position of transmission in coach. "Front" refers to the input or engine end of transmission while "Rear" refers to output or propeller shaft end of transmission. View of levers and propeller shaft yoke is shown in figure 2.

Key numbers in following descriptions refer to figure 12 except as otherwise indicated.

MAINSHAFT, GEARS, AND BEARINGS

Front end of mainshaft (36) is supported by pilot bearing (14) located in pocket in drive gear (15). Mainshaft rear bearing (43) which takes endwise thrust and carries radial load is installed in retainer (44). Rear bearing cap (34) locks bearing outer race in retainer. Lip of oil seal (35) in bearing cap (34) prevents lubricant leakage and seals out dirt. Speedometer drive gear (31) contacts inner race of bearing (43) and gear is locked in place by yoke assembly (41). Speedometer driven gear

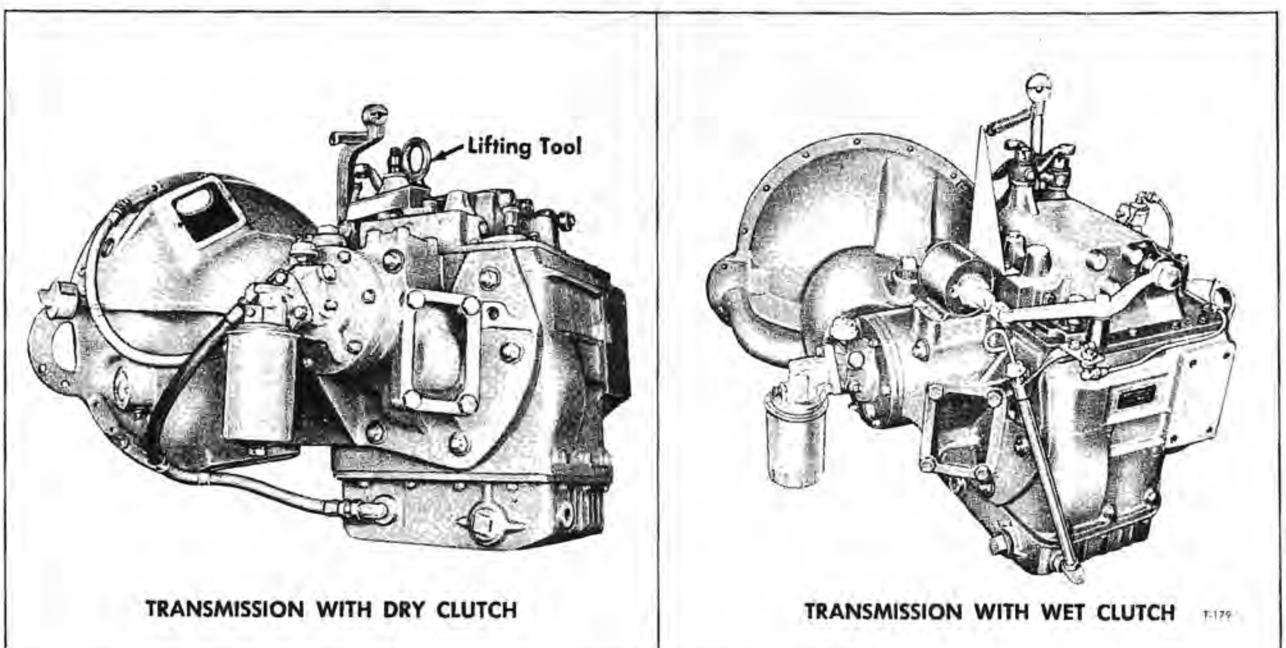


Figure 1—Mechanical Transmissions

(42) is installed in bearing cap (34) and is held in place by sleeve (2, fig. 2).

Mainshaft 3rd and 4th speed clutch gear (80) is mounted on splined portion of mainshaft and held in place with mainshaft gear retaining nut (17) and lock (81). First and 2nd speed clutch gear is integral with mainshaft.

Mainshaft 1st (21), 2nd (19), and 3rd (18) speed constant mesh gears are each mounted on double row needle bearings. Rows of bearings are separated by spacers.

Oil tube (13) in drive gear (15) supplies lubricant to drilled passage in mainshaft from which lubricant is distributed to bearings and to speedometer gears. Sliding clutch (27) is shifted to provide 1st and second speeds, and sliding clutch (79) is shifted to provide 3rd and 4th speeds. Figure 13 shows view of gears in transmission case.

COUNTERSHAFT AND GEARS

Countershaft (52) is supported at rear by single row ball bearing (50) held on shaft with two lock nuts (45 and 51) and nut lock (54). Front end of shaft is supported on countershaft front roller bearing (78) which is prevented from coming out of case by clutch housing (82). Inner race of roller bearing (78) is held on shaft by countershaft nut (77) and retaining washer (76).

Countershaft drive gear (68) and countershaft 3rd speed gear (66) are keyed to shaft and separated by spacer (70). Countershaft 2nd speed gear (72) and countershaft clutch gear are integral with shaft.

Countershaft 1st speed gear (49) is not keyed to shaft, but is carried on bronze bushing (47) and is driven by countershaft sliding clutch (48) carried on countershaft clutch gear. Countershaft sliding clutch is operated by reverse shift fork and is engaged in all forward speeds.

REVERSE IDLER GEAR

Reverse idler driving and driven gears (60 and 64) are mounted on roller bearings, with two rows of bearings in each gear separated by spacers.

Reverse idler gears are separate, revolving independently of each other in all forward speeds. Reverse idler drive gear is in constant mesh with countershaft 2nd speed gear (72) and reverse idler driven gear (60) is in constant mesh with mainshaft 1st speed gear (21). Reverse idler sliding clutch (62) is carried on hub of reverse idler driving gear, and engages both gears during reverse operation (fig. 15). Thrust washers (59 and 65) are installed between respective gears and adjacent portion of transmission case.

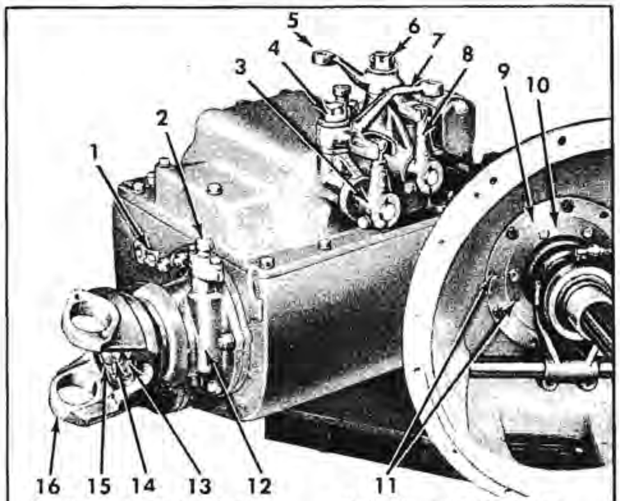
DRIVE GEAR AND BEARINGS

Drive gear (15) is supported at transmission case by roller bearing assembly (12). Bearing is held in place by retainer (10) which is bolted to transmission case. Seal (11) prevents leakage between retainer and clutch housing (82). Tapered roller bearings are used at outer end of drive gear. Outer bearings are adjustable, and shims (4) are used to provide proper contact between bevel pinion gear and bevel drive gear (83) keyed to shaft which is integral with drive gear (15). Oil tube (88) carries oil supplied by pump (fig. 3) to lubrication passage in drive gear. Passage is shown by dotted lines. Bearing cap assembly (1) incorporates a lubrication pressure relief valve and is machined for mounting lubricating oil filter assembly (fig. 3).

BEVEL GEARS AND BEARINGS

Key numbers in text refer to figure 12 unless otherwise indicated.

Bevel drive gear (12) is installed on front end of drive gear (21). Keys (7) in drive gear shaft are engaged with keyway in gear. Bevel drive gear (12) is driven by drive pinion (1). At clutch housing (27) drive pinion (1) is mounted on opposed tapered roller bearings which are installed in retainer (3). Spacer (5) and shims provide means for adjusting the bearing preload. Nut (35) holds bearings in



1 Reverse Idler Shaft Lock
2 Speedometer Drive Sleeve
3 1st, 2nd, and Reverse Outer Finger
4 Nut, Washer, and Cotter Pin
5 3rd and 4th Shift Lever
6 Nut, Washer, and Cotter Pin
7 1st, 2nd, and Reverse Lever
8 3rd and 4th Outer Finger
9 Bearing Retainer
10 Pinion Bearing Cap
11 Puller Screw Hole
12 Mainshaft Bearing Cap
13 Washer
14 Cotter Pin
15 Mainshaft Nut
16 Propeller Shaft Yoke

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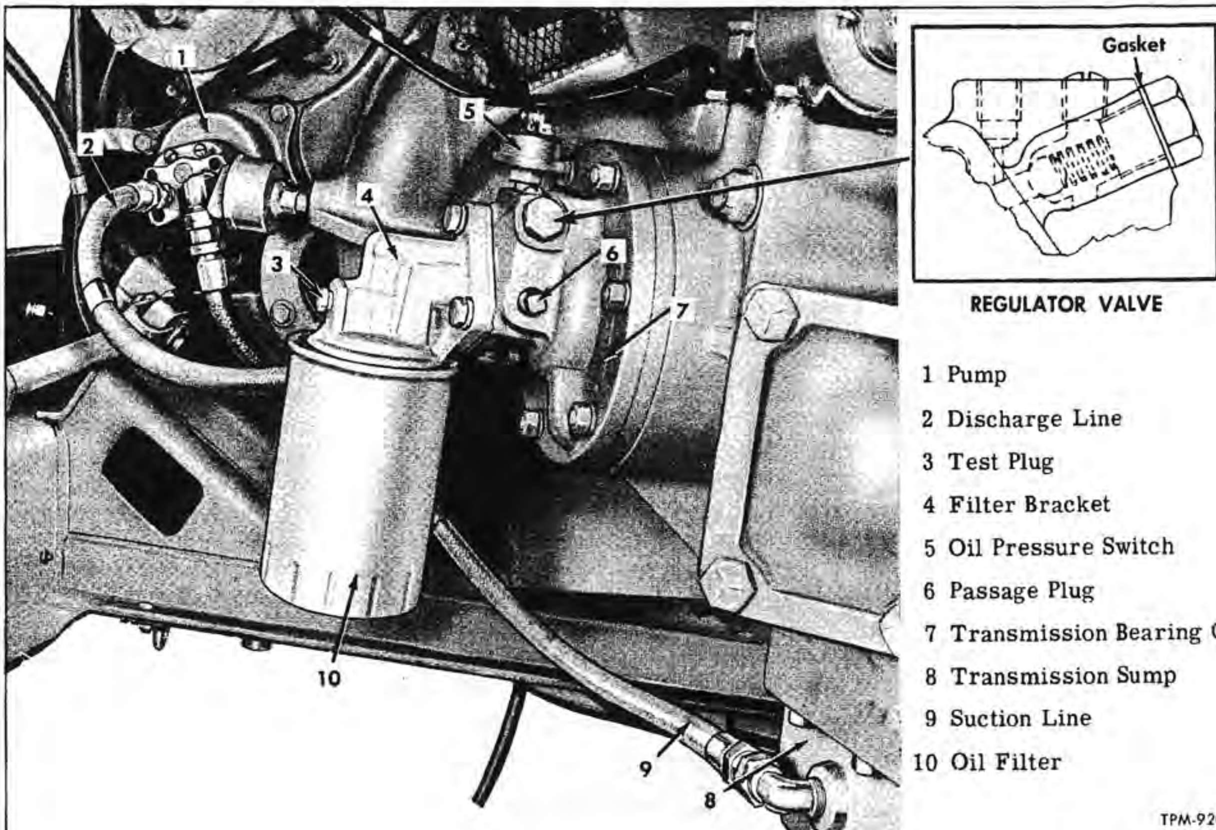
Figure 2—Transmission Showing Shift Levers and Propeller Shaft Yoke



1 Pump
2 Discharge Line
3 Test Plug
4 Filter Bracket
5 Oil Pressure Switch
6 Passage Plug
7 Transmission Bearing Cap
8 Transmission Sump
9 Suction Line
10 Oil Filter

TPM-9209

Figure 3—Transmission Oil Filter Lines and Pump

place on drive pinion. Oil tube (26) pressed into housing (27) carries lubricant to drilled passage in drive pinion to lubricate drive pinion bearings. Shims (16 and 32) are used to adjust gear backlash and gear tooth contact.

Refer to applicable sub-section in CLUTCH (SEC. 5) for method of support at front end of drive pinion.

COVER, SHIFT LEVERS, AND FORKS

Key numbers refer to figure 16 unless otherwise indicated.

External levers and fingers at transmission cover (fig. 2) are operated by transmission gearshift lever and linkage. Inner fingers (7 and 12) engage notches in shift forks. Three shift forks (1, 10, and 13) are clamped to shift rods (15, 16, and 17). Sleeves (5 and 9) on shift rods prevent overshifting, and spring-loaded poppet balls in cover engage notches in top of shift rods to lock the rods into proper position. Interlocks prevent lock-up of transmission by preventing engagement of two gears at once.

Reverse solenoid and lever (fig. 6) move shaft (4) endwise to engage inner finger (12) with notch in fork (13) when shifting into reverse. Spring (11) returns finger (12) to notch in 1st and 2nd shift fork when shifting transmission out of reverse. A breather assembly is installed in transmission cover on coaches with wet clutch. On other vehicles the breather is located in threaded opening in oil filler plug in transmission cover.

LUBRICATION SYSTEM (Fig. 3)

Lubricant which lubricates transmission is contained in oil reservoir bolted on bottom of transmission case. The pump (fig. 3), is mounted on and driven by the engine. Oil from reservoir is drawn to pump through suction line, and is discharged through line to oil filter assembly on transmission. Located in bearing cap (7, fig. 3) is a spring-loaded pressure regulator valve which maintains pressure at switch (5, fig. 3) at low engine speed. Lubricant is directed through oil passages to lubricate transmission bearings and gears.

On coaches with 6V-71 engine and wet type clutch, the drive pinion shaft is drilled lengthwise and clutch components are lubricated by oil pumped through oil passage in drive pinion. With wet clutch, a restricted fitting is used in front (engine) end of drive pinion shaft. Lubricant drains through screen (71, fig. 12) into reservoir.

Filter element is disposable type which is screwed onto threaded nipple on filter mounting base. A by-pass valve is provided in filter base to allow oil to by-pass the filter element and continue to lubricate transmission parts if filter element becomes clogged.

A switch (5, fig. 3) mounted on transmission lights a tell-tale on instrument panel to warn driver in case transmission oil pressure drops below safe operating pressure (1-1/2 to 2-1/2 psi).

TRANSMISSION CONTROLS

Selection of transmission gear is made by conventional shifting lever. Gearshift lever is mounted in a tower attached under floor near driver's seat. Two shift rails in base of gearshift lever tower are connected with control rods which are shown in figure 4. Shift rods are connected to bellcrank levers at engine compartment bulkhead. Shift rods have adjustable clevises at forward ends. Two rods in engine compartment connect bellcrank levers to shift levers on transmission cover. Gearshift lever movement is transmitted to transmission through the rods, bellcranks and levers. Figures 5 and 6 show the construction of controls at engine compartment bulkhead.

Rods are supported in looms which pass through grommets installed in holes in brackets and bulkheads. A bellows-type seal is used at front and at rear of each shift rod loom to seal out dirt and moisture.

Reverse solenoid is mounted on transmission and connected to lever (fig. 7) which moves 1st, 2nd, and reverse shaft endwise. Solenoid is energized by a button type switch at panel at left of driver which operates relay located in electrical compartment at R.H. rear corner of coach. Relay completes circuit to the reverse solenoid. When solenoid is energized, solenoid plunger which is linked to reverse lever (8, fig. 7) pulls on reverse lever and forces shift finger shaft endwise to disengage inner finger from notch in 1st and 2nd fork and engage finger with reverse shift fork. This action can take place only when gearshift lever is in the 1st speed position. See figure 4 for shift diagram.

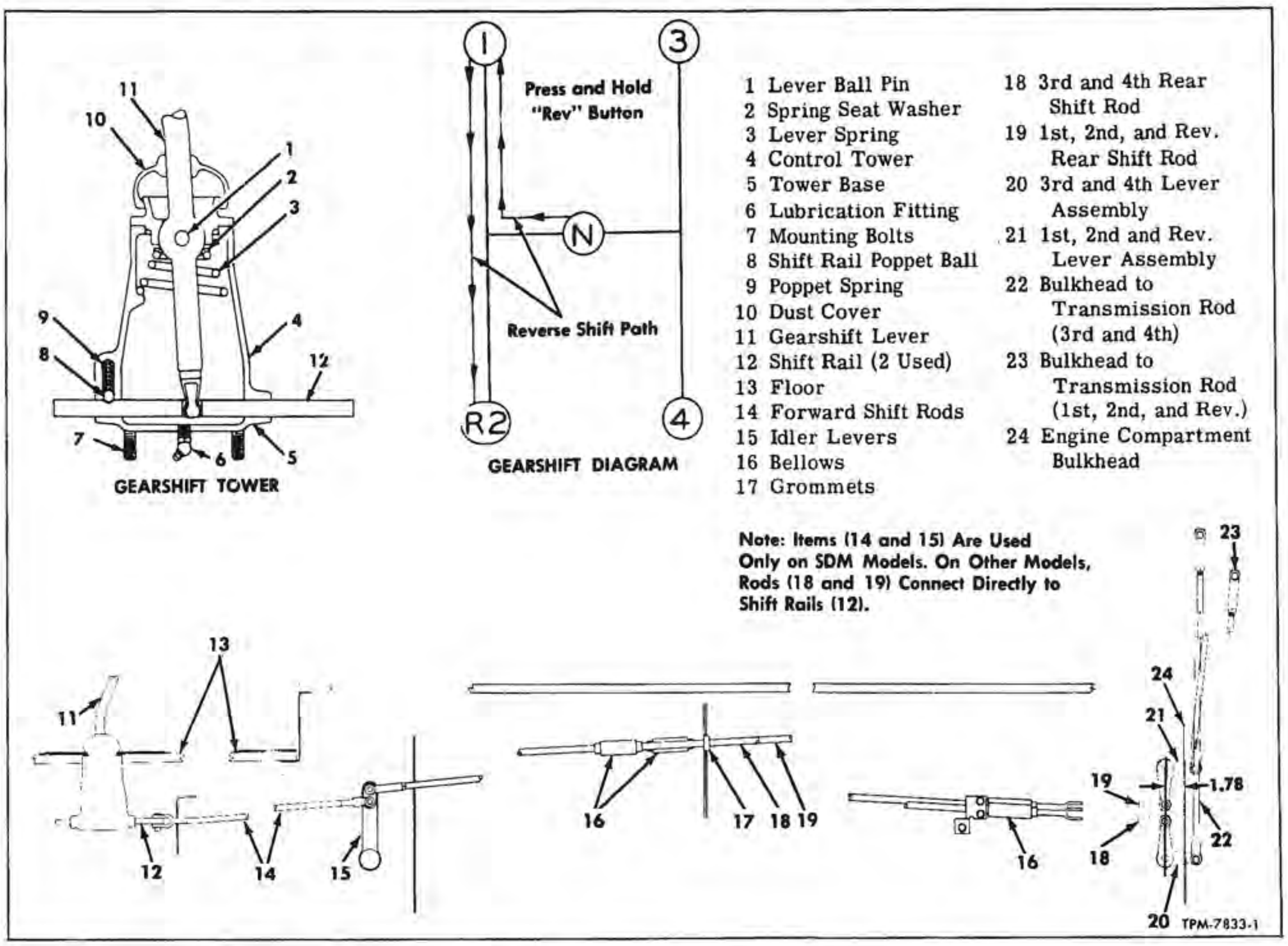


Figure 4—Transmission Controls

TRANSMISSION AND CONTROL MAINTENANCE

CONTROL ROD ADJUSTMENT

Key numbers in text refer to figure 4, except as otherwise indicated.

Provisions are made for adjustment of rear control rod length by use of adjustable yokes. When replacing transmission or any of the control linkage, before attempting to operate vehicle, be sure linkage is adjusted as follows:

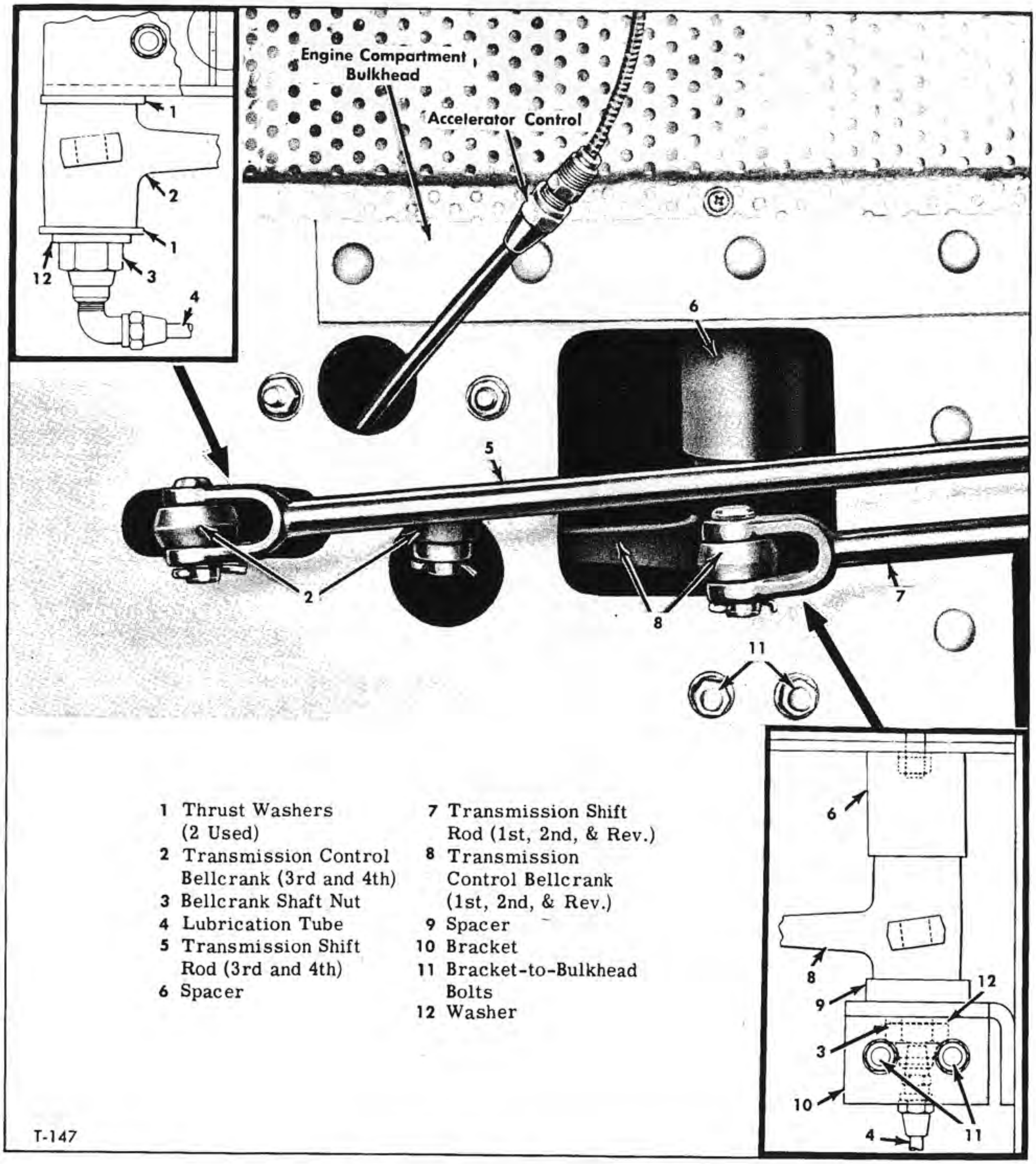
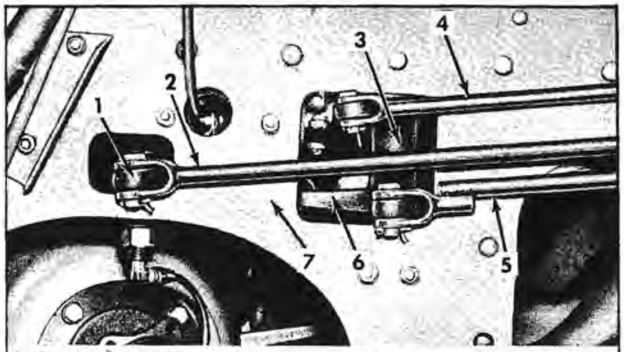


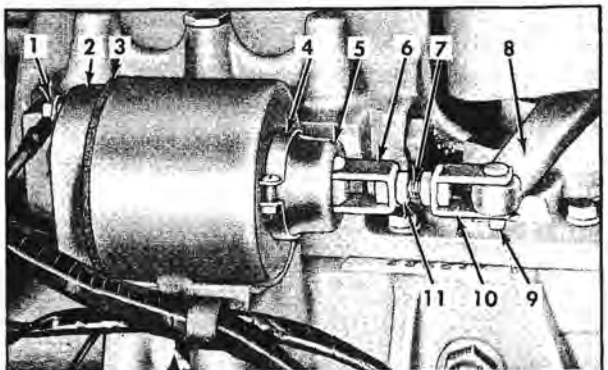
Figure 5—Control Mechanism at Engine Compartment Bulkhead (Vehicles with 8-V 71 Engine)



1 Transmission Control Bellcrank (3rd & 4th)
2 Transmission Shift Rod (3rd & 4th)
3 Clutch Control Bellcrank
4 Clutch Control Rod
5 Transmission Control Rod
6 Transmission Control Bellcrank
7 Engine Compartment Bulkhead

T-180

Figure 6—Levers and Rods at Compartment Bulkhead (w/6V 71 Engine)



1 Terminal
2 Cover
3 Felt Gasket
4 Clamp
5 Dust Shield
6 Link Assembly
7 Bolt
8 Reverse Lever
9 Clevis Pin
10 Clevis
11 Lock Nut

TPM 7782

Figure 7—Typical Reverse Solenoid and Linkage

1. Place gearshift lever in neutral position and disconnect rods from levers on transmission (fig. 2).

2. With clevises at ends of shift rods (18 and 19) connected at both ends, observe position of bellcrank lever assemblies (20 and 21) at engine compartment bulkhead. Center of clevis pins must be in line with each other and centered on a line through the two shaft assemblies. This line is 1.78 inches from bulkhead as shown in figure 4. If necessary, adjust clevises at front end of rods (18 and 19) to bring about the condition described above. Tighten lock nuts at clevises when adjustment is completed.

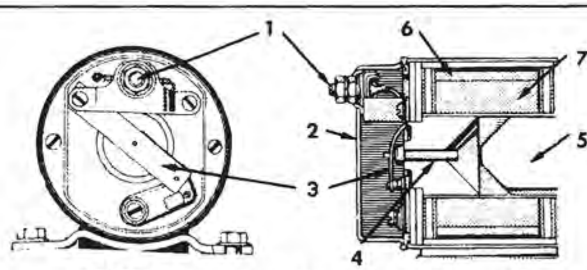
3. With transmission levers (5 and 7, fig. 2) in neutral position, adjust clevises on bellcrank-to-transmission rods (22 and 23) so clevis pins can be installed without moving gearshift lever or transmission shift levers out of neutral position.

4. With engine running, try shifting transmission into each gear. If there is evidence of binding or other difficulty in shifting, make necessary corrections.

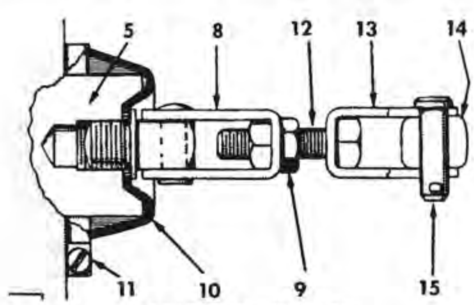
CONTROL LUBRICATION

1. Fittings are provided for lubricating gearshift control tower, transmission linkage idler levers (when used), and bellcrank levers. Refer to LUBRICATION (SEC. 13) in this manual for lubrication instructions.

2. Pivot points in linkage must be oiled periodically to keep them in free working condition.



SECTIONAL VIEWS OF REVERSE SOLENOID



SOLENOID LINKAGE

1 Wire Terminal
2 Cover
3 Contact Points
4 Pin
5 Plunger
6 Holding Coil
7 Pulling Coil
8 Link Assembly
9 Lock Nut
10 Dust Shield
11 Clamp
12 Adjusting Bolt
13 Clevis
14 Lever
15 Clevis Pin

TP 2938

Figure 8—Reverse Solenoid Views Showing Adjustment Points

CONTROL TOWER REPLACEMENT

Gearshift lever, mounted in control tower below floor at right of driver, can be removed and disassembled as described below. Mounting bolts and clevis pins are accessible below vehicle. Refer to figure 4 for layout of control rods.

Removal

1. Remove clevis pins attaching shift rods to shift rails in shift tower.

2. Remove parts attaching gearshift tower to mounting brackets and remove tower assembly from below vehicle.

3. If necessary to disassemble gearshift lever tower, the cap may be removed from top of tower to permit removal of lever, and the four bolts may be removed at bottom of the assembly to permit removal of shift rails and poppets.

Installation

1. Assemble gearshift lever tower components referring to sectional view in figure 4 for construction. Mounting bolts are installed from upper side of tower and are threaded into base.

2. Place gearshift tower in position at support bracket. Install attaching parts and tighten bolts firmly. Connect shift rods to shift rails on gearshift tower assembly.

3. Lubricate the assembly through fitting in bottom of tower base.

BULKHEAD LEVER REPLACEMENT
(VEHICLES WITH 8V-71 ENGINE)

Key numbers in text refer to figure 5.

When replacing transmission bell crank levers at bulkhead, lubrication tubes (4) must be disconnected. Shafts and levers can be removed after removing bracket bolts, lock nuts (3) and washers (12). Thrust washers (1) must be used above and below bell crank lever (2) when assembling. Long spacer (6) is used above bell crank lever (8) and short spacer (9) is used between bell crank and bracket (10).

BULKHEAD LEVER REPLACEMENT
(VEHICLES WITH 6V-71 ENGINE)

Key numbers in text refer to figure 6.

Levers and rods at engine compartment bulkhead which operate clutch and transmission are shown in figure 6. Transmission control bell crank (6) and clutch control bell crank (3) are installed on same shaft with a thrust washer above and below clutch control bell crank (3), and a spacer below transmission control bell crank (6).

When replacing bell cranks, the lubrication tubes and shaft nuts (8) must be removed as well as shaft bracket bolts.

When assembling clutch control and transmission control bell cranks on shaft, use shims as necessary to limit total end play in parts to 0.010 to 0.020 inch.

The transmission 1st, 2nd, and reverse control rod (5) must be installed with offset toward bulkhead (7) as shown. If rod is installed otherwise there will be interference at engine.

REVERSE SOLENOID AND
LINKAGE ADJUSTMENT

Whenever the reverse solenoid has been removed or if difficulty is experienced when shifting transmission into reverse speed, the following procedure will properly adjust the solenoid linkage:

1. Be sure transmission control linkage is properly adjusted.

2. Place gearshift lever in 1st speed position.

3. Disconnect wire from terminal and remove cover from solenoid. Inspect contact points. If points are burned or pitted, replace points or dress with a fine cut point file.

4. Try operating lever (8, fig. 7) while observing contact points (3, fig. 8). As lever pushes plunger (5, fig. 8) inward, plunger must contact pin (4, fig. 8) and open points when plunger reaches end of stroke. When current is supplied to solenoid both coils (6 and 7, fig. 8) are energized and cause magnetic pull on plunger; but when points open, the circuit through pulling coil (7) is broken and only the holding coil (6, fig. 8) remains energized. Damage to coils may occur if points do not open at end of plunger stroke.

5. If necessary to make an adjustment, refer to figure 7 and loosen lock nut (11), remove clevis pin (9) and turn clevis (10) while holding link assembly (6). Install clevis pin and tighten lock nut, then recheck action as directed in Step 4 above.

6. Finally, start engine and check operation of the transmission controls.

LUBRICATION SYSTEM MAINTENANCE

OIL FILTER ELEMENT REPLACEMENT

Key numbers in text refer to figure 3.

The oil filter assembly is mounted at base by three bolts threaded into transmission bearing cap. The element is disposable type which threads onto a nipple on filter base.

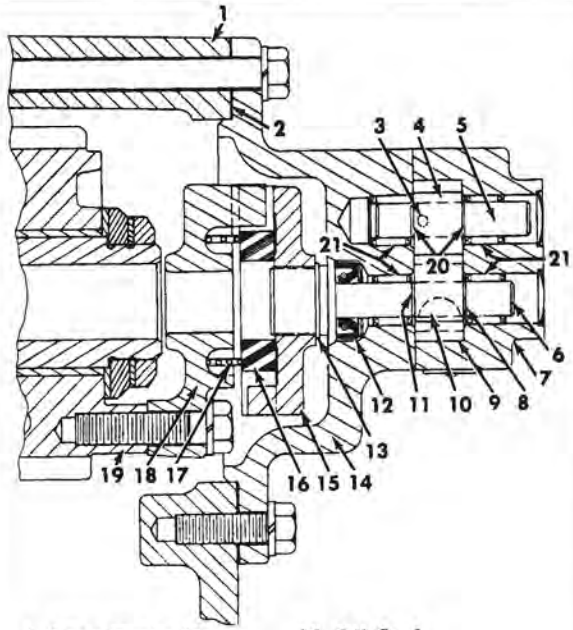
At intervals specified in LUBRICATION (SEC. 13) in this maintenance manual replace filter element as follows:

1. Use a wrench on the "hex"-shaped lower end of element and turn the element cartridge counterclockwise and remove from base.

2. Wipe filter base with clean cloth and check base mounting bolts to see that they are tight.

3. Oil the mating rubber surface on new filter cartridge gasket, then screw cartridge onto base. Torque to 10-15 foot-pounds. Do not overtighten.

4. Start engine and after running several min-



1 Gear Train Cover	12 Oil Seal
2 Gasket	13 Snap Ring
3 Gear Pin	14 Pump Body
4 Driven Gear	15 Driven Hub
5 Driven Gear Shaft	16 Coupling
6 Drive Gear Shaft	17 Coupling Spring
7 Pump Body Cover	18 Drive Hub
8 Snap Ring - Outer	19 Accessory Drive Gear
9 Drive Gear	20 Snap Rings
10 Gear Key	21 Bearing Assemblies
11 Snap Ring - Inner	TPM-8647-1

Figure 9—Oil Pump and Coupling

utes, check oil level on dipstick. Add oil as required to fill transmission to "OIL LEVEL" mark on dipstick.

Inspect filter for evidence of leakage.

LOW OIL PRESSURE SWITCH

To determine if low oil pressure switch (14, fig. 10) is functioning properly, turn on driver's master switch to either "Day" or "Nite" position. With engine stopped, the "TRANS. OIL" tell-tale should be illuminated. When engine is running, the tell-tale should not be illuminated.

If the tell-tale does not illuminate with engine stopped, connect a jumper wire between the switch terminals. If tell-tale does not light with jumper in place, the wiring or tell-tale bulb is defective. Refer to ELECTRICAL SYSTEM (SEC. 7) in this Maintenance Manual, for required information and replace bulb or make necessary repairs.

If tell-tale does light with jumper wire connected across switch terminals, the switch is defective and must be replaced.

To determine if a switch is functioning properly, connect switch in series with battery and light bulb, and connect switch to a hydraulic pressure port equipped with a gauge and means for varying the pressure.

With no pressure applied, the bulb should light. As pressure rises the bulb should "go out" at 1 to 2 psi.

Replace switch in case of malfunction.

TRANSMISSION OIL PUMP AND LINES

CHECKING PUMP PRESSURE AND CAPACITY

Fluid pump is gear type, mounted at rear of engine, and driven by coupling from accessory drive gear (fig. 9).

To check pump pressure, remove test plug (3, fig. 3) and connect pressure gauge. Start engine and operate at 2000 rpm. Note gauge reading which should be 20 to 60 psi if oil is cold, or 10 to 20 psi if oil is warm.

To check pump capacity, disconnect line (2, fig. 3) from fitting at oil filter, then start engine and run at 400 rpm. Oil from disconnected line should fill a one-quart measure in 10 to 12 seconds if pump is in satisfactory condition.

If tests indicate that pump is not functioning properly, remove, and overhaul or replace pump assembly.

PUMP REMOVAL (Fig. 3)

1. Disconnect suction and discharge lines (9 and 2). If there is oil in reservoir on transmission, tie the end of suction line up above oil level to prevent oil from draining out while line is disconnected.

2. Remove six bolts and lock washers attaching pump assembly to gear train cover, then remove pump assembly and discard gasket.

3. Remove driven hub, coupling spring, and coupling. If necessary to remove drive hub (18, fig. 9) remove bolts and lock washers which hold drive hub to accessory drive gear.

PUMP DISASSEMBLY

Key numbers in text refer to figure 9.

1. Remove eight machine screws which hold two parts of pump body together. Tap with soft hammer to separate the cover (7) from body (14).

2. Remove idler gear and shaft assembly.

3. Remove outer snap ring (8) from drive gear shaft (6), then remove drive gear (9) and key (10). Remove inner snap ring (11) and pull drive gear shaft (6) out of body.

4. If inspection indicates that bearings, gears or oil seal requires replacement, further disassembly is possible. Removal of snap rings (20) and pin (3) permits removal of gear (4) from shaft (5). If bearing assemblies (21) require replacement, they may be removed from cover (7) and

body (14) and new bearing assemblies can be pressed into place.

CLEANING AND INSPECTION

1. Clean all pump components thoroughly, using cleaning solvent. Be sure that bearings are clean.

2. Inspect shafts at areas contacted by bearings and oil seal for evidence of wear.

3. Inspect pump gears for wear, nicks, or other damage that would render these parts unfit for further service.

4. Inspect both halves of pump body for evidence of wear at points contacted by gears.

PUMP ASSEMBLY

Key numbers in text refer to figure 9.

During assembly operations apply engine oil freely to all parts to prevent rusting and provide initial lubrication.

1. Install oil seal (12) with seal lip toward mounting flange.

2. Press bearing assemblies (21) into place in body and cover.

3. Insert drive gear shaft (6) through oil seal (12) using care to avoid damage to seal. Install inner snap ring (11) and gear key (10) in shaft (6), then install gear and retain with outer snap ring (8).

4. If driven gear (4) has been removed from shaft, install gear and retain with pin (3) and snap rings (20).

5. Set driven gear and shaft assembly in place with short end in bearing in body (14).

6. Apply lead sealer on contact surfaces, then place body cover assembly at body and install eight machine screws. Tighten screws alternately and firmly to seat cover firmly at body.

PUMP INSTALLATION (Fig. 3)

1. Install driven hub on pump shaft splines.

2. Install gasket to pump body.

3. Install coupling spring in drive hub, then install coupling.

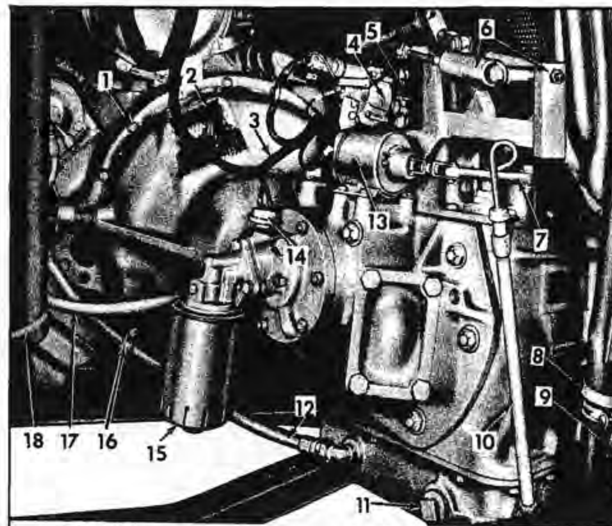
4. Position pump assembly to gear train cover, using care that coupling mates with drive hub and driven hub. Refer to figure 9.

5. Secure pump with cap screws and lock washers.

6. Connect suction and discharge lines (2 and 9) at locations shown. If suction line (9) has been removed, clip line at clutch housing. Check oil level in transmission, start engine and inspect pump and lines for leaks.

TRANSMISSION REPLACEMENT

NOTE: Coach should be placed on run-up blocks approximately 5 inches high. Access to transmission is gained by opening engine compartment doors and removing rear bumper extension. Dust pans - one below transmission and one below propeller shaft - must also be removed.



1 Flywheel Housing Bolts and Washers	9 Ground Straps
2 Cover (Screen)	10 Dipstick Tube
3 Wiring Harness	11 Drain Plug
4 Speedometer Sending Unit	12 Suction Line
5 Transmission Shift Levers	13 Reverse Shift Solenoid
6 Clutch Release Mechanism	14 Oil Pressure Switch
7 Reverse Lever	15 Transmission Oil Filter
8 Drain Hose Clip	16 Line Clip
	17 Oil Supply Line
	18 Engine Oil Filter

Figure 10—Transmission Installed

Since some of the operations required prior to removing transmissions depend on whether coach is equipped with 6- or 8-cylinder engine, the procedure for each type is covered separately below:

PRELIMINARY OPERATIONS

Vehicles With 6V-71 Engine (Wet Clutch)

1. Remove drain plug from flywheel housing and drain out oil.

2. Unhook clutch lever return spring and remove spring anchor bracket from transmission cover. Refer to figure 1.

3. Remove lock nut and clutch adjusting nut from clutch release rod.

Vehicles With 8V-71 Engines (Dry Clutch)

Key numbers in text refer to figure 10.

1. Remove clutch lever spring, then remove clevis bolt which attaches clutch release rod yoke to clutch release mechanism (6).

2. Remove yoke from clutch release rod, then

remove adjusting handle from clutch release rod.

3. Referring to CLUTCH (SEC. 5) in this manual for information pertaining to clutch release mechanism, remove the mechanism (6) including bracket as an assembly.

REMOVING TRANSMISSION (Fig. 10)

NOTE: The following instructions are applicable to all coaches unless otherwise indicated.

1. Disconnect propeller shaft at transmission referring to PROPELLER SHAFT (SEC. 18) in this manual for necessary information. Also disconnect speedometer drive from transmission. If electric speedometer is used, disconnect wiring and remove sending unit from transmission.

2. Remove ground strap bolts from transmission case.

3. Disconnect transmission shift rods from levers at transmission cover. Remove 3rd and 4th shift lever from stud in cover. Removal of lever provides clearance for swinging transmission during removal. Tie or wire clutch release lever to transmission to prevent its falling toward engine during transmission removal.

4. Remove reverse solenoid shift lever from transmission.

5. Disconnect wiring from oil pressure switch and reverse solenoid.

6. Drain oil out of transmission and remove oil dipstick tube and elbow.

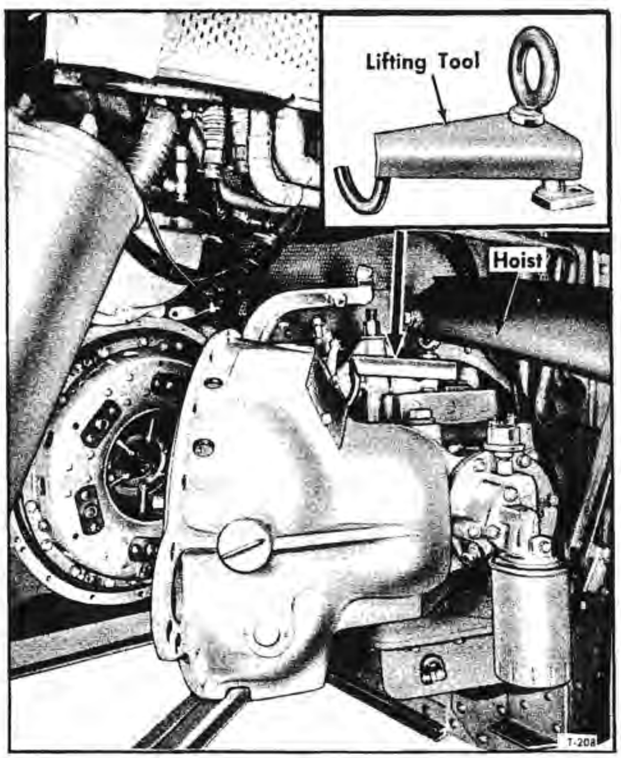


Figure 11—Replacing Transmission

7. Disconnect fluid lines at pump on engine. Tie lines up to transmission.

SAFETY CAUTION

Before proceeding with step below, block coach body securely. When attaching hoist to take weight of transmission, the coach body may be inadvertantly raised just enough to cause height control valve to exhaust, in which case entire weight of rear end of coach will be placed on hoist.

8. Attach lifting tool (fig. 11) to transmission, and attach hoist to lifting eye. Remove clutch and flywheel housing bolts and washers (1), then lift transmission assembly and move straight away from engine until splines are disengaged. Turn the transmission as shown in figure 11 and remove from engine compartment.

9. On transmission with wet clutch, remove gasket used between clutch housing and flywheel housing.

INSTALLING TRANSMISSION (Fig. 11)

NOTE: Before installing transmission, condition of clutch parts should be carefully checked. Refer to CLUTCH (SEC. 5) for instructions in regard to inspection of clutch parts and setting of release levers (dry clutch only).

1. On transmission used with wet clutch, place new gasket at clutch housing flange. Use light coat of cement to hold gasket in place.

2. With clutch release parts assembled in clutch housing, lift transmission with hoist and lifting tool as shown in figure 11. Move transmission into engine compartment and guide splined shaft into position in line with clutch members, also enter clutch release rod through hole at upper end of release lever.

3. Carefully guide splined shaft through clutch members, and align bolt holes in clutch housing with corresponding holes in flywheel housing. Install bolts and washers from flywheel housing side using three long bolts and tubular spacers at original locations. Install balance of bolts and washers from clutch housing side of bolting flange.

4. Remove lifting tool and install transmission shift lever on stud at transmission cover.

5. Connect propeller shaft at yoke on transmission output shaft. Refer to PROPELLER SHAFT (SEC. 18) for information on construction and assembly procedure. Install bolts to attach ground straps to transmission case.

6. Connect fluid lines from transmission sump and from oil filter bracket to pump. Refer to figure 3.

7. Install dip stick tube elbow and tube as shown in figure 10. Connect speedometer drive at transmission. If electric sending unit is used, mount sending unit on transmission.

8. Install reverse shift lever and connect lever to solenoid link.

9. Connect shift rods to respective levers. Check transmission control linkage and adjust if necessary referring to "Control Rod Adjustment" covered previously in this section.

10. Connect electrical wiring at oil pressure switch, reverse solenoid, and electric speedometer sending unit (if used). Check the operation of reverse solenoid and adjust solenoid linkage if required, referring to "Reverse Solenoid and Linkage Adjustment" previously covered in this section.

11. Fill transmission with oil to level mark on dipstick. Refer to LUBRICATION (SEC. 13) of this manual, for correct type of lubricating oil to use and also for lubricant capacity of each type of transmission.

INSTALLING CLUTCH RELEASE MECHANISM (VEHICLES WITH DRY CLUTCH)

1. Install clutch release mechanism referring to CLUTCH (SEC. 5) for necessary information pertaining to mounting bolts.

2. Install adjusting handle on clutch release rod, then install lock nut and short clevis on release rod. Connect clevis to rod end bearing with bolt and nut. Tighten clevis bolt nut to 40 foot-pounds torque.

3. Refer to CLUTCH (SEC. 5) and check linkage adjustments as directed under "Control Linkage and Units in Engine Compartment" in sub-section covering "Dry Type Clutch."

4. Install cover (screen) identified as item (2) in figure 10.

INSTALLING CLUTCH LEVER SPRING AND BRACKET (VEHICLES WITH WET CLUTCH)

1. Install adjusting nut and lock nut on clutch release rod. Adjust clutch release linkage, referring to pertinent instructions in CLUTCH (SEC. 5) in sub-section covering "Wet Type Clutch" of this manual.

2. Install clutch lever return spring anchor bracket on transmission cover, and hook up lever return spring.

NOTE: Before starting engine be sure drain plug in engine flywheel housing is in place and firmly tightened.

AFTER-INSTALLATION INSPECTIONS

1. Start engine and inspect all connections and plugs for oil leaks.

2. Try operating transmission in each speed to check transmission shifting mechanism.

3. Check operation of clutch controls. Refer to CLUTCH (SEC. 5) of this manual, for instructions covering clutch adjustments.

NOTE: After operating transmission, recheck oil level on dipstick and fill to level mark if necessary. Install dust pans and bumper extension when inspections have been completed.

TRANSMISSION OVERHAUL

REMOVING REVERSE SOLENOID AND TRANSMISSION COVER

1. Remove bolts which attach reverse solenoid and bracket.

2. On vehicles with electric speedometer, remove sending unit and drive cable assembly.

NOTE: On some transmission the above operations may have been done in removing transmission from coach.

3. Remove bolts which attach cover assembly (6) to transmission case, then remove the cover assembly including shift levers and forks.

4. Remove cover gasket.

REMOVING CLUTCH HOUSING AND BEVEL DRIVE GEARS

Key numbers in text refer to figure 12 unless otherwise indicated.

1. Remove oil filter assembly (23) from mounting pad on bearing cap assembly (25).

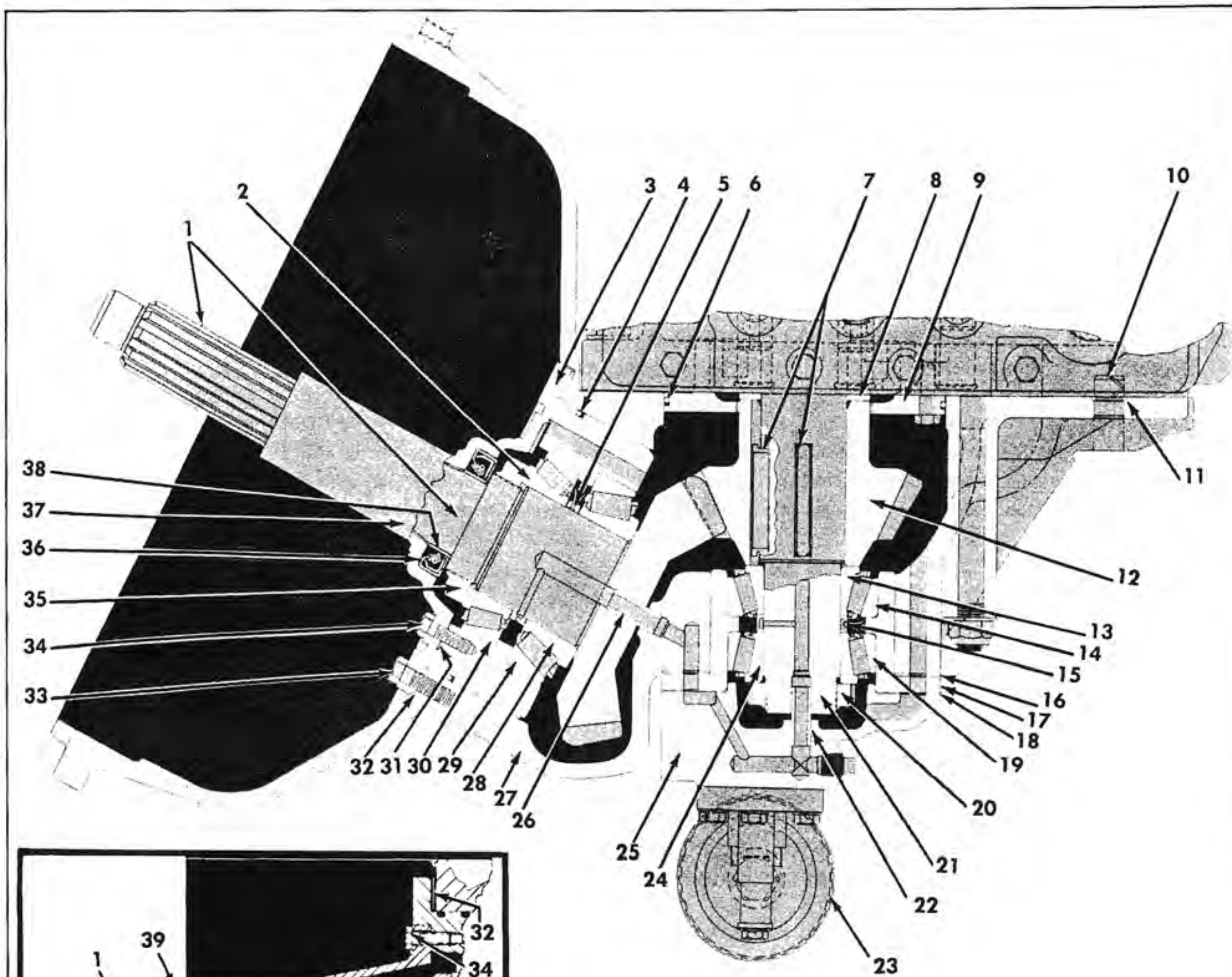
2. Remove stud nuts and washers attaching bearing cap (25). Remove bearing cap assembly and gasket (18).

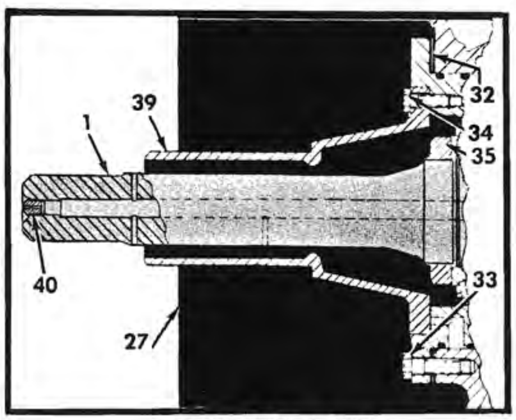
3. Referring to figure 13 shift the sliding clutches to lock mainshaft so it cannot be turned, then remove bearing retaining nut (20) from drive gear (21).

4. Using puller screws in tapped holes in flange on bearing retainer (17) pull retainer and bearing assembly (24) out of clutch housing (27). Remove and tag shims (16) so same shims can be installed at assembly.

5. Remove stud nuts and washers which hold clutch housing in place on transmission case (two of the nuts are at transmission case flange), then with lead hammer, jar clutch housing loose and remove from studs. Remove retainer seal (6) from groove in retainer (9), and remove clutch housing gasket.

TRANSMISSION (MECH.)





CONSTRUCTION WITH
WET TYPE CLUTCH

1 Drive Pinion
2 Outer Bearing Assembly
3 Bearing Retainer
4 O-Ring Seal
5 Bearing Spacer
6 Retainer Seal
7 Keys
8 Gear Spacer
9 Drive Gear Bearing Retainer
10 Dowel Pin
11 Dowel Pin Snap Ring
12 Bevel Drive Gear
13 Inner Bearing Assembly
14 Inner Bearing Cup
15 Bearing Spacer
16 Shims and Gaskets (See Text)
17 Bearing Retainer
18 Gasket
19 Outer Bearing Cup
20 Bearing Retaining Nut
21 Drive Gear
22 Oil Tube
23 Oil Filter Assembly
24 Outer Bearing Assembly
25 Bearing Cap Assembly
26 Oil Tube
27 Clutch Housing Assembly
28 Inner Bearing Assembly
29 Inner Bearing Cup
30 Outer Bearing Cup
31 Gasket
32 Shims
33 Bearing Retainer Bolt
34 Bearing Cap Bolt
35 Bearing Retaining Nut
36 Oil Seal
37 Bearing Cap (with Dry Clutch)
38 Oil Seal Sleeve
39 Bearing Cap (with Wet Clutch)
40 Restriction Fitting T-209

Figure 12—Cross Section at Transmission Bevel Gears

6. Remove bearing spacer (15) and any shims which may be present. Tie spacer and shims (if used) together for use at assembly. Remove inner bearing assembly (13).

7. Remove bevel drive gear (12) from drive gear (21), pry keys (7) out of slots in shaft, and remove spacer (8).

REMOVING OIL RESERVOIR

1. Remove stud nuts and washers which attach oil reservoir to transmission case. Remove reservoir and gasket.

2. Remove screws which hold screen to reservoir and remove screen.

REMOVING REVERSE IDLER GEAR

1. Remove reverse idler gear shaft lock (1, fig. 2) at rear of transmission case.

2. Use puller in tapped hole in reverse idler gear shaft and pull shaft out of transmission case. Referring to figure 13 remove reverse gears, thrust washers and bearings.

REMOVING MAINSHAFT ASSEMBLY AND DRIVE GEAR

Key numbers in text refer to figure 14.

1. With sliding clutches shifted to lock transmission and prevent shafts from turning, remove nut (39) and washer (38) which retain yoke assembly (41) on mainshaft (36). Remove yoke assembly from mainshaft splines.

2. Remove stud nuts and washers which retain rear bearing cap (34), then remove bearing cap and gasket (33). Also remove countershaft bearing cap (53).

3. Remove cotter pin at countershaft nut (77), then remove nut (77). Bend lock (54) away from nuts (45 and 51) at rear end of countershaft. Remove these nuts.

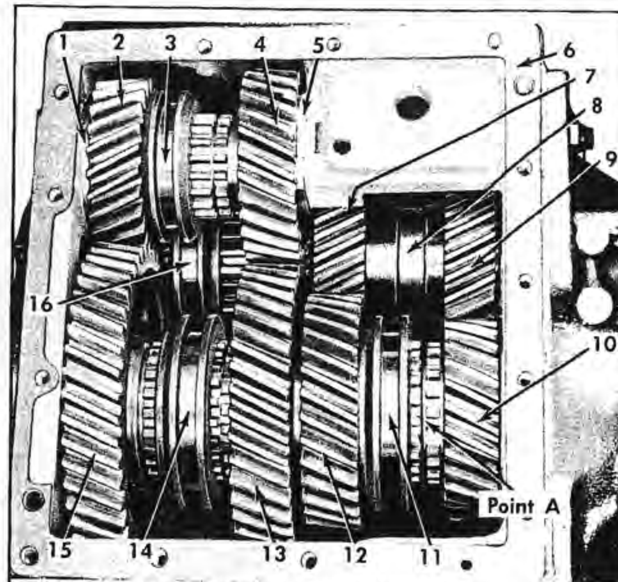
The operations described in step 3 are not required in order to remove mainshaft and gears, but should be performed while both shafts are locked to facilitate loosening the countershaft nuts if countershaft is to be removed and disassembled.

CAUTION: To avoid damage to countershaft rear bearing when removing nuts (51 and 45), use a short socket or partially fill cavity in deep socket with suitable spacer to prevent socket from contacting bearing cage.

4. At front of transmission remove bolts which attach bearing retainer (10), then use two 3/8-16 bolts in puller screw holes in retainer flange to pull retainer (10), bearing (12) and drive gear (15) out of transmission case. Remove mainshaft pilot bearing (14) from mainshaft.

5. Remove speedometer drive gear (31), then remove key (40) from mainshaft.

6. Use two 7/16-14 bolts in puller screw holes in flange on bearing retainer (44), to pull retainer and bearing (43) out of case. Remove retainer and bearing assembly from rear end of mainshaft, then tie mainshaft gears to hold them in place and lift the mainshaft and gear assembly out of transmission case.



1 Rear Thrust Washer
2 Reverse Idler Driven Gear
3 Reverse Idler Sliding Clutch
4 Reverse Idler Drive Gear
5 Front Thrust Washer
6 Cover Gasket
7 Countershaft 3rd Speed Gear
8 Gear Spacer
9 Countershaft Drive Gear
10 Drive Gear
11 3rd and 4th Speed Sliding Clutch
12 Mainshaft 3rd Speed Gear
13 Mainshaft 2nd Speed Gear
14 1st and 2nd Speed Sliding Gear
15 Mainshaft 1st Speed Gear
16 Countershaft Sliding Clutch

TPM 8503

Figure 13—Transmission with Cover Removed

REMOVING COUNTERSHAFT ASSEMBLY

1. With nuts (45 and 51) removed from rear end of countershaft (see step 3 in preceding operation) assemble puller to rear bearing retainer (55). Use two 7/16-14 bolts to attach puller to retainer. Tighten puller screw against rear end of countershaft to pull retainer out of case (69) and at the same time remove rear bearing (50) from countershaft.

2. Use arbor press to remove bearing (50) from retainer (55).

3. Remove countershaft 1st speed gear (49) and thrust washer (46) from rear end of countershaft, move countershaft assembly rearward, then raise front end of countershaft and remove the assembly from the transmission case.

TRANSMISSION (MECH.)

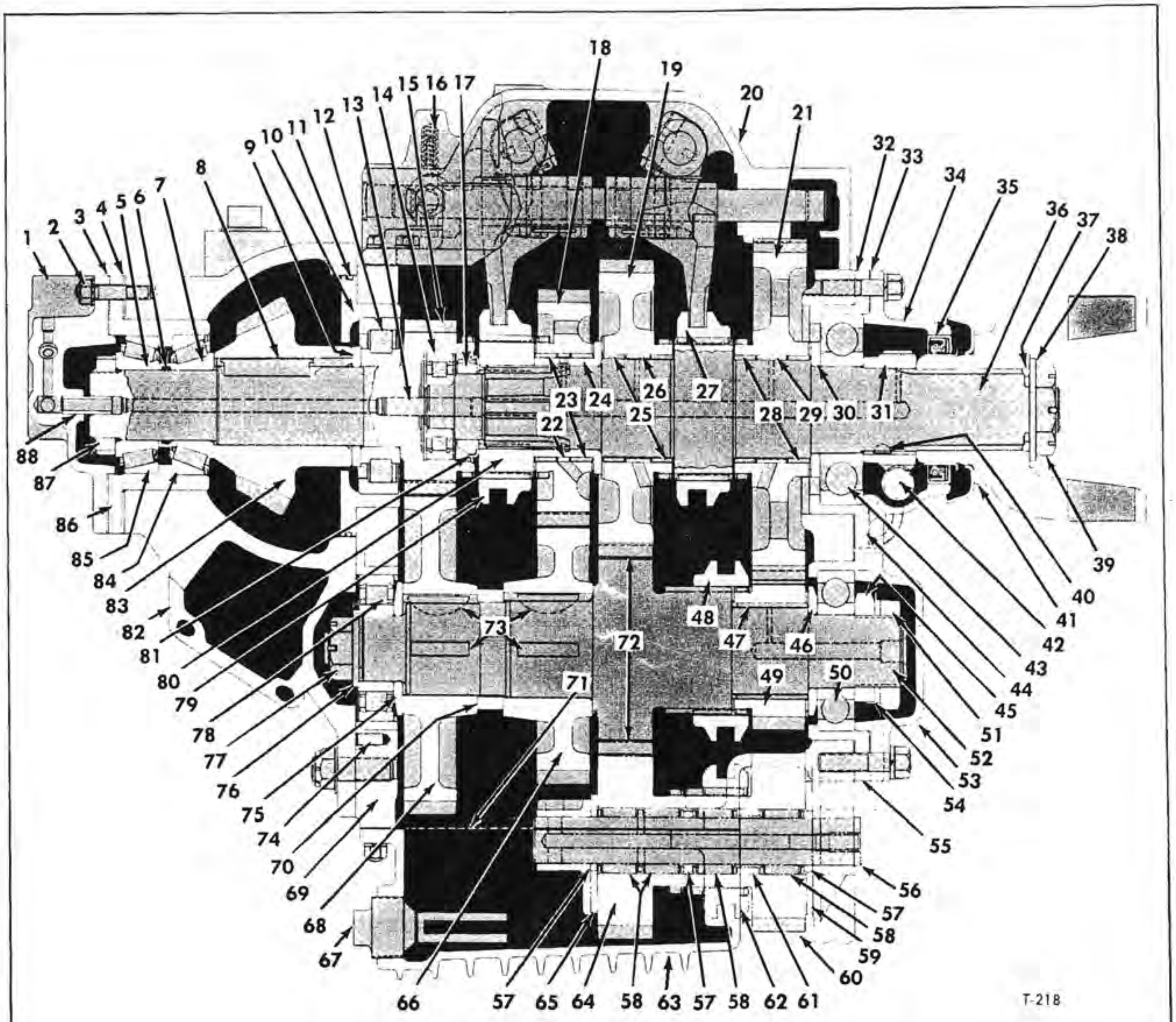


Figure 14—Cross Section of Transmission Assembly

DISASSEMBLY OF SUBASSEMBLIES

Key numbers in text refer to figure 14 unless otherwise indicated.

MAINSHAFT DISASSEMBLY

1. Untie gears and remove first speed gear (21) bearings (28) and spacers (29), first and second speed sliding clutch (27) and third and fourth speed clutch (79).

2. Raise tangs on lock (81) and remove nut (16) from end of mainshaft (36).

3. Remove clutch gear (80), then remove 3rd speed gear (18), bearings (23) and spacer (22). Remove thrust collar (24) from mainshaft, then remove 2nd speed gear (19), bearings (25) and spacer.

COUNTERSHAFT DISASSEMBLY

1. Remove low speed gear sliding clutch (48).

2. With front bearing nut (77) and washer (76) removed, remove front bearing inner race, and retaining washer (75). Bearing and outer race need not be removed unless bearing is to be replaced. In that event, use a suitable tool to remove bearing from retainer in transmission case.

4. Drive gear (68), and gear (66) may be pressed off countershaft separately. Keys (73) at front of countershaft must be removed before spacer (70) and gear (66) can be removed.

BEVEL GEAR AND BEARING DISASSEMBLY

Key numbers in text refer to figure 12 unless otherwise indicated.

1. If clutch release bearing and operating

1 Bearing Cap Assembly
2 Stud Nut & Toothed Washer
3 Gasket
4 Shims (See Text)
5 Outer Bearing Assembly
6 Bearing Spacer
7 Inner Bearing Assembly
8 Key
9 Gear Spacer
10 Drive Gear Bearing Retainer
11 Retainer Seal
12 Drive Gear Rear Bearing
13 Oil Tube
14 Mainshaft Pilot Bearing
15 Drive Gear
16 Shift Shaft Poppet
17 Mainshaft Nut
18 3rd Speed Gear
19 2nd Speed Gear
20 Transmission Cover
21 1st Speed Gear
22 Bearing Spacer
23 3rd Speed Gear Bearings
24 3rd and 4th Speed Gear Thrust Collar
25 2nd Speed Gear Bearings
26 Bearing Spacer
27 Sliding Clutch
28 1st Speed Gear Bearings
29 Bearing Spacer
30 Thrust Washer
31 Speedometer Drive Gear
32 Retainer Gasket
33 Cap Gasket
34 Rear Bearing Cap
35 Oil Seal
36 Mainshaft
37 Seal
38 Washer
39 Yoke Nut
40 Key
41 Yoke Assembly
42 Speedometer Driven Gear
43 Mainshaft Rear Bearing
44 Bearing Retainer
45 Inner Lock Nut
46 Thrust Washer
47 Bushing
48 Countershaft Sliding Clutch
49 Countershaft 1st Speed Gear
50 Countershaft Rear Bearing
51 Outer Nut
52 Countershaft
53 Bearing Cap
54 Nut Lock
55 Bearing Retainer
56 Reverse Idler Shaft
57 Bearing Spacer (Short)
58 Roller Bearing Assembly
59 Thrust Washer
60 Reverse Idler Driven Gear
61 Bearing Spacer (Long)
62 Reverse Idler Sliding Clutch
63 Transmission Oil Reservoir
64 Reverse Idler Gear
65 Thrust Washer
66 Countershaft 3rd Speed Gear
67 Drain Plug
68 Countershaft Drive Gear
69 Transmission Case
70 Spacer
71 Screen
72 2nd Speed Gear Teeth (Integral with Countershaft)
73 Gear Keys
74 Dowel Pin
75 Gear Retaining Washer
76 Bearing Retaining Washer
77 Countershaft Nut
78 Countershaft Front Bearing
79 3rd and 4th Speed Sliding Clutch
80 Mainshaft Clutch Gear
81 Lock
82 Clutch Housing
83 Bevel Drive Gear
84 Inner Bearing Cup
85 Outer Bearing Cup
86 Bearing Retainer
87 Bearing Retaining Nut
88 Oil Tube

Captions For Figures 14 and 15

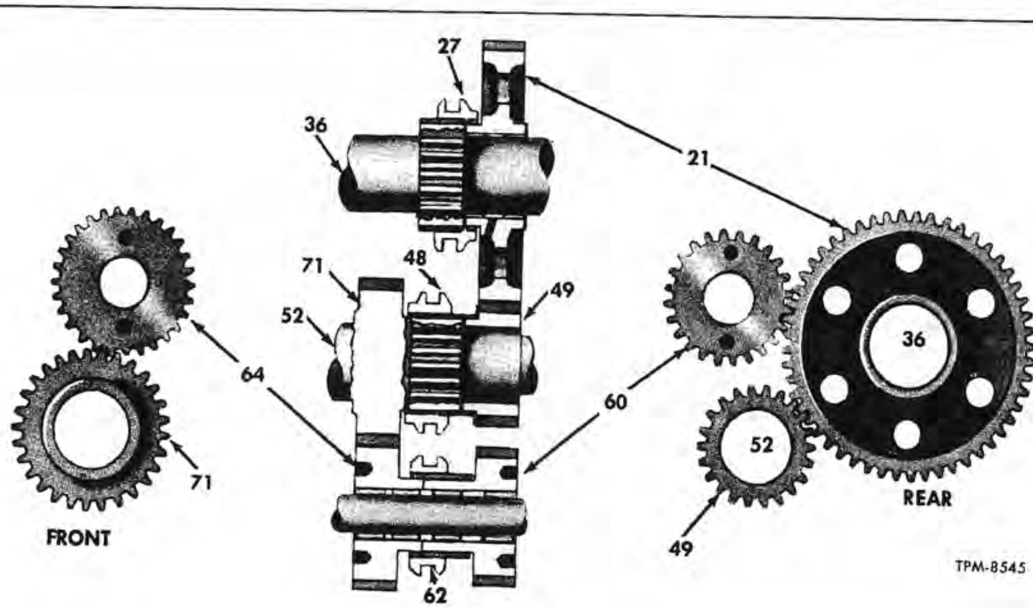


Figure 15—Position of Gears For Reverse Operation

parts are in clutch housing, refer to CLUTCH (SEC. 5) for instructions and remove clutch parts.

2. Remove bearing cap bolts (34), then use two puller screws in tapped holes (11, fig. 2) and remove bearing cap (37).

3. On transmissions with dry clutch, remove oil seal (36) assembly from bearing cap (37).

4. Remove bearing retainer bolts (33), then using puller screws in tapped holes in retainer flange, force the bearing retainer (3) out of clutch housing. Drive pinion (1) and bearings will come out with the retainer. Remove O-ring seal (4) from groove in retainer (3). Tag shims (32) so original pack may be used when reassembling.

5. Drive flat wedge under front edge of nut to raise staked portion of nut (35) out of slots in drive pinion (1), then remove bearing retaining nut. Use arbor press and press on front end of drive pinion (1) to remove pinion and inner bearing assembly (28) from retainer (3). Remove outer bearing assembly (2) from retainer and remove bearing spacer (5) and shims (when used) from pinion shaft. Tie spacer and shims together for use when assembling. Use suitable drift through holes in pinion gear to drive inner bearing assembly (28) off pinion shaft, when it is necessary to replace inner bearing assembly. Bearing cups (29 and 30) can be removed from retainer (3) if worn or damaged.

TRANSMISSION COVER AND SHIFT MECHANISM DISASSEMBLY

Key numbers in text refer to figure 16 unless otherwise indicated.

1. Referring to figure 2, remove levers from transmission cover. Outer fingers (3 and 8) are held to respective shafts by clamp bolt and lock washer and are located by Woodruff keys.

2. Move all shift forks to neutral position and remove lock wires used to secure bolts (18).

3. Remove clamp bolts which hold 3rd and 4th shift fork (10) on rod (17). Drive rod (17) forward through fork and force hole plug out of cover. Remove rod (17), sleeve (5), and fork (10). Hold hand over hole in cover boss below poppet and catch poppet ball, plunger and spring as rod is removed from cover.

4. Remove two clamp bolts holding fork (1) on shift rod (16), then drive rod (16) forward out through cover in same manner as described in step 3 above. Use care not to lose poppet parts.

5. Remove two clamp bolts holding reverse shift fork (13) to shift rod (15). Drive rod (15) forward and remove in same manner as previously described for removing rods (16 and 17). Remove threaded plug from side of cover, then remove two shift rod interlocks.

6. At outer side of cover, remove reverse lever collar from shift finger shaft (4). Remove clamp bolt from 1st, 2nd, and reverse inner finger (12), move finger to expose Woodruff key, and remove key. Pull shaft (4) out of cover and remove washer, spring (11) and inner finger (12) from inside cover.

7. Remove clamp bolt from inner finger (7), move finger to expose Woodruff key and remove key. Remove shift finger shaft from cover, and remove inner finger (7) and washer (8) from inside cover. If finger shaft oil seals require replacement, drive old seals out of transmission cover.

CLEANING AND INSPECTION

Clean all parts carefully in suitable cleaning fluid and blow dry with compressed air.

All bearings should be cleaned thoroughly. After bearing assemblies have been soaked in cleaning fluid, tap them sharply on a block of wood to dislodge any solid particles. Slush them again in cleaning fluid and blow dry with air. Do not spin the bearings with the air - revolve them slowly in races with fingers as air is directed at right angles to the balls or rollers. Examine races and bearings for pits and scores, then oil each assembly thoroughly with clean engine oil.

Individual needle bearing rollers which were removed from main shaft gears should be thoroughly washed and inspected. Replace those bearing rollers which show signs of scores or pits. (There are 138 rollers to each gear.)

Examine teeth on all gears carefully for nicks and worn spots. Do not take chances with gears which are appreciably nicked or scored. Small nicks may be carefully removed with a "slipstone" or hone.

Inspect wear sleeve on propeller shaft yoke and sleeve on drive pinion which are contacted by oil seal lips. If sleeves are worn, replace with new parts.

Clean interior of main case and covers thoroughly. Remove magnetic drain plug and clean all particles of metal from magnet and remove all dirt from screen. Blow out all oil passages with compressed air.

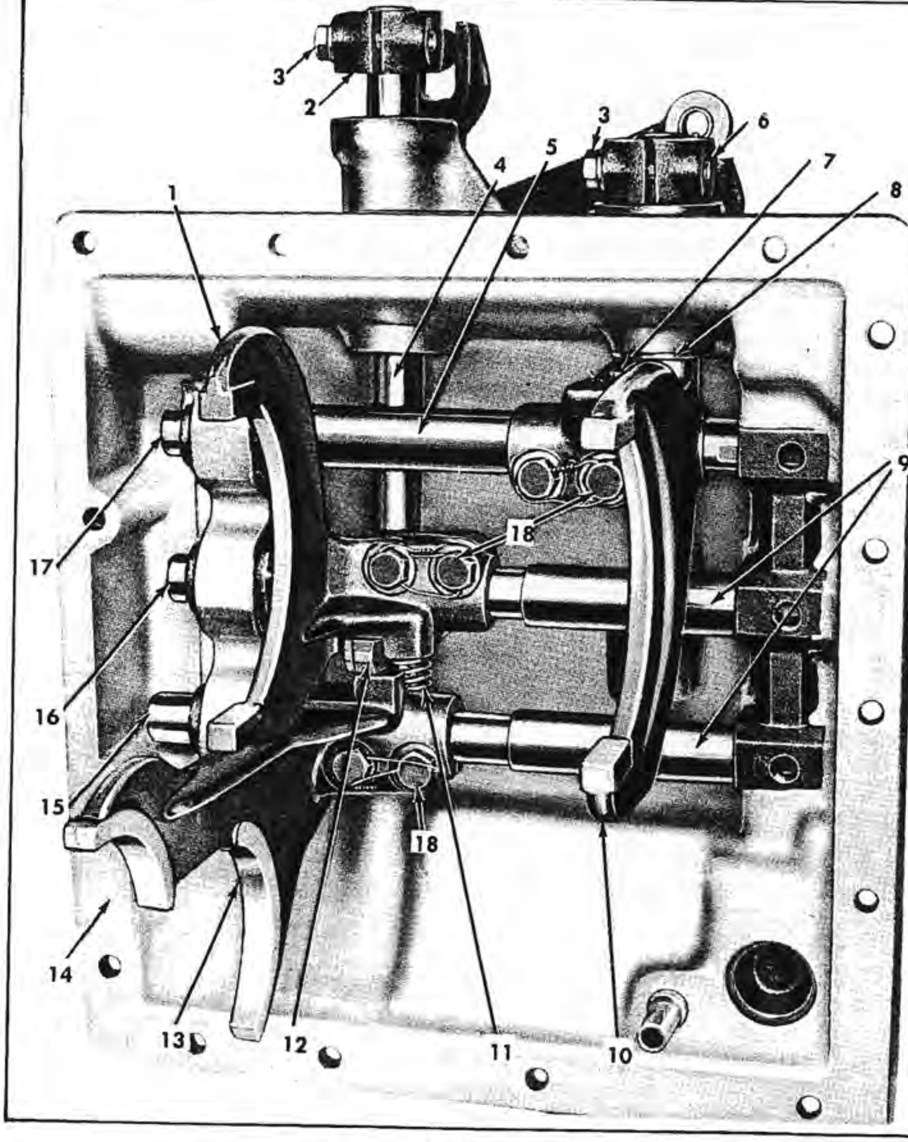
Inspect faces on shift forks which contact respective sliding clutches. If forks or sliding clutches are worn or scored replace parts as necessary.

ASSEMBLY OF SUBASSEMBLIES

Key numbers in text refer to figure 14 except as otherwise indicated.

COUNTERSHAFT ASSEMBLY (Fig. 14)

1. Press third speed countershaft gear (66) onto shaft with long hub of gear toward front. Make certain that both keys (73) are in position and keyways are free from burrs.



1 1st and 2nd Shift Fork
2 Shaft Outer Finger
3 Clamp Bolt
4 1st, 2nd and Reverse Shift Finger Shaft
5 Shift Rod Stop Sleeve
6 Outer Finger
7 Inner Finger
8 Shaft Washer
9 Shift Rod Stop Sleeves
10 3rd and 4th Shift Fork
11 Shift Shaft Spring
12 1st, 2nd and Reverse Inner Finger
13 Reverse Shift Fork
14 Cover
15 Reverse Shift Rod
16 1st and 2nd Shift Rod
17 3rd and 4th Shift Rod
18 Fork Bolts

Figure 16—Transmission Cover with Forks and Shifting Mechanism

2. Place spacer (70) and keys (73) in position and press drive gear (68) onto shaft with long hub of gear toward rear.

3. Install drive gear retaining washer (75) with recessed edge toward bearing (78).

4. Install front bearing inner race, retaining washer (76) and nut (77). Tighten nut to 300 to 350 foot-pounds and install cotter pin.

5. Install front bearing (78) in case if it has been removed.

6. Install sliding clutch (48) over countershaft clutch gear with long hub toward front. Do not install first speed gear (49) at this time.

MAINSHAFT AND DRIVE GEAR ASSEMBLY (Fig. 14)

1. Place mainshaft (36) in vise with rear end of shaft down (vise should be equipped with "soft" jaws).

2. Make sure second speed gear (19) is clean, especially on inside diameter, then apply a coat of heavy gear oil. Place gear over mainshaft with gear clutch teeth toward rear.

3. Install 69 roller bearings (25) in hub of gear. Install bearing spacer (26) and push bearings and spacer in position. Then install another row of roller bearings.

4. Install third speed gear thrust collar (24) with oil hole indexed with oil hole in shaft. Install third speed gear (18) and bearings (23) in same manner as second speed gear, except that gear clutch teeth are toward front.

5. Install third and fourth speed clutch gear (80) over splines of mainshaft with chamfered end

of splines toward rear. Install sliding clutch (79) over gear (80) with extended edge of gear toward rear.

6. Install lock (81) and retaining nut (16) and tighten nut firmly. Bend lock over flat of nut (16). Install pilot bearing (14) on mainshaft pilot.

7. Position mainshaft with rear end upward, then install sliding clutch (27) with extended edge toward rear (upper) end of mainshaft. Place 1st speed gear (21) on mainshaft with clutch teeth toward sliding clutch (27). Install 1st speed gear bearings (28) and bearing spacer (29) in same manner as described previously for installing second and third speed gears (18 and 19).

8. Coat inner face of thrust washer (30) with grease and place in position. Grease will prevent washer from sliding out of place when assembly is lowered into case and in that manner prevent bearings from falling out when shaft is tilted for installation. It is also a good practice to temporarily wire gears (18, 19, and 21) together to hold them in place while installing shaft assembly.

9. Press outer race of bearing (12) into drive gear bearing retainer (10) and press inner race and roller assembly onto drive gear (15). Install gear spacer (9), and drive gear key (8) into slot in shaft.

NOTE: Assembly and adjustment of inner and outer tapered bearings (7 and 5) is accomplished during transmission build-up and is covered later in this section under "Assembly of Transmission."

DRIVE PINION AND BEARINGS ASSEMBLY

Key numbers in text refer to figure 12.

1. Press inner bearing assembly (28) into place on pinion (1).

2. Install cups (29 and 30) in bearing retainer (3) if cups have been removed.

3. If original retainer and bearings are being used, install bearing spacer (5) and shims which were removed at disassembly. If new bearings and/or retainer are being installed, select service spacer (5) (0.395" thick, #2419741) and service shims to provide a total thickness of 0.439 inches. Shims are furnished in following thicknesses: .003", .005", .010", and .020". Set pinion on bench with splines upward and lower the retainer (3) over pinion shaft (1) and into position at inner bearing (28). Position outer bearing (2) at pinion shaft and drive or press bearing into contact with spacer (5).

4. Install bearing retaining nut (35) and tighten to 500 foot-pounds torque; then measure endwise movement of pinion with respect to bearings. Make note of endwise movement and remove bearing nut, outer bearing assembly, spacer and shims.

5. Determine correct shim pack to use as follows:

Add 0.001 inch to the end play noted in step 4 above, then subtract this sum from the 0.439 inch dimension specified in step 3 above. The result is the correct total thickness for shims and spacer to provide proper bearing pre-load.

6. Select the combination of shims and spacer (5) to give total thickness specified above, and reassemble spacer, shims, outer bearing (2), and nut (35). Tighten nut to 500 foot-pounds.

7. Preload on pinion bearings should be 5 to 15 inch-pounds when bearing nut is tightened. Preload may be determined without a special torque measuring devise by using a spring scale on a string wrapped around the stem end of pinion. The force required on string to rotate pinion is from 5.5 to 17 pounds for proper pre-load.

If pull required to rotate pinion is not 5.5 to 17 pounds, the shim pack must be changed as necessary to provide correct pre-load. A change of 0.001 inch in shim pack will change the torque required to rotate pinion shaft by 7 inch-pounds.

8. When bearing adjustment is completed, stake the bearing retaining nut at slots in pinion to lock the nut.

9. On transmission used with dry clutch, coat outer circumference of new bearing cap oil seal with sealer, then install seal in counterbore in cap with seal lip pointing toward transmission side of cap as shown in figure 12.

ASSEMBLING TRANSMISSION COVER COMPONENTS

Key numbers in text refer to figure 16 unless otherwise specified.

1. Install 1st, 2nd, and reverse shift finger shaft (4), in cover, assembling flat washer, spring (11) and inner finter (12) as shaft is installed. Install finger key in shaft, then locate finger so clamp bolt will engage notch in shaft, and install clamp bolt in finger (12). Secure clamp bolt with lock wire. If shaft oil seals - one at each side of transmission cover - have been removed, drive new seals into place in cover with seal lips pointing inward. Install outer lever (2) on outer end of shaft (4) using Woodruff key and clamp bolt (3) with lock washer.

2. Install 3rd and 4th shift finger shaft in cover, assembling washer (8) and inner finger (7) on shaft as it is moved into place. Install Woodruff key in slot, locate inner finger (7) on shaft, and install clamp bolt. Secure clamp bolt with lock wire. Install shaft oil seal at outer side of cover if seal has been removed, then install outer finger (6) on outer end of shaft using key and clamp bolt (3) with lock washer.

3. Position cover assembly up-side-down, then drop 3rd and 4th shift rod poppet spring, plunger, and ball through hole in shift rod boss. Hold poppet ball down and insert 3rd and 4th shift rod (17) through hole in front of cover. When end of shift rod is through front support, hold shift fork (10)

in cover and push shift rod through fork. Assemble stop sleeve (5) on rod, and move rod into position in cover. Notches in shift rod must be aligned with clamp bolt holes in fork (10) and inner finger (7) must engage notch in shift rod lug. Install two clamp bolts (18), tighten bolts firmly and secure with lock wire.

4. Place one interlock in hole between rods (16 and 17). Install spring, plunger, and poppet ball in center poppet hole, then install 1st and 2nd shift rod (16), stop sleeve (9), and shift fork (1) in position shown in figure 16. Inner finger (12) must engage notch in lug on fork (1). Install and tighten two fork clamp bolts (18) and secure with lock wire.

5. Place one interlock between rods (15 and 16) and move rods (16 and 17) to neutral position (poppet ball engaging center notch), then install spring, plunger, and poppet ball in poppet hole at reverse shift rod. Install reverse shift rod (15) assembling stop sleeve (9) and shift fork (13) on rod as it is moved into place. Install and tighten two clamp bolts (18) and secure with lock wire.

6. Install three shift rod hole plugs at front of cover and install threaded hole plug at side of cover.

7. Referring to figure 2 install shift levers on transmission cover, with lever yokes engaging outer fingers as shown.

ASSEMBLY OF TRANSMISSION

Apply transmission oil on transmission parts to provide initial lubrication and prevent rusting.

TRANSMISSION MAIN CASE BUILD-UP

Key numbers in text refer to figure 14 unless otherwise indicated.

COUNTERSHAFT INSTALLATION

1. Place countershaft and gear assembly into case, tilt front end upward and lower rear end into case, inserting rear end through rear bearing hole in case far enough to permit front end to be inserted into front bearing (78).

2. Install first speed gear (49) on countershaft by inserting gear through rear bearing hole in case.

3. Install thrust washer (46), recessed edge toward bearing (50).

4. Press rear bearing (50) into retainer (55). Place retainer gasket on studs at transmission case. Be sure retainer dowel pin is in place, then install bearing and retainer, being careful to align notch in retainer with dowel pin in case.

5. Install inner lock nut (45) and tighten to 300 to 350 foot-pounds.

6. Install nut lock (54) and outer nut (51). Tighten nut and lock both nuts by bending lips of washer over flats of nuts.

NOTE: Steps 5, and 6 above may be deferred until after mainshaft has been installed, at which time the gears can be locked to prevent shafts from turning when tightening nuts.

REVERSE IDLER GEAR INSTALLATION

Refer to figure 14 and note position and width of spacers installed, at ends and in between roller bearings. Make sure that oil passages in shaft are clean and that plug in end of shaft is in place. Install reverse idler shaft in following manner:

1. Drive shaft into case just far enough to install thrust washer (59), driven gear, bearings (58) and spacers (57 and 61).

2. As shaft is driven into case, install remaining parts. Front thrust washer fits in notch in case as shown in figure 13.

3. After shaft is driven into case, flat on outer end of shaft must be in vertical position.

4. Install lock plate at rear of transmission case to hold reverse idler shaft in position.

MAINSHAFT AND MAIN DRIVE GEAR INSTALLATION

1. Tilt front end of mainshaft and gears assembly upward and lower rear end into transmission case and out through bearing retainer hole in case.

2. Fit drive gear (15) onto pilot bearing (14) on end of mainshaft assembly, then install retainer (10) and outer race of bearing (12) over end of drive gear and start retainer bolts into transmission case. Do not tighten retainer bolts until mainshaft rear bearing and retainer (44) have been installed.

3. Place retainer gasket (32) on studs in transmission case. Press bearing assembly (43) into retainer (44) with loading slots in races toward rear. Install the bearing and retainer assembly over rear end of mainshaft. Fit rear bearing retainer (44) over studs, and force inner race of bearing (43) into contact with thrust washer (30).

4. Install key (40) in slot in mainshaft, and install speedometer drive gear (31). Check for indexing of oil hole in speedometer gear with oil hole in mainshaft.

5. With oil seal (35) installed in mainshaft rear bearing cap (34) install bearing cap using new gasket (33). Install nuts and lock washers on bearing cap and retainer studs and tighten firmly. Install speedometer driven gear (42) and sleeve.

6. Install yoke assembly (41) on mainshaft splines, install O-ring seal (37) in recess in yoke, then install washer (38) and nut (39).

7. At front of transmission case tighten drive

gear bearing retainer bolts, then shift sliding clutches to lock transmission shafts. Tighten yoke nut (39) to 500 to 550 foot-pounds. Install cotter pin to secure nut (39). If countershaft bearing nuts (45 and 51) have not been tightened, tighten inner nut (45), install lock (54). Install and tighten outer nut (51), then bend lock to prevent nuts from loosening. Also tighten countershaft nut (77).

CAUTION: There is danger of damaging countershaft rear bearing if too deep a socket is used in tightening nuts (45 and 51). If necessary install spacer in socket so edge of socket will not contact bearing (50).

8. Install countershaft rear bearing cap (53) using new bearing cap gasket. Tighten bearing cap and retainer stud nuts firmly.

9. If oil reservoir (63) is removed from transmission, attach screen (71) with three screws, then install reservoir on transmission case using a new gasket.

CLUTCH HOUSING AND ANGLE DRIVE GEAR INSTALLATION

NOTE: If it should be necessary to replace clutch housing or transmission main case, remove two dowel pins (10, fig. 12), then bolt clutch housing to transmission case. Drive gear bearing retainer (9) will serve to properly align housing with case. Drill and line ream dowel pin holes to accommodate oversize dowel pins. Separate the parts and install oversize dowel pins in transmission case. Provide counterbores in clutch housing to accommodate snap rings.

Procedure following includes instructions for installing clutch housing, bevel drive gears, and procedure for setting gears for proper tooth contact.

Key numbers in text refer to figure 12 unless otherwise indicated.

Adjusting Bevel Drive Gear Bearing Pre-Load

1. Install bevel drive gear (12) on drive gear (21).

2. Place O-ring seal (6) in groove in bearing retainer (9) and place clutch housing gasket at transmission case; then install clutch housing on studs and into contact with gasket. Install flat washers and stud nuts on clutch housing-to-transmission studs. Tighten stud nuts evenly and firmly. Stud nuts are self-locking type. Two studs are in clutch housing and nuts are installed at flange on transmission case.

3. Install inner bearing assembly (13), so bearing cone contacts solidly at gear. Place spacer (15) (0.394" thick, #2419742) and a combination of shims to provide total thickness of 0.433 inch on drive gear (21). With inner and outer bearing cups (14 and 19) in place in bearing retainer, assemble retainer to clutch housing using original shims (16) between retainer and housing. Use suitable spacers and nuts on studs to hold retainer firmly to housing.

4. Install outer bearing assembly (24) and nut (20) on drive gear (21) and tighten nut (20) to 300 to 350 foot-pounds torque.

5. Mount dial indicator on retainer stud and check amount of end play in drive gear (21).

6. Shift sliding clutches to neutral and check torque required to rotate drive gear. This can be done with spring scale and string wrapped around nut (20). This rotating torque (without bearing pre-load) must be known in order to compute the amount of pre-load after changing shims as instructed in step 8 following:

7. Remove nut (20), outer bearing assembly (24), and spacer (15) and shims.

8. Determine correct shim pack to use as follows:

Add 0.002 inch to the amount of end play found in step 5 previously; then subtract this sum from the 0.433 inch dimension specified in step 2. previously. The result is the correct total thickness of spacer and shims to use to produce required bearing pre-load of 5 to 15 inch-pounds.

9. Select the combination of shims and spacer (15) to give total thickness specified above, then reassemble spacer (15), shims, outer bearing assembly (24), and nut (20). Tighten nut to 400 foot-pounds.

10. Determine drive gear bearing pre-load using spring scale and string wrapped around nut (20). Pre-load on bearings will be total pull required above, minus the pull required to rotate drive gear (step 5). This result will be from 3.5 to 11 pounds if bearing pre-load is correct.

NOTE: The bevel pinion (1) should not be assembled to clutch housing while making the foregoing check.

If proper pre-load is not obtained, a change in spacer or shim pack thickness is necessary. Changing the shim pack 0.001 inch will result in a change of 3 inch-pounds pre-load.

11. Stake bearing retaining nut (20) when properer pre-load is obtained. After bearings are properly adjusted, proceed to install bevel pinion and bearing assembly and set up gears for correct tooth contact and backlash.

INSTALLING BEVEL PINION AND BEARING ASSEMBLY

Key numbers in text refer to figure 12.

1. Install O-ring seal (4) in groove in bearing retainer (3).

2. Locate original shims (32) at flange of retainer (3), then install bevel pinion and bearing assembly in clutch housing and install bearing retainer bolts (33). With transmission in neutral, try turning bevel pinion (1) as bolts (33) are tightened. If any binding is noted, it may be due to in-

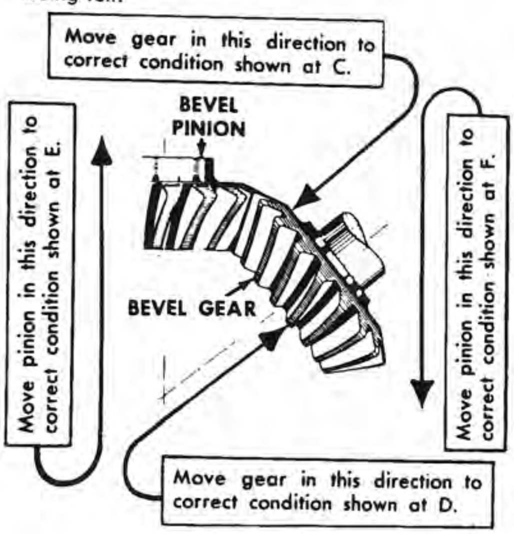
INSTRUCTIONS

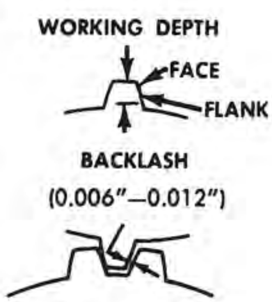
1—Install bevel pinion and bevel gear assemblies; then adjust pinion and bevel gear for proper backlash as directed in "Bevel Gear and Pinion Adjustments" paragraph of this section.

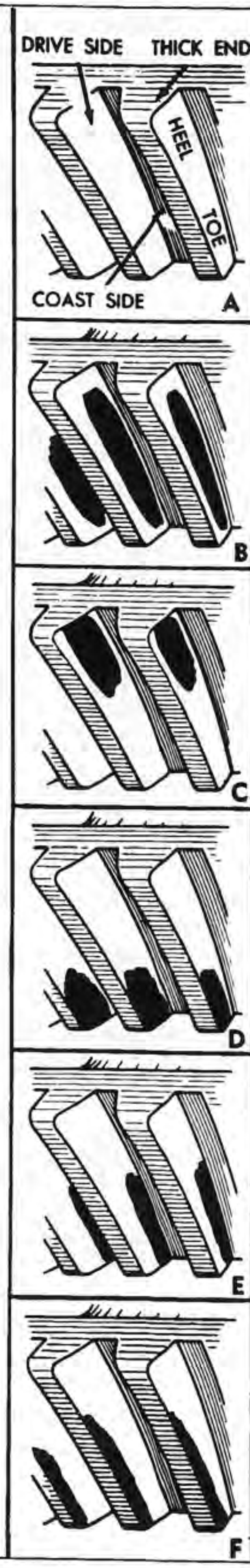
2—Paint three or four teeth of bevel gear with red lead or mechanics blue and rotate bevel gear in direction of rotation until pinion makes complete revolution.

3—Note area of tooth contact which should start at toe and extend about 80 percent of tooth length toward heel, as at B.

4—Vary position of pinion and gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that gear can be completely revolved without any highspots being felt.







A—Check tooth Contact Pattern at drive side of BEVEL GEAR tooth

B—Shows correct tooth contact

NOTE: Key Numbers Below Refer to Figure 12

C—Shows short contact at heel. To correct, increase thickness of shims (16) to move gear toward pinion. Then increase thickness of shims (32) to move pinion away from gear to again secure correct backlash.

D—Shows short contact at toe. To correct, decrease thickness of shims (16) to move gear away from pinion. Then decrease shim thickness (32) to secure correct backlash.

E—Shows heavy contact on flank or lower portion of tooth. To correct, increase thickness of shims (32) to move pinion away from gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then increase thickness of shim (16) to move gear toward pinion to secure correct backlash.

F—Shows heavy contact on face or upper portion of tooth. To correct, decrease thickness of shims (32) to move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then decrease thickness of shims (16) to move gear away from pinion to secure correct backlash.

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Figure 17—Gear Tooth Contact Chart

sufficient backlash between bevel gears (1 and 12). Backlash can be increased by adding shims (32) at retainer flange and backlash must be from 0.006 to 0.012 inch.

3. Check bevel gear backlash with dial indicator. Mount a C-clamp on bevel pinion shaft and mount dial indicator on clutch housing. Set stem of indicator at a point on clamp 2-1/8 inches from surface of pinion shaft. Note on indicator dial the amount shaft can be rotated without moving bevel gear (12).

NOTE: When necessary to change backlash, a change of 0.002 inch in shim pack will change backlash 0.001 inch.

4. Check Gear Tooth Contact. NOTE: The outside shims (gaskets) in shim pack (16, fig. 12) are aluminum. These should be replaced with new parts when assembling transmission. Remove square head filler plug at top of housing above bevel gears. Use a stiff brush and apply a thin even coat of red lead on bevel gear teeth. Rotate bevel pinion shaft in same direction as in normal operation, while applying tension at propeller shaft flange. After rotating gears to produce a clear contact impression at drive side of bevel gear teeth (fig. 17), observe contact area through filler plug hole. Use flashlight to illuminate gears.

a. Tooth contact impression should start at toe of tooth and extend back about 80% of tooth length toward heel on drive side of tooth. Contact should be distributed evenly over flank of tooth indicating center of contact below pitch line. Refer to diagrams "A" and "B" in figure 17.

b. If tooth contact is short and too far out on heel of tooth (diagram "C" fig. 17), increase thickness of shims (16) between bearing retainer (17) and housing (27), moving gear (12) toward pinion (1). Restore backlash by increasing shims (32) between bearing retainer (3) and housing (27).

CAUTION: When necessary to add shims (16) between retainer (17) and housing, it is important to measure space at point "A" (fig. 13) to determine if drive gear (21) is being pulled too far forward. If space between drive gear and clutch gear (15 and 80, fig. 14) exceeds 0.170 inch, there is danger of rollers in bearing (12, fig. 14) riding against shoulder in bearing outer race. To correct this condition a thicker spacer (9, fig. 14) must be used.

c. If tooth contact extends back from toe appreciably less than 80% of tooth length (diagram "D" fig. 17), move gear (12) away from pinion (1) by decreasing shims (16). Restore backlash by decreasing shims (32).

d. If contact is low on flank of tooth (see diagram "E" fig. 17), move pinion (1) away from gear (12) by increasing shims (32). Restore backlash by increasing shims (16).

e. If contact is high on face of tooth (diagram "F" fig. 17), move pinion (1) toward gear (12) by decreasing shims (32). Restore backlash by decreasing shims (16).

5. After tooth contact and backlash have been adjusted, install bearing cap assembly (25) using new gasket (18). Install oil filter assembly (23) using new gasket.

TRANSMISSION CONTROL
COVER INSTALLATION

1. Move the four sliding clutches (3, 11, 4 and 16, fig. 13) to neutral position and locate new cover gasket on transmission case.

2. Shift all forks in cover (fig. 16) to neutral position, then carefully lower the cover assembly into place with forks entering grooves in respective sliding clutches.

3. Install cover bolts and lock washers.

4. Mount reverse solenoid and solenoid lever as shown in figure 7, and adjust solenoid linkage as previously directed under "Maintenance."

5. On vehicles with electric type speedometer sending unit, mount sending unit on transmission and connect flexible drive shaft between adapter at transmission rear bearing cap and sending unit.

NOTE: If transmission is to be installed immediately, steps 4. and 5. above should be deferred until transmission is installed in coach. Unless the power plant and cradle are out of vehicle, there will be interference if reverse solenoid and lever are mounted on transmission.

SPECIFICATIONS

GENERAL DATA

Make	Spicer
Model	7145V
Speeds	Four Forward—One Reverse
Mounting	On Power Plant
Gear Selection	Manual, Remote Control

GEAR RATIOS

Spicer Model*	7145V	7145VA	7145VB	7145VC	7145VD
Angle Drive Gears	1.04 to 1	1.04 to 1	.808 to 1	.808 to 1	.808 to 1
First Speed	4.53 to 1	4.01 to 1	3.52 to 1	3.12 to 1	3.96 to 1
Second Speed	2.95 to 1	2.60 to 1	2.29 to 1	2.02 to 1	2.29 to 1
Third Speed	1.77 to 1	1.56 to 1	1.37 to 1	1.21 to 1	1.37 to 1
Fourth Speed	1.04 to 1	1.04 to 1	.808 to 1	.808 to 1	.808 to 1
Reverse	3.87 to 1	3.42 to 1	3.00 to 1	2.66 to 1	3.35 to 1

*Refer to name plate attached to transmission case for model number and part number.

GEAR BACKLASH

Angle Drive Gears	0.006"-0.012"
Mainshaft and Countershaft Gears	0.006"-0.011"
Sliding Clutches and Clutch Gears	0.004"-0.007"

MAINSHAFT GEAR BEARING ROLLERS

Number of rollers per gear	138
Length	0.655"-0.675"
Lapped Diameter	0.12500"-0.12525"

BEARING ADJUSTMENTS

Bevel Drive Gear Tapered Bearing
- See Instructions in Text.

BEARING SPACER THICKNESS (Service)

Bevel Pinion Bearings	0.395"
Drive Gear Bearings	0.394"

BEARING ADJUSTING SHIMS

Sizes Available (Thickness)	0.003", 0.005", 0.010" and 0.020"
Bearing Preload (Rotating Torque)	
Bevel Pinion Bearings	5 to 15 in. lbs.
Bevel Drive Gear Bearings	5 to 15 in. lbs.

BEARING RETAINER SHIMS (for Adjusting Gear tooth contact)

Sizes Available (Thickness)	
Bevel Pinion Gear Bearing Retainer	0.003", 0.005", 0.010", 0.030"
Drive Gear Outer Bearing Retainer	0.003", 0.005", 0.010", 0.030"
Average Thickness of Bearing Retainer Shim Pack	
(at Bevel Pinion)	0.066"
(at Bevel Gear)	0.066"
Necessary Space at Point "A" (Fig. 13) See text.	
Minimum	0.060"
Maximum	0.170"
Thrust Washer Thickness	
Reverse Gear	
Front	0.182"-0.187"
Rear	0.185"-0.187"
Countershaft 1st. Speed Gear	0.245"-0.249"
Mainshaft 1st. Speed Gear	0.262"-0.266"

COUNTERSHAFT 1ST SPEED GEAR BUSHING

Inside Diameter (As Serviced)	2.3460"-2.3490"
Inside Diameter (In Place)	
Grind to	2.3595"-2.3605"

TRANSMISSION OIL PUMP

Make	John S. Barnes Corp.
Type	Positive Displacement (Gears)
Capacity (At Zero psi, 400 Eng. rpm)	1 qt. in 10 to 12 sec.
Operating Pressure (Max.)	50 psi
Test Pressure	
Cold	20-60 psi
Hot	10-20 psi
Gear Length	0.6240"-0.6242"
Pump Body Counterbore	
Depth	0.6250"-0.6255"
Diameter	1.1660"-1.1667"

TRANSMISSION OIL FILTER

Make	AC
Type	Full Flow w/By-Pass Valve
Element Type	Disposable
Number	PF-7
By-Pass Valve Opens at	4.5 to 5.5 psi

TRANSMISSION OIL LOW PRESSURE SWITCH

Make	Hobbs Div. of Stewart-Warner Corp.
Circuit Opens at	1 to 2 psi
Vendor No.	MI-1822

REVERSE SOLENOID

Make	Delco-Remy Div.
Number	001535
Volts to Operate	12
Current Draw (Amps.)	
Both Windings	49.5-56.7
Hold-in Windings	9.53-10.5

1ST AND REVERSE SHIFT MECHANISM

Shift Fork to Sliding Clutch Clearance	
Mainshaft Sliding Clutches	0.005"-0.016"
Reverse Gear Sliding Clutch	0.005"-0.016"
Reverse Shift Shaft Spring	
Free Length	5 1/16"
Lbs. Pressure @ 1¾ inch	38-42

SPECIFICATIONS (CONT.)

TORQUE WRENCH SPECIFICATIONS
(Ft. Lbs.)

Companion Flange Nut	500-550
Mainshaft Nut	300-350
Countershaft Rear Nut	300-350
Countershaft Front Nut	300-350
Drive Gear Outer Bearing Nut	300-350
Bevel Pinion Bearing Nut	500
Bevel Pinion Bearing Cap Bolts	27-32
Bevel Pinion Bearing Retainer Bolts	36-39
Drive Gear Inner Bearing Retainer Bolts	36-39
Shift Lever Studs (In Cover)	240
Oil Filter Element	10-15
Stud Nuts	
Mainshaft Shaft Rear Bearing Cap	35-43
Countershaft Rear Bearing Cap	53-66
Bevel Drive Gear Bear Cap	27-32
Oil Reservoir	27-32
Clutch Housing	127
Transmission Cover	27-32

Propeller Shaft

Propeller shaft, used to transmit power from transmission to differential, is tubular type, equipped with heavy duty needle bearing type universal joints (fig. 1).

On SDH and TDH models, flange yoke at slip joint end is bolted to transmission mainshaft companion flange. On SDM and TDM models, slip yoke is connected directly to a fixed yoke which is splined to transmission mainshaft and secured by a nut. Shaft is splined to slip yoke. A steel dust cap which screws onto slip yoke (fig. 6) prevents entry of dust. Flange yoke at fixed joint end is bolted to companion flange at differential.

Slip joint at transmission end of shaft compensates for variation in distance between transmission and differential. These variations are brought about by the rise and fall of the rear axle as the vehicle passes over uneven ground. Slip joint facilitates removal of power plant.

LUBRICATION

Journals of universal joints are drilled and provided with lubrication fittings, through which lubricant travels to all four oil reservoirs (fig. 1) and then, through a hole in side of each reservoir, direct to needle bearings. Needle bearings are protected against lubricant leakage and the entry of dust by gaskets. Splines of slip joint are lubricated through lubrication fitting installed in slip yoke.

Universal joints and slip yoke splines should be lubricated periodically as specified in LUBRICATION (SEC. 13).

YOKE FLANGES

Flanges should be checked at regular intervals to see that lock wire is not broken and that nuts and bolts are tight.

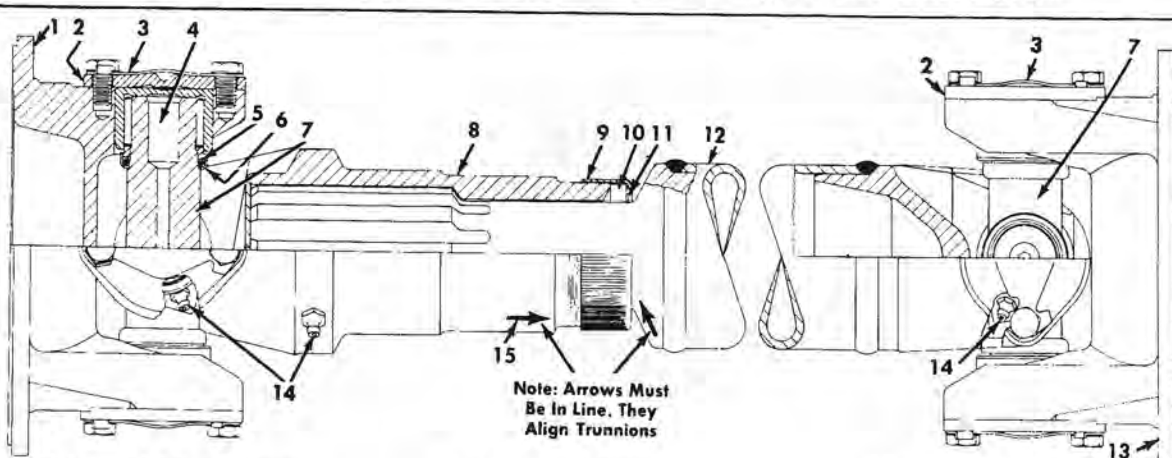
PROPELLER SHAFT AND UNIVERSAL JOINT REMOVAL

Slip yoke and shaft are marked with arrows (fig. 1) to insure correct alignment at assembly. Make sure arrows are clearly discernible before disconnecting slip joint. If arrows are not visible, mark yoke and shaft distinctly.

When it is necessary to remove the propeller shaft from the vehicle when the axle and transmission are in place, use the following steps:

1. Remove nuts and lock washers attaching hand brake drum to differential flange; then slide drum back on propeller shaft.

2. Remove lock wire, nuts, lock washers, and bolts attaching propeller shaft yoke flange to companion flange at differential (fig. 2).



1 Universal Joint Flange (At Transmission)
2 Bearing Assembly
3 Lock Strap
4 Lubricant Reservoir
5 Gasket
6 Gasket Retainer
7 Journal
8 Slip Joint Yoke
9 Dust Cap
10 Washer (Cork)
11 Washer (Steel)
12 Propeller Shaft
13 Universal Joint Flange (At Differential)
14 Lubrication Fitting
15 Aligning Arrows

TPM-7033

Figure 1—Cross Section of Propeller Shaft Assembly (Typical)

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PROPELLER SHAFT

1 Universal Drive Flange
2 Hand Brake Drum
3 Drive Pinion Nut
4 Washer
5 Drive Pinion Companion Flange
6 Oil Slinger
7 Drive Pinion Shaft
8 Lock Wire
9 Flange Stud
10 Lock Washer

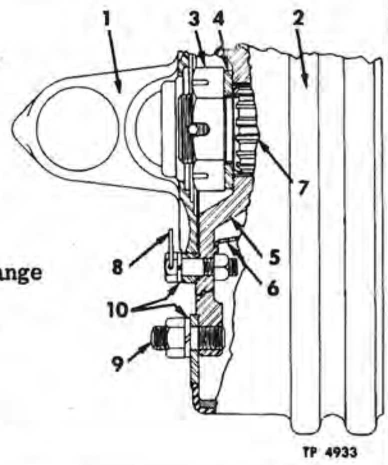


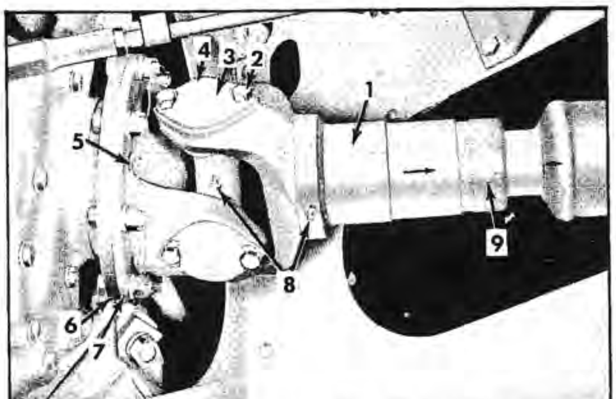
Figure 2—Propeller Shaft Installation at Rear Axle

3. On SDH and TDH models remove lock wires, nuts, lock washers, and bolts attaching propeller shaft yoke flange to transmission companion flange (fig. 3).

4. On SDM and TDM refer to "Universal Joint Disassembly" for journal disassembly at transmission end (fig. 4). Refer to TRANSMISSION (SEC. 17) for yoke removal.

5. Unscrew dust cap from slip yoke. On SDH and TDH Models, remove slip yoke and universal joint; on SDM and TDM models, remove slip yoke.

6. Remove propeller shaft and fixed universal joint assembly from under vehicle, removing brake drum from shaft as shaft is removed.



1 Slip Yoke Assy.
2 Cap Screw
3 Lock Strap
4 Needle Bearing Assy.
5 Lock Wire
6 Transmission Companion Flange
7 Flange Yoke
8 Lubrication Fittings
9 Dust Cap
TPM-7032

Figure 3—Propeller Shaft Installation at Transmission (SDH and TDH Models)

UNIVERSAL JOINT DISASSEMBLY

(Refer to Figure 5)

The following procedures apply to both the slip and fixed universal joint assemblies.

1. Use a chisel or screwdriver and bend ends of lock straps away from cap screws, then remove cap screws and lock straps.

2. Remove needle bearings by tapping with a plastic or rawhide hammer. CAUTION: Never use a steel hammer when removing bearings and do not let bearings drop on floor; this may cause serious damage.

3. Slide journal into one side of yoke as far as possible. Tilt journal to clear yoke and remove.

4. Slide gaskets from journal. Remove lubrication fitting from journal. Unless gasket retainers are to be replaced, do not remove retainers from journals.

CLEANING AND INSPECTION

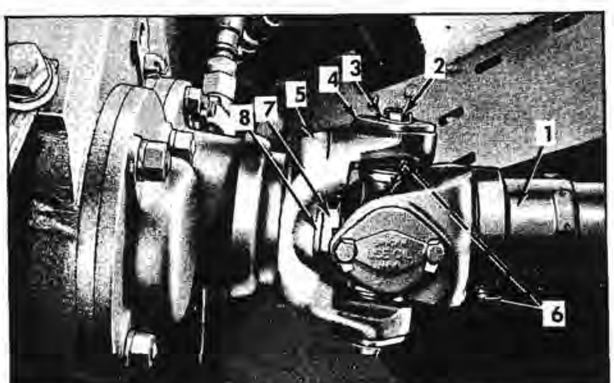
PROPELLER SHAFT

Use a wire brush and clean all dirt and old lubricant from splines on shaft. Inspect for broken or bent splines. Check shaft for warpage or breaks. If warped or broken, it should be replaced. Welding of broken shafts is not recommended.

SLIP AND FIXED JOINT YOKES

Inspect each yoke for cracks, wear, damage, or bent condition.

Small burrs or rough spots can usually be removed with a hone. See "Specifications" at end of this section for clearance between shaft and yoke splines. Replace if defective or badly worn.



1 Slip Yoke Assy.
2 Cap Screw
3 Lock Strap
4 Needle Bearing Assy.
5 Transmission Yoke
6 Lubrication Fitting
7 Transmission Yoke Nut
8 Transmission Yoke Nut Washer
TPM-9261

Figure 4—Propeller Shaft Installation at Transmission (SDM and TDM Models)

UNIVERSAL JOINTS

Wash all parts with suitable cleaning fluid. Clean all lubricant passages in journals (fig. 5) and lubrication fitting. Soak needle bearing assemblies in cleaner to soften particles of hard grease. Clean bearing assemblies thoroughly, then blow out dirt with compressed air.

IMPORTANT: Be sure that bearing assemblies are clean. Small particles of dirt or grit can cause excessive bearing wear.

Do not attempt to disassemble needle bearings. Inspect journal bearing surfaces for roughness or needle bearing grooves. If grooves and roughness will not smooth out with moderate honing, journal and bearing assemblies should be replaced. Check each bearing assembly for wear and missing rollers (see "Specifications" at end of this section). If rollers drop out of bearing, bearing assemblies should be replaced. After needle bearing assemblies are thoroughly clean, pack with clean grease and turn on journal to check wear.

If excessive clearance is noted, further check of parts is necessary to determine which parts to replace. Inspect gasket and gasket retainer and replace if not in good usable condition.

UNIVERSAL JOINT ASSEMBLY

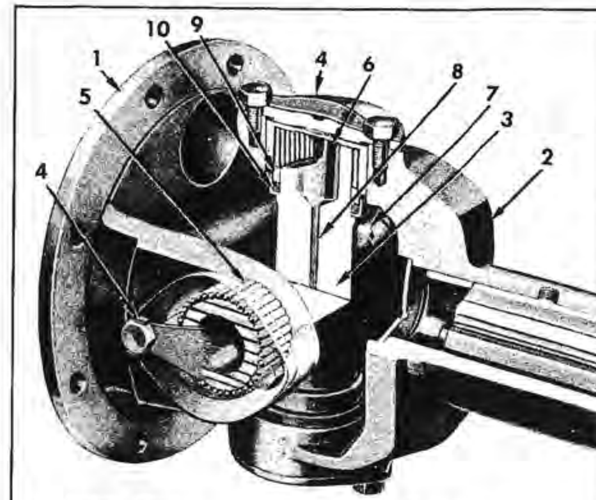
(Refer to Figure 5)

The following procedures apply to both the slip and fixed universal joint assemblies.

1. Install lubrication fitting in journal. If gaskets and gasket retainers were removed, install gasket retainers and gaskets on journals.
2. Insert one end of journal into yoke as far as possible from inside and tilt until opposite end of journal clears yoke and drops into position.
3. Insert bearing assemblies from outside of yoke and tap into place with a rawhide or plastic hammer. Do not use steel hammer for this purpose.
4. Joints should move freely in the bearings and not bind. If joints are too tight, change bearings around until joints are free and operate smoothly in the assembled position.
5. Install new lock straps and cap screws. Tighten cap screws, then bend ends of lock straps against heads of cap screws.

PROPELLER SHAFT INSTALLATION

1. On SDH and TDH Models, install slip joint assembly on transmission companion flange and attach with bolts, lock washers, and nuts. Tighten nuts firmly, leaving notches in nuts aligned with lock wire holes in bolts. Thread lock wire through bolts and twist ends of wire together (fig. 3).
2. On SDM and TDM Models, refer to TRANSMISSION (SEC. 17) for yoke installation. Refer to "Universal Joint Assembly" and assemble slip joint to yoke (fig. 4).
3. Install dust cap, steel washer, and cork washer on fixed joint end of shaft (fig. 6).
4. Apply a thin coating of lubricant recommended in LUBRICATION (SEC. 13) on propeller shaft splines. Place hand brake drum over fixed end of shaft, then place shaft assembly in position under vehicle. Align arrows as shown in figure 1. Insert splined end of shaft into slip joint, with arrows on slip yoke and shaft aligned as shown in figure 1.
5. Position fixed joint flange at differential companion flange and attach with bolts, lock washers, and nuts. Bolt nuts should be positioned so that



1 Yoke Flange
2 Slip Yoke
3 Journal
4 Lock Strap
5 Needle Bearing Assembly
6 Oil Reservoir
7 Lubrication Fitting
8 Lubricant Passage
9 Gasket
10 Gasket Retainer TPM-1334

Figure 5—Cross Section of Universal Joint

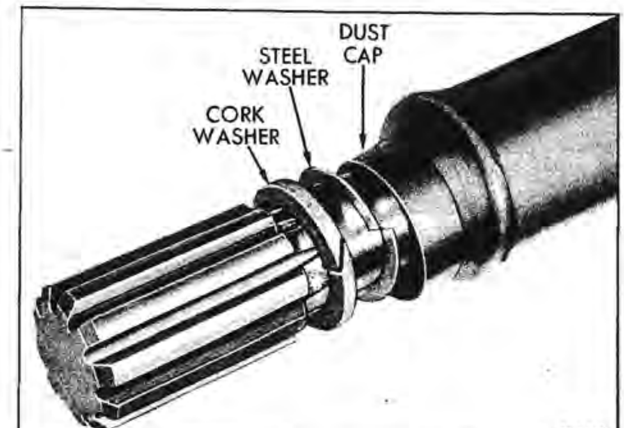


Figure 6—Propeller Shaft with Slip Joint Removed

PROPELLER SHAFT

they will lock against shoulder on differential companion flange. Tighten nuts firmly, then thread lock wire through bolt heads and twist ends of wire together. Assemble hand brake drum to differential companion flange (fig. 2).

6. Place cork and steel washer against end of slip yoke, then thread dust cap onto slip yoke. Tighten dust cap by hand. CAUTION: Do not use wrench.

7. Lubricate universal joints and slip joint with lubricant specified in LUBRICATION (SEC. 13).

SPECIFICATIONS

Universal Joint (Slip Joint End)	1701 Series
Universal Joint (Fixed Joint End)	1708 Series
Shaft Diameter	3½"
Journal Diameter	1.3201"-1.3206"
Bearing Rollers	
Number of Rollers	36
Diameter	⅛"
Length	0.920"-0.925"
Slip Joint	
Yoke Spline Thickness	0.3885"-0.3900"
Shaft Spline Thickness	0.3855"-0.3870"
Clearance—Shaft Splines to Slip Yoke Splines	0.0015"-0.0045"

Hubs, Wheels, and Tires

This group includes two sections covering maintenance information on HUBS AND BEARINGS and WHEELS AND TIRES.

Hubs and Bearings

Wheels and hubs are carried on two opposed tapered roller bearings as shown in figures 1 and 2. Bearings are adjustable for wear. Satisfactory operation and long life of bearings depend upon proper adjustment and correct lubrication. If bearing adjustment is too tight, bearings will overheat and wear rapidly. Loose adjustment of bearings will result in pounding and will contribute to steering difficulties, uneven tire wear, and inefficient brakes. Before checking or adjusting wheel bearings, always be sure brakes are fully released and not dragging. Wheel studs are installed in hub flange as shown in figures 1 and 2. Brake drums are mounted over wheel studs on outer side of hub flange and attached to hub with countersunk screws.

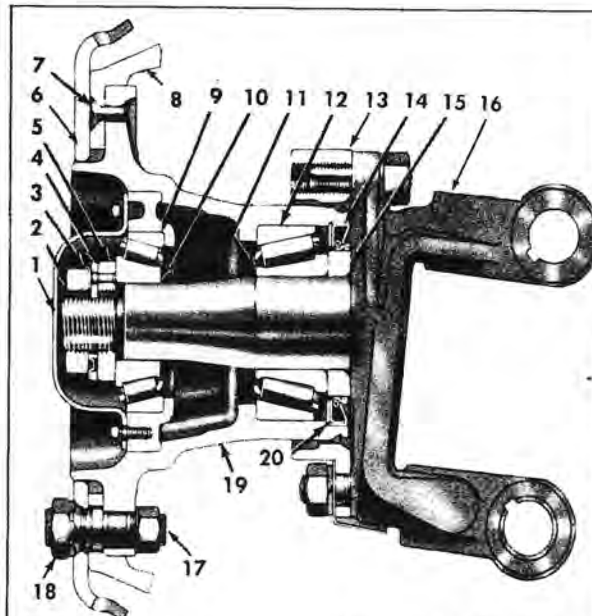
BEARING ADJUSTMENT

Wheel bearing adjustment should be checked carefully at each inspection period. Jack up wheels one at a time and check bearing play by using a pry bar under tires. Observe movement of brake drum in relation to brake spider or brake shoes. If bearings are adjusted correctly, movement of brake drum will be just noticeable and wheel will turn freely with no drag. If test indicates that adjustment of bearings is necessary, make adjustments as follows:

FRONT WHEEL BEARINGS

Key numbers in text refer to figure 1.

1. Remove cap screws and lock washers which attach hub cap (1) to hub (19); then remove hub cap and gasket.
2. Raise lip of nut lock (3) and remove lock nut (2), nut lock (3), and lock ring (4) from steering knuckle spindle (16).
3. Tighten wheel bearing adjusting nut (5) until wheel binds, at the same time turning wheel to make sure all surfaces are in proper contact.
4. Back off bearing adjusting nut (5) 1/6 turn, or more if necessary, making sure wheel turns freely.
5. Position lock ring (4) on steering knuckle spindle, with dowel pin in adjusting nut (5) inserted into hole of lock ring (4). Either side of ring may be turned toward adjusting nut. When installing lock ring, place first one side then the other toward adjusting nut, to determine which position will permit dowel pin in nut to line up with hole in ring, with least change in position of adjusting nut.
6. Install nut lock (3) and lock nut (2) on steering knuckle spindle. Draw lock nut up tight.
7. Recheck wheel bearing adjustment as described previously; then bend lip of nut lock (3) down against flat of lock nut (2).
8. Position hub cap (1) and new gasket against hub; then attach with cap screws and lock washers.

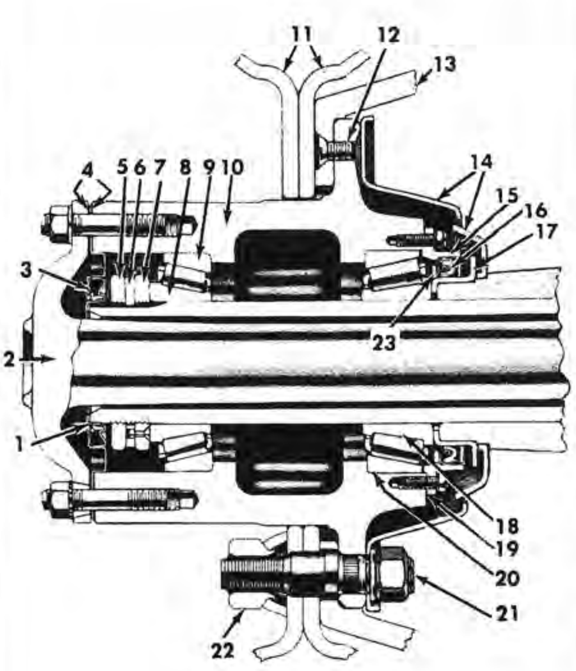


1 Hub Cap	11 Inner Bearing Cone and Roller Assy.
2 Lock Nut	12 Inner Bearing Cup
3 Nut Lock	13 Brake Spider
4 Adjusting Nut Lock Ring	14 Oil Seal
5 Bearing Adjusting Nut	15 Bearing Spacer
6 Wheel	16 Steering Knuckle
7 Brake Drum Retaining Screw	17 Wheel Stud
8 Brake Drum	18 Wheel Nut
9 Outer Bearing Cup	19 Hub
10 Outer Bearing Cone and Roller Assy.	20 Oil Seal Washer

TPM-1905-1

Figure 1—Front Hub and Bearings (Typical)

HUBS AND BEARINGS



1 Oil Seal Wiper and Cork Assembly	12 Brake Drum Retaining Screw
2 Axle Shaft	13 Brake Drum
3 Outer Oil Seal Assembly	14 Oil Slinger
4 Gaskets	15 Oil Seal Retainer
5 Lock Nut	16 Inner Oil Seal
6 Lock Ring	17 Oil Seal Wiper Sleeve
7 Bearing Adjusting Nut	18 Inner Bearing Cone and Roller Assembly
8 Outer Bearing Cone and Roller Assembly	19 Gasket
9 Outer Bearing Cup	20 Inner Bearing Cup
10 Hub	21 Wheel Stud
11 Wheels	22 Wheel Nut
	23 Oil Seal Washer T-175

Figure 2—Rear Hub and Bearings (Typical)

REAR WHEEL BEARINGS

Key numbers in text refer to figure 2.

1. Remove axle shaft as directed in REAR AXLE (SEC. 2) of this manual.

2. Remove gaskets (4) and wheel bearing outer oil seal (3) from axle shaft flange studs.

3. Remove wheel bearing outer oil seal wiper and cork assembly (1) from end of axle housing tube.

4. Unscrew lock nut (5) and remove adjusting nut lock ring (6) from axle housing tube.

5. Tighten wheel bearing adjusting nut (7) until wheel binds, at the same time turning wheel to make sure all surfaces are in proper contact.

6. Back off adjusting nut (7) about 1/6 turn, or more if necessary, to make sure wheel turns freely.

7. Position lock ring (6), with dowel pin in adjusting nut (7) inserted in hole of lock ring (6). Either side of ring may be turned toward adjusting nut. When installing lock ring, place first one side then the other side of ring toward adjusting nut, to determine which position will permit dowel pin in nut to line up with hole in lock ring with least change in position of adjusting nut.

8. Install lock nut (5) and tighten firmly; then recheck bearing adjustment as described previously.

9. Press oil seal wiper and cork assembly (1) on end of axle housing tube.

10. Place new oil seal inner gasket (4) on hub over axle shaft flange studs.

11. Coat lip of outer oil seal (3) and oil seal wiper and cork assembly (1) with grease; then install oil seal with holes in retainer over axle shaft flange studs. If oil seal is damaged or worn, even slightly, use a new oil seal.

12. Position new outer gasket (4) on hub over axle shaft flange studs.

13. Install axle shaft as directed in REAR AXLE (SEC 2) of this manual.

OIL SEALS

Front and rear hubs have oil seals at inner end to prevent leakage of wheel bearing lubricant from hubs into brake drums. Inner oil seals also prevent water and dirt from entering hubs and contaminating wheel bearing lubricant. Oil seals at outer end of rear hubs prevent rear axle differential lubricant from entering hubs and mixing with wheel bearing lubricant.

Inner seals used in both front and rear hubs are rotating, spring-loaded type. Front seals are pressed into inner end of hub and seal lip wipes on bearing spacer (fig. 1). Rear hub inner seals are pressed into seal retainers. Retainers are attached to inner end of hub with screws. Seal lip wipes on a wiper sleeve. Wiper sleeve is pressed on rear axle housing tube (fig. 2).

Outer seals used in rear hubs are spring loaded lip-type seals with integral retainers. Retainers fit over axle shaft drive plate studs. Lip of oil seal wipes on oil seal wiper. Wiper is pressed on outer end of axle housing tube. Wiper to tube cork gasket is cemented to inner side of wiper.

At regular inspection periods, examine all seals carefully. If there is the slightest indication of wear, deterioration, or damage at sealing surface, a complete new oil seal assembly must be installed. Examine surface of oil seal wiper, wiper sleeve, and bearing spacer, against which oil seals bear. Any nicks, scratches, or rough spots, on these surfaces will impair efficiency of seals.

Always spread a thin coating of grease on face of oil seal, oil seal wiper, wiper sleeve, and bearing spacer before installing parts in hub.

FRONT HUB AND BEARING REMOVAL

Key numbers in text refer to figure 1.

1. Raise front end of coach until tires just clear floor.
2. Remove wheel stud nuts and remove wheel and tire.
3. Remove brake drum to front hub retaining screws (7); then remove brake drum (8) from hub (19).
4. Remove cap screws and lock washers; then remove hub cap (1) and gasket.
5. Raise lip of nut lock (3); then remove lock nut (2), nut lock (3), lock ring (4), and bearing adjusting nut (5) from steering knuckle spindle.
6. Pull front hub assembly (19) straight off spindle, being careful not to permit outer bearing (10) to fall out of hub (19).
7. Remove outer bearing cone and roller assembly (10) from hub (19).
8. Pull inner bearing oil seal (14) and washer (20) out of hub (19); then lift inner bearing cone and roller assembly (11) from hub (19).
9. Perform cleaning and inspection operations outlined under "Cleaning and Inspection" later in this section. If inspection indicates need for replacing inner (12) and outer (9) bearing cups, they may be driven out of hub by using a long brass drift and hammer through opposite end of hub.
10. If necessary to remove bearing spacer (15), drive a chisel between inner edge of spacer and steering knuckle spindle (16) to force spacer out far enough to permit use of a puller. Be extremely careful not to mar or damage steering knuckle spindle with chisel.

REAR HUB AND BEARING REMOVAL

Key numbers in text refer to figure 2.

1. Raise rear end of vehicle until tires just clear floor.
2. Remove wheel stud nuts (22), then remove wheels and tires.
3. Remove brake drum to hub retaining screws; then remove brake drum (13) from hub (10).
4. Remove axle shaft (2) as directed in REAR AXLE (SEC. 2) of this manual.
5. Remove wheel bearing outer oil seal and retainer assembly (3) and gaskets (4) from axle shaft flange studs.
6. Remove wheel bearing outer oil seal wiper and cork assembly (1) from end of axle housing tube.
7. Remove lock nut (5), lock ring (6), and bearing adjusting nut (7) from axle housing tube.
8. Lift rear hub (10) off axle housing tube, holding hand over outer end of hub to prevent outer bearing (8) from falling out. Remove outer bearing cone and roller assembly (8) from hub (10).
9. Remove screws attaching inner oil seal retainer (15) to hub; then remove inner oil seal (16) and retainer assembly (15) and gasket (19) from hub. If desired inner oil seal (16) and washer (23) can be pushed out of oil seal retainer (15).
10. Lift inner bearing cone and roller assembly (18) out of hub (10).
11. If necessary to remove inner oil seal wiper sleeve (17), as indicated under "Cleaning and Inspection" later in this section, use a chisel or suitable tool and drive sleeve off axle housing. Be careful not to damage axle housing tube.
12. If necessary to remove inner (20) and outer (9) bearing cups as indicated under "Cleaning and Inspection" later in this section, they may be driven out of hub by using a hammer and long brass drift through opposite end of hub.

CLEANING AND INSPECTION

CLEANING

1. Immerse bearing cone and roller assemblies in clean cleaning solvent. Clean bearings with stiff brush to remove old lubricant. Blow bearings dry with compressed air, directing air stream at right angles to bearing. DO NOT SPIN BEARINGS WITH AIR PRESSURE WHILE BLOWING THEM DRY.
2. Thoroughly clean all old lubricant out of inside of hubs; then wipe hubs dry. Make sure all particles of old gasket are removed from inner end of rear hubs.
3. Clean all lubricant off rear axle housing tube and front axle steering knuckle spindle. Do not permit cleaning solvent or grease to get on brake linings.
4. Using a clean cloth dampened with cleaning solvent, wipe old lubricant off oil seals.
5. Wash all small parts such as bearing nuts, lock rings, and oil seal wipers in cleaning solvent. Wipe or blow parts dry.

INSPECTION

1. Inspect bearing rollers for excessive wear, chipped edges, or other damage. Slowly rotate roller bearings around cone to detect any flat or rough spots on cone or rollers. Do not mistake dirt or grit for roughness. Replace bearing assemblies if any damage is found.
2. Examine bearing cups in hubs. If cups are

HUBS AND BEARINGS

pitted or cracked, they must be replaced with new parts.

3. Carefully examine oil seals for signs of wear, deterioration, distortion, or damage at sealing surfaces. Replace oil seal assembly if any of the above conditions are evident.

4. Inspect oil seal wiper, wiper sleeve, and bearing spacer for nicks or rough spots which would cause rapid wear of oil seals. Replace with new parts as required.

5. After inspection is completed and parts replaced as deemed necessary, lubricate bearings and inside of hub as directed in LUBRICATION (SEC. 13).

FRONT HUB AND BEARING INSTALLATION

Key numbers in text refer to figure 1.

1. If inner bearing spacer (15) was removed, drive into place on steering knuckle spindle. Make sure spacer is fully seated against knuckle flange.

2. If inner (12) and outer (9) bearing cups were removed from hub, drive or press new cups into hub with wide side of cups toward inside of hub. Make sure cups are fully seated against shoulder in hub and not cocked.

3. Be sure inner (10) and outer (11) wheel bearings and inside of hub are well lubricated as directed in LUBRICATION (SEC. 13).

4. Position inner bearing cone and roller assembly (11) inside hub (19).

5. Place oil seal washer (20) in hub (19); then press oil seal (14) into hub against washer. Lip of oil seal must point toward inside of hub.

6. Coat face of inner oil seal (14) and bearing spacer (15) with grease.

7. Install hub assembly (19) on front axle steering knuckle spindle. Be careful not to damage wheel bearing oil seal assembly (14).

8. Place outer bearing cone and roller assembly (10) on steering knuckle spindle (16); then push bearing into hub with fingers.

9. Install wheel bearing adjusting nut (5) on steering knuckle spindle. Tighten adjusting nut against outer bearing finger-tight.

10. Position brake drum (8) on flange of hub (19) and attach with retaining screws.

11. Place wheel and tire on hub; then attach with stud nuts. Tighten stud nuts as directed in "WHEELS AND TIRES."

12. Adjust front wheel bearings and complete installation as previously directed under "Bearing Adjustment" earlier in this section.

REAR HUB AND BEARING INSTALLATION

Key numbers in text refer to figure 2.

1. If inner oil seal wiper sleeve (17) was removed from axle housing, reinstall wiper sleeve on housing.

2. If inner and outer bearing cups (9 and 20) were removed from hub (10), drive or press new cups into hub with wide side of cups toward inside of hub. Make sure cups are fully seated against shoulder in hub and not cocked.

3. Lubricate wheel bearings and inside of hub as directed in LUBRICATION (SEC. 13).

4. If oil seal (16) was removed from retainer (15), install washer (23), then press new seal assembly into retainer. Use extreme care when pressing oil seal into place not to distort seal flange.

5. Place inner bearing cone and roller assembly (18) inside hub (10); then position inner oil seal (16) and retainer (15) on inner end of hub, using new oil seal gasket (19) between retainer and hub.

6. Attach retainer (15) to hub (10) with screws and lock washers. Tighten screws evenly and firmly.

7. Coat face of oil seal (16) and oil seal wiper sleeve (17) with grease.

8. Position hub assembly (10) on axle housing tube. Be careful not to damage inner oil seal (16).

9. Place outer bearing cone and roller assembly (8) on axle housing tube. Push bearing into hub with fingers.

10. Install bearing adjusting nut (7) on axle housing tube. Tighten adjusting nut against outer bearing finger-tight.

11. Position brake drum (13) on flange of hub (10) and attach with retaining screws.

12. Install wheels and tires on hubs and attach with wheel stud nuts. Tighten stud nuts as directed in "WHEELS AND TIRES."

13. Adjust rear wheel bearing; then complete installation as previously directed under "Bearing Adjustment" in this section.

Wheels and Tires

WHEEL MAINTENANCE

These coaches may be equipped with either Motor or Budd type wheels. When Budd type wheels are used, wheel studs and nuts on left side of vehicle have left-hand threads, and studs and nuts on right side have right-hand threads. When Motor wheels are used, all studs and nuts have right-hand threads.

1. Before new vehicle goes into service and after each wheel removal, all wheel stud nuts should be thoroughly tightened. Refer to instructions later for wheel nut torque and wheel nut tightening procedure. See that studs and nuts are free from grease or oil. Do not use oil on studs or nuts.

2. To tighten stud nuts on dual rear wheels with Budd type wheels, loosen outer nuts, then tighten inner nuts. Tighten opposite nuts alternately so that wheel will be square against hub flange. After tightening inner nuts, tighten outer nuts to specified torque. On Motor wheels, make sure that inner dual is flush against hub flange, then tighten nuts to specified torque.

3. Re-tighten stud nuts every 100 miles for first 500 miles to offset setting-in of clamping surfaces.

4. Inspect wheel stud nuts at least every 1000 miles thereafter. If vehicle is subjected to severe service, inspection should be made daily regardless of mileage.

5. When changing wheels or tires and before assembling wheels to hubs, remove dirt, grease, and excess paint from the mating surfaces. Dual rear wheels should be positioned with valve stems 180 degrees apart.

WHEEL NUT TORQUE

Excessive tightening of wheel stud nuts has proven to be the cause of erratic brake action in some cases. Where excessive torque is applied, brake drum distortion will occur.

Improper procedure in tightening of wheel stud nuts, including excessive torque, has also been found to cause wheel distortion and wheel runout. Such condition will have decided effect on tire life. Wheel nuts should be carefully torqued to within limits listed in "Specifications" at end of this section. These limits should not be exceeded.

These specifications have proven to be entirely satisfactory to insure wheel tightness and torque applied exceeding these limits is not recommended. To insure correct torque, a large size torque wrench should be used. A number of torque wrenches suitable to this application are available, one of which is made by "Snap-On" in a 0 to 600 foot-pounds capacity with a 3/4" drive. "Snap-On" tool number is TA 602A, and is also available with a light indicator under tool number TQ602AL. If a pneumatic impact wrench is used for tightening wheel stud nuts, it should be used only for initial "run-in" of nuts in order to allow wheel to correctly position itself on the hub. Final tightening should be done with a torque wrench to insure that all nuts are torqued evenly and not beyond the limits shown in "Specifications."

WHEEL STUD NUT TIGHTENING PROCEDURE

It is important that wheel stud nuts be tightened alternately on opposite sides of wheel. A suggested sequence for tightening is shown in figure 3, and a recommended procedure is as follows:

1. Run the stud nuts in lightly, following the sequence shown, so that wheel will position itself concentrically with hub. THIS IS IMPORTANT, OTHERWISE WHEEL MAY BE ECCENTRIC WITH HUB AND WILL NOT RUN TRUE. In this initial step, run the nuts up only as necessary to correctly position wheel.

2. Tighten nuts progressively, in the sequence shown in figure 3, with torque wrench until torque limit is reached. Do not tighten each nut completely at one time but progress from one nut to another so that wheel is tightened uniformly.

WHEEL INSPECTION

Do not use wheels with bent rims. Continued use of wheels with bent rims will result in exces-

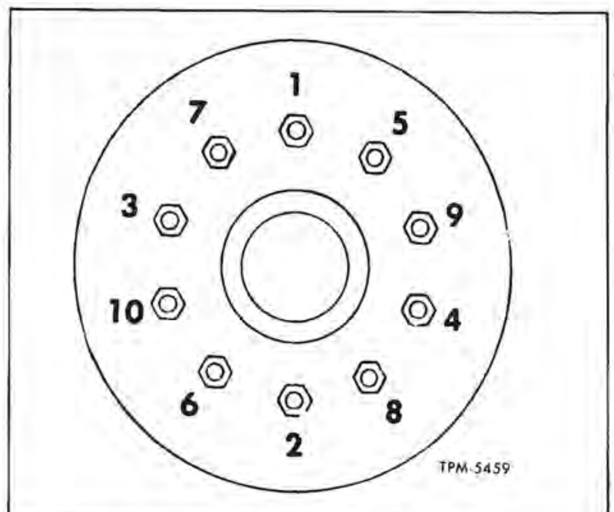


Figure 3—Wheel Nut Tightening Sequence

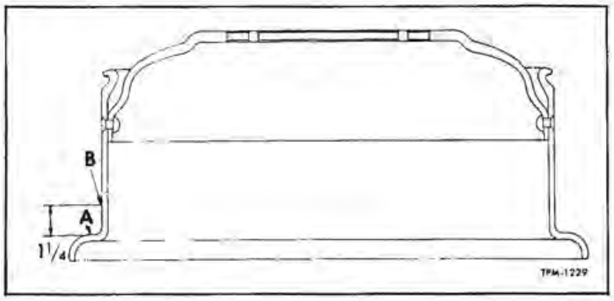


Figure 4—Typical Wheel Checking Diagram

sive tire wear and, if wheel is mounted on front of vehicle, difficulty in steering vehicle will be experienced. Wheels that are thought to be distorted should be checked as follows (see fig. 4):

1. Remove wheel from vehicle and dismount tire.

2. Clean all rust, scale, dirt, and grease from rim.

3. Mount wheel securely in lathe or other suitable fixture. NOTE: Face of hub must run true, as any run-out at that point will be increased from 1-1/2 to 3 times at checking points on rim.

4. Revolve wheel slowly and check at point "A" for lateral runout (wobble). This should not exceed 3/32-inch. Check at point "B" for radial run-out (out-of-round). This should not exceed 3/32-inch total indicator reading. Wheels that are distorted in excess of these limits should be replaced.

TIRE MAINTENANCE

Some coaches are equipped with tubeless tires, while others have tube type tires.

One of the most important factors of economical and safe motor vehicle operation is systematic and correct tire maintenance. Tires must not only support weight of loaded vehicle, but they are also integral parts of the transmission and braking systems. Therefore, tires should receive careful, systematic, and regular maintenance as do other operating units. Three major causes of tire trouble are (1) improper-inflation, (2) overloading, and (3) misalignment. Tires should be checked periodically for these conditions.

INFLATION OF TIRES

Improper-inflation is the greatest cause for loss of tire life expectancy. Tires should be checked frequently for this condition. Tire fabric, rubber, bead, contour, and size used on these vehicles are designed to obtain maximum length of service under all operating conditions to which vehicles may be subjected. TIRES ARE DESIGNED TO OPERATE EFFICIENTLY ONLY ON A PRESCRIBED AMOUNT OF AIR. Unless correct air pressure is consistently maintained, tires will not function as they should; consequently, safe, economical operation of vehicle will be materially affected.

Operating air pressure recommended by the tire manufacturer is as essential to safe and economical operation of tire, as proper amount of oil would be to an engine or other chassis units.

An under-inflated tire runs sluggishly, heats up quickly because of greater flexing, and is subjected to more frequent bruising.

Over-inflation does not compensate for overloading. It does not add strength to tire, in fact, it actually weakens the tire by reducing its ability to absorb road shock, and may cause a blow-out.

In addition to the deteriorating effect improperly-inflated tires may have on tire life, improperly-inflated tires will effect steering, riding comfort, and safe driving.

Tires are designed to operate at a certain recommended inflation, which provides normal flexing with proper deflection and road contact. If flexing is changed from normal, either by over-inflation, under-inflation, or overloading, proper service from tire cannot be obtained. FOLLOW TIRE PRESSURE RECOMMENDATIONS OF THE TIRE MANUFACTURER.

BALANCED INFLATION

The operating efficiency of vehicle will be seriously upset if air pressures in tires are out of balance. Balanced inflation may be expressed as; all tires on the same axle should always carry same air pressure. A difference in air pressure of rear tires and front tires may be permissible within certain limitations; however, there should not be a difference in pressures between right and left tires on the same axle. A five pound under-inflation in one front tire not only can destroy ease of steering, but creates steering hazards which generally point to a potential accident. An under-inflated rear tire can destroy the value of the most efficient brakes. Balance tire pressures for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maximum tire mileage.

PRESSURE LOSS

At periodic intervals, each tire should be gauged for pressure loss with an accurate gauge before tires are brought to correct operating pressure. Purpose of this check is to determine exact pressure losses in each tire. In other words, if at the time this check is made, a definite pressure loss is noted in any one of the tires, an inspection should be made of tire showing loss and cause of loss corrected. This method should definitely establish a "danger signal" on the condition of tires. Pressure loss check should be made consistently with the same gauge, so that any element of inaccuracy in gauge will be the same for all tires.

ROTATION OF TIRES

Tires should be interchanged at regular intervals to obtain maximum life. Change wheels without dismounting tires so direction of rotation will be reversed. The following system of interchanging is suggested: Right front to left rear inside or right rear outside. Left front to right rear inside or left rear outside.

If inside dual tires show more wear than outside dual tires, place front tires on inside when changing. In this case, outside dual tires can be interchanged between right- and left-hand side of vehicle.

If outside dual tires show more wear than inside dual tires, place front tires on outside dual tires when changing. At the same time, interchange right- and left-hand inside dual tires.

New tires should be installed on front wheels where they run coolest.

TIRE VALVES

The valve core is a spring-loaded check valve installed in valve stem, permitting inflation or deflation of the tire. This check valve, or core, is not intended to hold the air during operation. The valve cap is provided to seal air in the tube or tire. When valve cap is tightened down on stem, the sealing washer inside cap is pressed tightly against top of stem, preventing air leakage. Valve cap also prevents dirt and moisture from entering valve stem to injure valve core mechanism. It is important, therefore, that valve caps be used.

SELECTION OF TIRES

All tires on the same axle should, whenever possible, be of the same make, since differences in design and tread in some instances result in unequal tire rolling radii. It is not possible to match all tires exactly. Therefore, some tolerance must be permitted. When installing tires on a vehicle, all tires on same axle should have the same outside diameter within tolerance limits. The most desirable matching is obtained by not exceeding 3/4-inch difference in circumference or 1/4-inch difference in diameter. If tires do not have the same outside diameter (within 1/4-inch) excessive tread scuffing and hard steering will result. Tire diameters may be measured with a conventional tire measuring gauge.

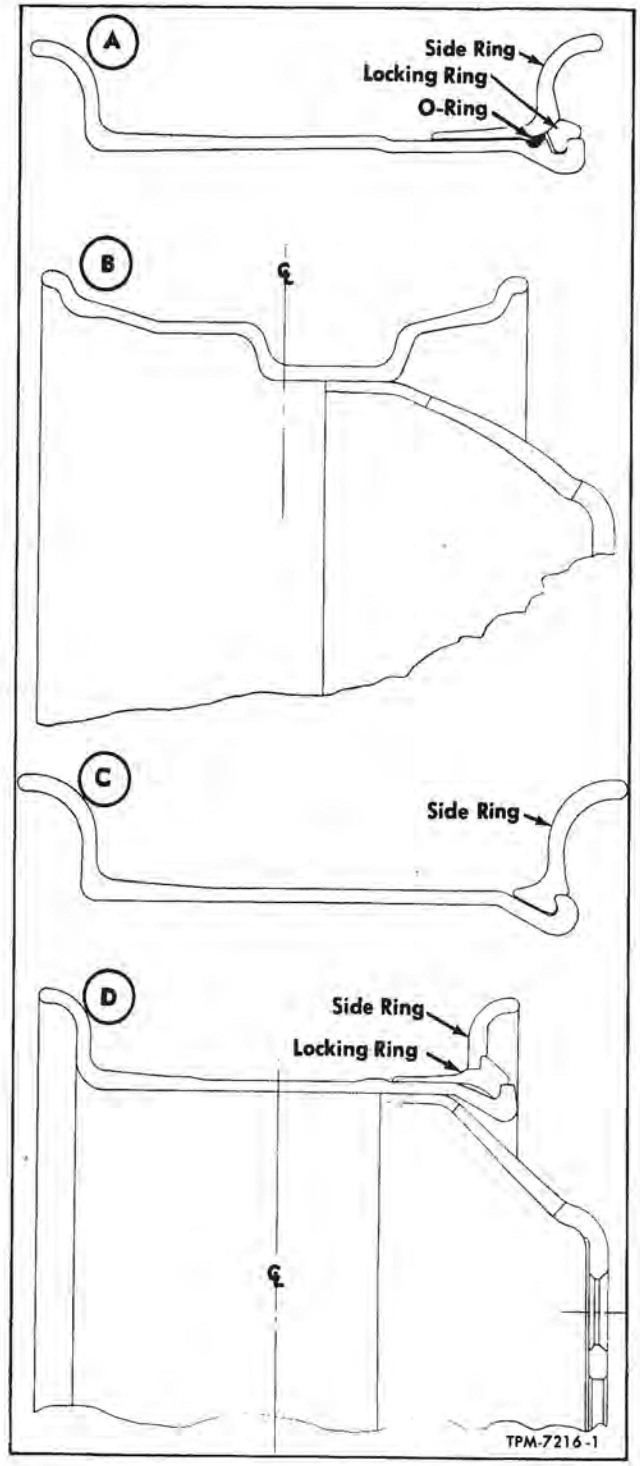


Figure 5—Typical Wheel Rims

TIRE REPLACEMENT

The standard wheel rims shown in view A, figure 5, are flat base rims with a side ring and locking ring. The toe of the side ring forms the seat for the tire bead. Either tubeless or tube type tires can be used on this rim. When tubeless tires are used, a black Neoprene O-ring is used to seal air in. When tube type tires are used, a red vinyl O-ring is used to exclude dirt and water.

Wheel rim shown in view B, figure 5, is an optional one-piece drop-center rim that requires no side ring or locking ring. This wheel is used exclusively with tubeless tires.

WHEELS AND TIRES

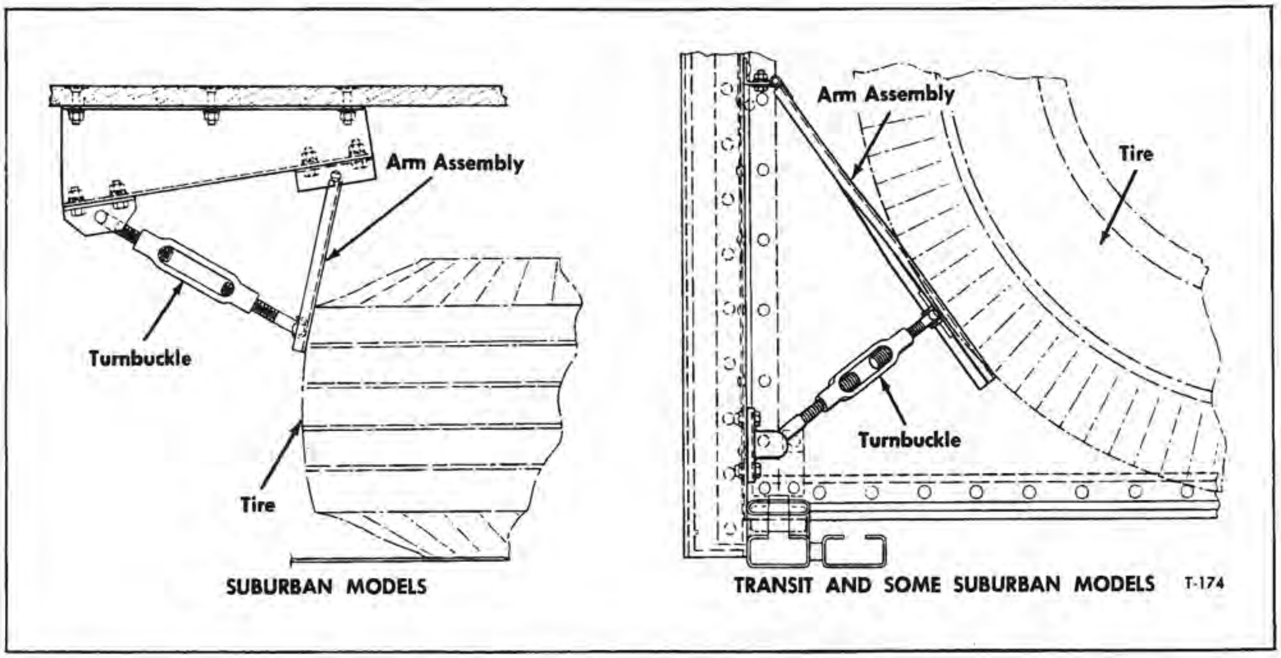


Figure 6—Spare Wheel and Tire Hold-Down Equipment Installed

Wheel rim shown in view C, figure 5, is an optional flat base rim having a one-piece continuous type side ring. Tube type tires only are used with this type rim.

Another optional flat base rim is shown in view D, figure 5. This rim has a continuous type side ring and a locking ring. The toe of the locking ring forms the tire bead seat. Tube type tires only are used with this type rim.

IMPORTANT: Most "rim accidents" are caused by carelessness and thoughtlessness when inflating tires after mounting. Such accidents are always serious and sometimes fatal. Be on the safe side -

ALWAYS FOLLOW PRECAUTIONS DESCRIBED IN THE FOLLOWING:

On all wheels using lock ring, the lock ring must be fully seated in rim gutter before inflating tire. This is important for the safety of person inflating tire.

As an added precaution, use a steel bar 1" in diameter and long enough to extend several inches over lock ring at both ends. Bend bar so it can be inserted through wheel spoke openings with both ends of bar extending over lock ring. Leave bar in place until tire is fully inflated. Examine lock ring to see that it is fully seated; then remove safety bar.

SPARE TIRE AND WHEEL

Spare wheel and tire (Special Equipment) is located in forward side compartment. Views in figure 6 show wheel and tire hold-down equipment installed on indicated models.

NOTE: On some suburban models, a strap is attached to wheel and tire to assist in removing it from compartment.

IMPORTANT: After placing wheel and tire in compartment, rotate hold-down arm turnbuckle to clamp wheel and tire firmly in position.

WHEEL NUT TORQUE SPECIFICATIONS

Motor Wheel - Front and Rear Wheels . . .	500-550 Ft.-Lbs. - No Lubricant
Budd Type - Front Wheel Nuts and Rear Wheel Inner and Outer Nuts	500-550 Ft.-Lbs. - No Lubricant

Air Conditioning

This group, covering operation, maintenance, and repair information on GM Air Conditioning is divided into eight major sections as shown in index below:

Information pertaining to a specific control, service, or test, will be found by using quick page reference index shown at beginning of each respective section.

NOTE: Air conditioning controls and units, such as temperature control Grad-U-Stat (thermostat), underfloor blowers, heater core unit, and air filter screens are also used in conjunction with the coach heating system. These controls and units which are common to both systems are covered in "HEATING AND VENTILATION" (SEC. 3) in this manual.

General Description

The GM coach air conditioning is designed to provide passenger comfort by cooling, dehumidifying, and filtering the air which is force-circulated within the coach.

The air conditioning system is entirely independent of the coach heating system; however, the entire heating system is utilized to control or temper the air which is cooled by air conditioning. This tempering or temperature-raising process provides the necessary "reheat" phase of air conditioning system.

The air conditioning system units are accessible in coach through access doors shown in figure 1. System units are located schematically in coach as shown in figure 2.

Briefly, the air conditioning system is comprised of the following system and controls. Refer to figure 2.

THE CONDENSING SYSTEM

The condensing system consists of:

1. A Four-Cylinder Reciprocating-Type Refrigerant Compressor, shaft-driven from accessory drive take-off of coach engine. Compressor is mounted below floor, forward of engine bulkhead at left side of coach.

2. A Fin and Tube-Type Condenser Coil with an eight-blade type cooling fan. Condenser and fan are mounted to roof structure at rear of coach. Fan blade is hydraulically driven from a fluid pump which is mounted to, and belt-driven from refrigerant compressor.

3. A Liquid Refrigerant Receiver which is mounted to understructure at left side near center of coach.

THE COOLING UNITS

The cooling units consists of:

1. An Evaporator Coil of fin and tube-type construction mounted in underfloor heating and cooling compartment. Coil is accessible from underneath coach, after lowering compartment access panel and doors.

2. A Refrigerant Expansion Valve of multi-outlet-type mounted to evaporator coil and refrigerant liquid line. Expansion valve is also accessible from underneath coach.

3. A Refrigerant Heat Exchanger of tank and internal coil-type is mounted into both high pressure liquid line and low pressure gas line. Heat exchanger is accessible after opening side closure door near left center of coach (fig. 1).

4. A Dehydrator-Strainer of disposable-type is mounted in high pressure liquid line in same compartment as the heat exchanger above.

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GENERAL DESCRIPTION

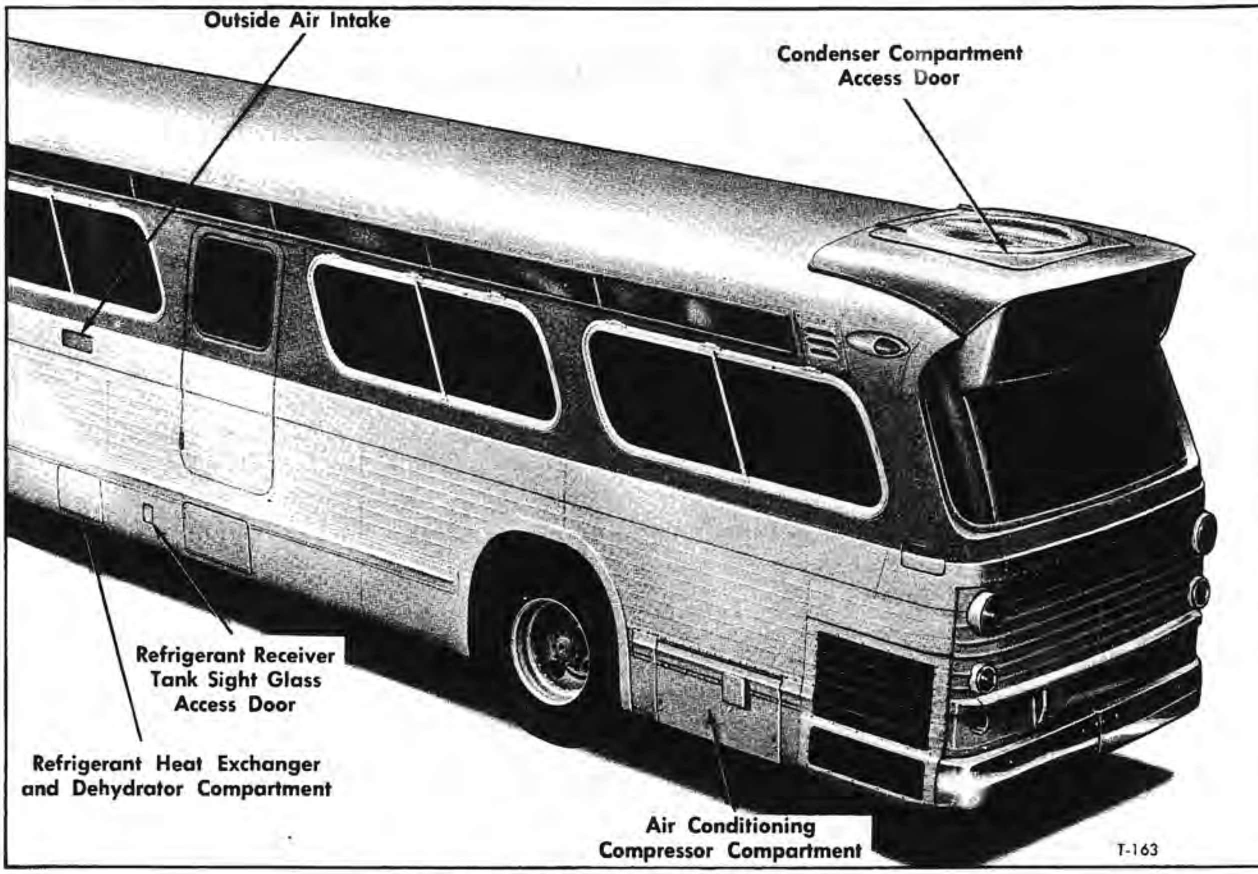


Figure 1—Access Doors to Air Conditioning Units

THE AIR CIRCULATION SYSTEM

The Air Circulating System consists of same air intakes, filter screens, blowers, and air distribution ducts which are employed for coach heating.

SYSTEM CONTROL UNITS

The air conditioning system controls consist of "VENTILATION" switch on panel at left of driver, an electrically-energized air-operated friction clutch mounted to drive end of refrigerant compressor, and automatic controls such as pressure switches, relay and air supply solenoid valve which are described later under "System Operation."

DRIVER'S OPERATING INSTRUCTIONS

Driver's control of air conditioning is accomplished by the positioning of switch marked "VENTILATION" mounted on control panel at left of driver. Switch positions are marked "AIR CONDITION," "BLOWER - LOW - HI" and "OFF."

TO OPERATE COOLING SYSTEM

With engine running at idle speed, rotate switch knob to "AIR CONDITION" position. With switch in this position, the underfloor blower high speed circuit is energized and blowers run continuously at high speed. Except for this action the operation of the air conditioning is completely automatic.

A short delay may occur before air conditioning system starts to operate. Two likely reasons for this condition are:

1. Engine oil pressure too high at normal idle. Engine oil pressure switch contacts will not close to complete circuit to air conditioning controls if oil pressure exceeds 15 psi. Engagement will occur as soon as oil warms up and pressure drops below 15 psi.

2. Pressure in coach air system is low: A minimum of 65 psi air pressure is required to operate compressor clutch controls. Build up required air pressure.

NOTE

The "A/C STOP" tell-tale located at bottom of gauge and tell-tale panel in front of driver will illuminate whenever the refrigerant "HI-LO" pressure switch contacts are open and compressor clutch is disengaged. If light stays on and coach temperature rises, report condition to service personnel.

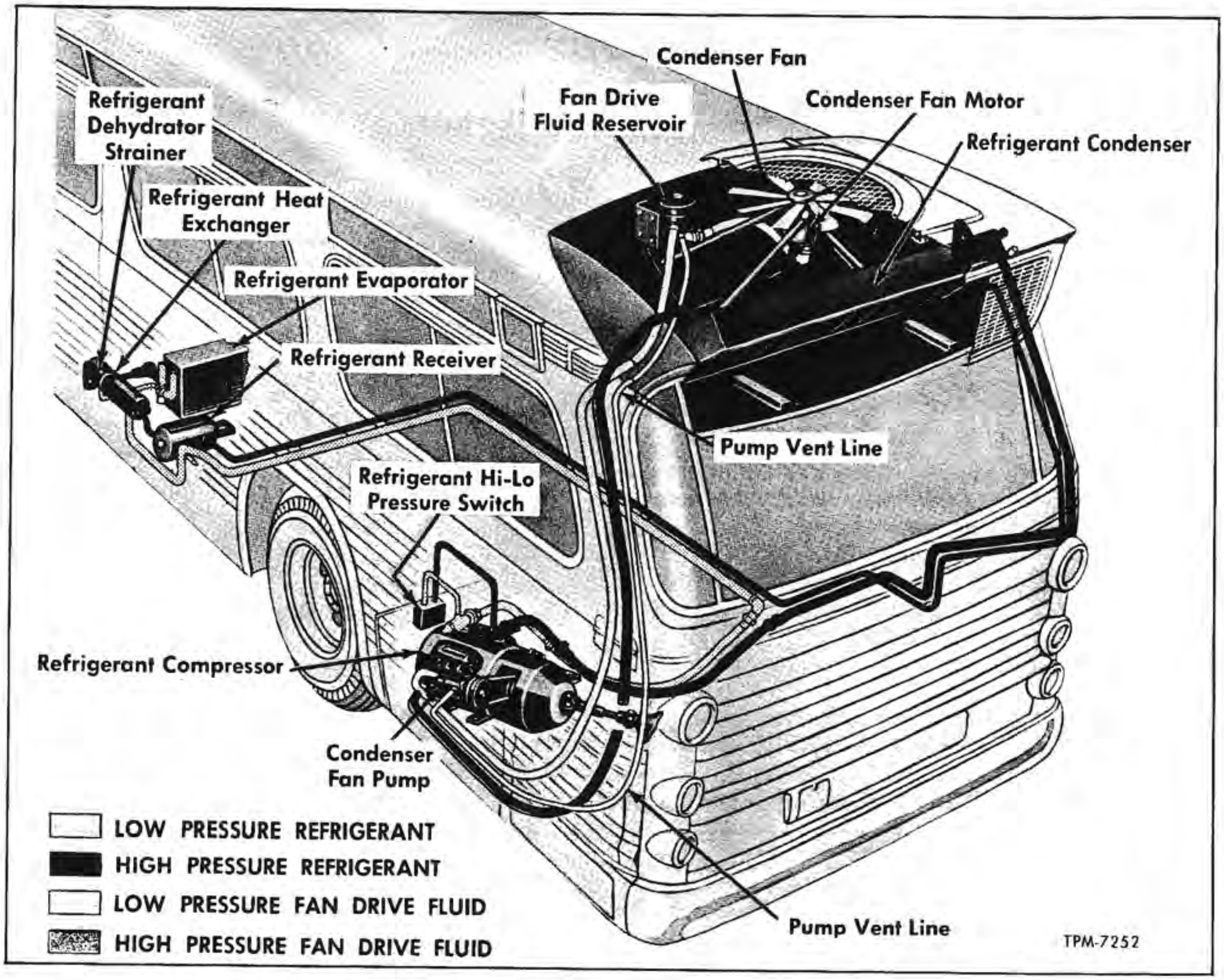


Figure 2—Refrigerant Lines and Condenser Fan Drive Fluid Lines (Typical)

IMPORTANT: KEEP WINDOWS AND OUTSIDE AIR FRONT INTAKES CLOSED AND DO NOT LEAVE DOORS OPEN ANY LONGER THAN NECESSARY.

TO OPERATE HEATING SYSTEM

"VENTILATION" switch on vehicles having air conditioning need not be positioned to "BLOWER - HI" or "LOW" for heating system to operate, as underfloor blowers will run at low speed whenever the Grad-U-Stat (thermostat) calls for heat. However, on these vehicles the switch can be positioned to "BLOWER - HI" or "LOW" as desired to provide ventilation regardless of the demands of Grad-U-Stat.

IMPORTANT

Excessive use of defroster heater at front end may cause high temperature in front of coach, thereby satisfying the thermostat control and leaving the rear area in the coach cold. For information covering operation of outside air vents over the windshield and for right and left front air intakes, refer to current OPERATING MANUAL.

System Operation

CONTENTS OF THIS SECTION

GENERAL OPERATION

Some controls and units used with the air conditioning system are common to the coach heating system. These controls and units are: "VENTILATION" control switch, marked "AIR CONDITION," "BLOWER - LOW-HI," and "OFF," air filter screens, heater core unit, air intake and distribution ducts, and the Grad-U-Stat.

The heating and cooling systems operate independently of each other, except under certain conditions of cooling system operation when there is an overlapping operation of both systems as explained previously under "GENERAL DESCRIPTION."

When the "VENTILATION" switch on panel at left of driver is placed in "AIR CONDITION" position, the air conditioning system functions as follows:

NOTE: Follow the schematic wiring diagram (fig. 3) for simplified electrical circuits or refer to the Air Conditioning Wiring Diagram in back of this manual for detailed diagram of electrical circuits and connections.

1. With engine running and control switch closed, underfloor blower high speed circuit is energized and blowers run continuously at high speed.

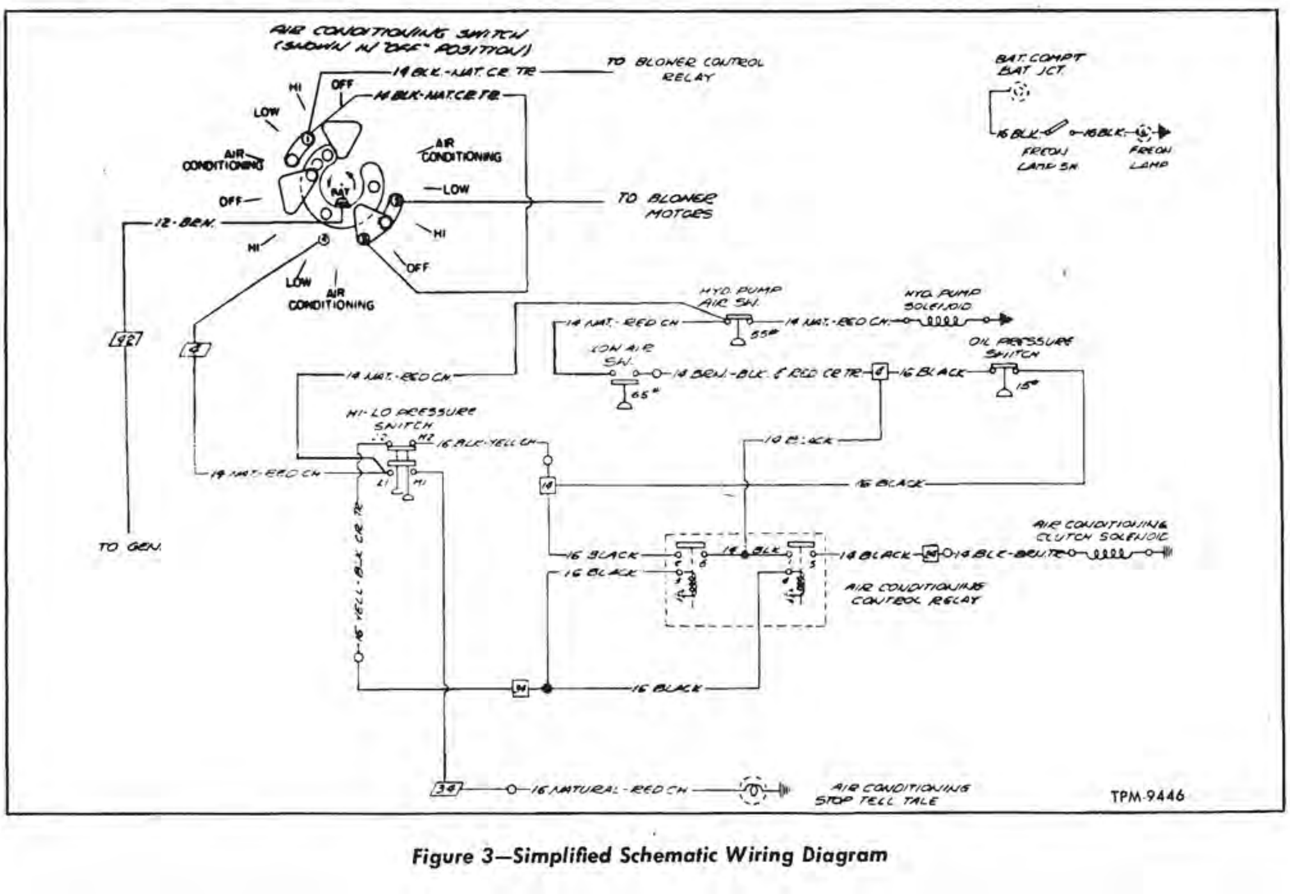


Figure 3—Simplified Schematic Wiring Diagram

2. The engine must be running at idle speed, and the air pressure in coach air system must be more than 65 psi to close low air pressure switch before circuit through the refrigerant "HI-LO" pressure switch is completed to operating coils of air conditioning control relay. Relay is located in engine electrical compartment. With relay operating coils energized, contacts close and circuit is completed to the air conditioning drive clutch solenoid valve. Solenoid valve is located in compressor compartment.

3. Air conditioning control relay is a lock-in type unit; that is, after operating coils are energized and contacts close, contacts will remain closed as long as the circuit through the contacts is not broken. Either of five conditions can break the circuit and cause relay contacts to open:

a. Too high or low refrigerant pressure.
b. Coach engine stops running.
c. Generator system fails.
d. Low air pressure (below 65 psi).
e. "VENTILATION" switch not in "AIR CONDITION" position.

4. The purpose of the lock-in feature of the air conditioning drive control relay is to maintain circuit to air conditioning clutch solenoid valve after the oil pressure safety switch opens. Oil pressure safety switch opens at 15 psi oil pressure (approximately 600 engine rpm). Purpose of this switch is to prevent engagement of air conditioning compressor drive clutch, if driver should turn control switch to "AIR CONDITION" position with engine running at 600 rpm or more.

5. On models without air conditioning, engine idle speed is set at 400 rpm. With air conditioning, idle speed is set at 465 rpm (8V engine) and 465 to 490 rpm (6V engine) depending on compressor load. NOTE: Too low a setting will cause engine to stall.

FUNDAMENTAL PRINCIPLES OF REFRIGERATION

The principle of operation of the refrigeration system is based on a few simple laws of physics which are stated informally as follows:

1. Temperature is a measurement of the intensity of heat.

2. Heat is a form of energy. When heat is added to a substance, it is noticed by an increase in temperature. For example, in order to raise the temperature of water from 35°F. to 100°F., it is necessary to add a certain amount of heat.

3. When an object cools, it does not absorb cold, but rather it loses heat to a colder object or substance nearby. When a bottle containing warm liquid is placed on a cake of ice, the ice will melt and the bottle and its contents will become cool. Heat from the bottle and contents is lost to the ice.

4. When a liquid boils, turning to vapor, it absorbs a great amount of heat. For instance, water boiling on a stove is absorbing a great amount of heat from the burner as it is changing to the vapor commonly called steam. Boiling is a rapid form of evaporation.

When a liquid boils, it absorbs heat without changing temperature. For example, when heat is added to water at sea level, as when heating on a stove, the temperature of the water will rise until it reaches 212°F. If the water remains on the hot stove, it will boil, but the temperature will remain at 212°F. The heat being absorbed by the water is changing it to steam rather than raising the temperature.

Refrigerant-22 used in air conditioning system, boils at 41.7°F. below zero. Thus, if it were exposed to the air at normal room temperature, it would absorb heat from surrounding air and boil, immediately changing to a vapor.

5. When heat is removed from this water vapor, it will condense back into a liquid. For example, the steam caused by boiling water on a stove will condense into water on the underside of the cover. This is due to the fact that the cover is not as hot as the steam. The cover, therefore, takes heat from the steam, causing it to condense back to water.

6. The temperature at which substances will boil or condense is affected by pressure. If the pressure is increased, the liquid will not boil until a higher temperature is reached. Thus, we can prevent refrigerant from boiling if it is kept under high pressure. If this high pressure is suddenly released, refrigerant will immediately boil. This has been demonstrated in modern vehicles with pressure cooling systems.

When the pressure of a vapor is increased, the temperature at which it will condense is also raised. Steam condenses at 212°F., if heat is removed from it, but it can be made to condense at higher temperature by increasing the pressure.

7. Compressing a vapor increases its temperature. For example, when pumping air into a tire with hand pump, the pump will become warm due to the heating of the air as it is compressed.

8. When a liquid is heated until it is converted to a gas, then this gas is heated additionally without changing pressure, the gas is said to be superheated. For instance, in the evaporator refrigerant absorbs heat and boils at a constant temperature and pressure until it has been completely vaporized, and it continues to absorb heat from the warm air passing over the evaporator without any increase in pressure. Since this heat is no longer being used to convert the refrigerant from a liquid to a gas, it will now cause the temperature of the refrigerant gas to rise. The refrigerant is then superheated.

SYSTEM OPERATION

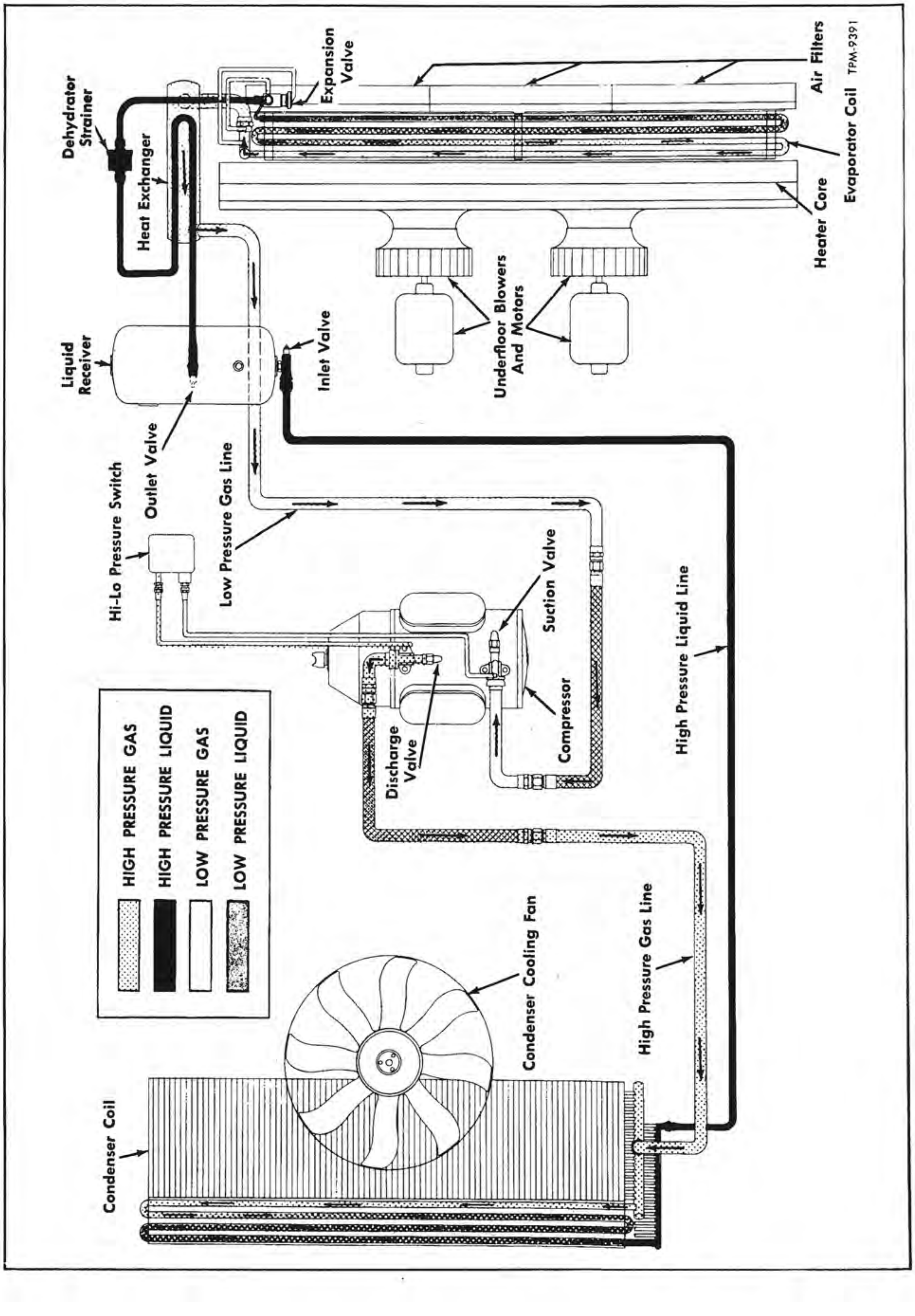


Figure 4—Schematic of Refrigerant Controls and Lines Showing High and Low Pressures

REFRIGERANT

The refrigerants used are commonly known by their trade name of Freon-22, Isotron-22, or Genetron-22. Regardless of brand, refrigerant-22 must be used. The chemical name of refrigerant-22 is monochlorodifluoromethane ($CHClF_2$).

REFRIGERANT CHARACTERISTICS

Refrigerant exists as a gas at atmospheric pressure and must be held under pressure to remain liquid. At ordinary temperatures, it will exist as a liquid under a pressure of about 75 pounds per square inch.

Refrigerant has very little odor, but in large concentrations a distinct odor may be detected. It is colorless in both its liquid and gaseous states.

Refrigerant is nonpoisonous, nonflammable, and nonexplosive. It is noncorrosive to any of the ordinary metals.

Goggles should be worn whenever there is the slightest possibility of refrigerant coming in contact with the face or eyes, because refrigerant evaporates and cools so rapidly it will cause an injury similar to frostbite.

PROCUREMENT

Refrigerant is shipped and stored in metal drums. It is serviced in one size, a 22 lb. drum.

It will be impossible to draw all the refrigerant out of the drum. The use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the drum. Be sure to follow the instructions under "Charging The System" explained later.

PRECAUTIONS IN HANDLING REFRIGERANT

1. Do not leave drum of refrigerant uncapped.
2. Do not subject drum to high temperature.
3. Do not weld or steam clean on or near system.
4. Do not fill drum completely.
5. Do not discharge vapor into area where flame is exposed.
6. Do not expose eyes to liquid.

All refrigerant drums are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is good practice to replace the cap after each use of the drum for the same reason. If the drum is exposed to the radiant heat from the sun, the resultant increase in pressure may cause the safety plug to release or the drum to burst.

For the same reason, the refrigerant drum should never be subjected to excessive temperature when charging a system. The refrigerant drum should be heated for charging purposes by placing in 125°F. water. Never heat above 125°F. or use blowtorch, radiator, or stove to heat the drum.

Welding or steam cleaning on or near any of the refrigerant lines or components of the air conditioning system could build up dangerous and damaging pressures in the system.

If a small drum is ever filled from a large one, never fill the drum completely. Space should always be allowed above the liquid for expansion. Weighing drums before and during the transfer will determine fullness of drums.

Discharging large quantities of refrigerant into a room can usually be done safely as the vapor would produce no ill effects. However, this should not be done if the area contains a flame-producing device such as a gas heater. While refrigerant normally is nonpoisonous, heavy concentrations of it in contact with a live flame will produce a poisonous gas. The same gas will attack all bright metal surfaces.

One of the most important cautions concerns the eyes. Any liquid refrigerant which may accidentally escape is approximately 41°F. below zero. If liquid refrigerant should touch the eyes, serious damage could result. Always wear goggles to protect the eyes when opening refrigerant connections.

TREATMENT IN CASE OF INJURY

Should liquid refrigerant come in contact with the skin, injury should be treated the same as if skin were frost-bitten or frozen. Should liquid refrigerant get into the eyes, a good eye specialist should be consulted immediately. Avoid rubbing or irritating the eyes. Give the following first aid treatment as soon as possible.

1. Drops of sterile mineral oil (obtainable at any drug store) should be introduced into the eyes. The mineral oil will absorb the refrigerant.

2. Eyes should then be washed, if irritation continues at all, with one of the following:

a. A weak boric acid solution.

b. A sterile salt solution not to exceed 2% sodium chloride (table salt).

3. If irritation continues for a period longer than 12 hours, eyes should be treated for secondary infection with 10% Argyrol solution or with 1% Mercuric Oxide ointment.

REFRIGERANT CIRCULATION

Refrigerant control units and piping is illustrated in figure 4. A complete cycle of the refrigerating system is as follows:

1. Refrigerant in its gaseous state is drawn into the compressor where it is compressed and discharged into the condenser.

2. As the heated gas circulates through the condenser coils, it is cooled by air being forced through the condenser by a hydraulically-driven

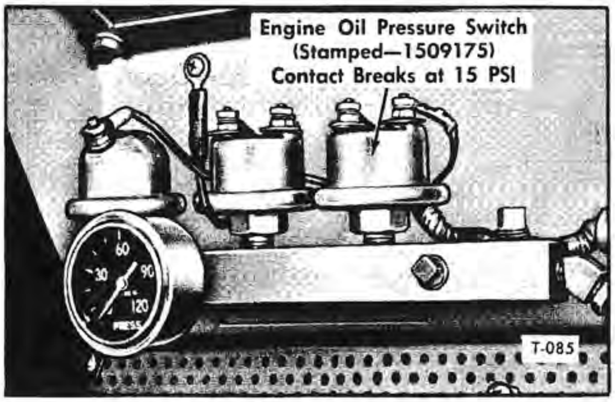


Figure 5—A/C Control Engine Oil Pressure Safety Switch Installed

fan. The combined effects of the decreased temperature and increasing pressure cause the gas to condense (liquify).

3. The liquid refrigerant is then forced from condenser into the liquid receiver.

4. By its own pressure, liquid refrigerant is forced from liquid receiver through the heat exchanger, where it is cooled somewhat by the returning suction line low pressure gas, then through the dehydrator and expansion valve into the evaporator.

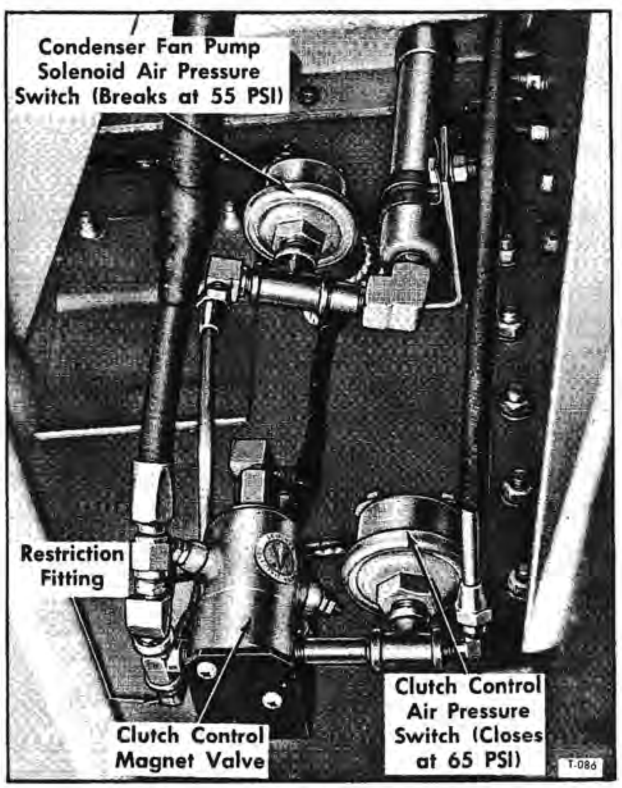


Figure 6—Clutch Control Air Solenoid Valve, Air Switches and Air Dome Installed (Typical)

5. In the evaporator, where the pressure is reduced, the liquid refrigerant evaporates, or changes into its gaseous state. As the liquid evaporates, heat is absorbed from the air passing through the evaporator coils, thus the air is cooled.

6. Flow of refrigerant into the evaporator is regulated by the expansion valve. The expansion valve is actually a pressure reducing valve which serves two purposes: a - It maintains pressure on the liquid line. b - It admits only the required amount of liquid refrigerant into the evaporator, this requirement being determined by the temperature of the gaseous refrigerant at the evaporator outlet.

7. The low pressure refrigerant gas passes from the evaporator through the heat exchanger and back through the suction line to compressor, thus completing the cycle.

NOTE: Gauges for checking pressures in the refrigerant system can usually be obtained from a local refrigeration service and supply dealer.

AIR CIRCULATION

With "VENTILATION" switch on control panel in "AIR CONDITION" position and with a minimum of 65 psi air pressure to compressor clutch control, the compressor will operate and the underfloor blowers will run continuously at high speed.

Blowers draw outside air into heating and cooling compartment through two grilled openings, one each side of coach just below windows. The outside air is blended with recirculated air which enters same heating and cooling compartment through two screened openings in the floor, one each side of aisle. This blended air is then drawn by blowers through screens where it is filtered, through evaporator coils where it is cooled and dehumidified, and then through the heater core unit where the temperature is raised to comfort level to extent determined by the control Grad-U-Stat. Tempered air then flows into coach interior through flat, wide, vertical ducts located below the windows.

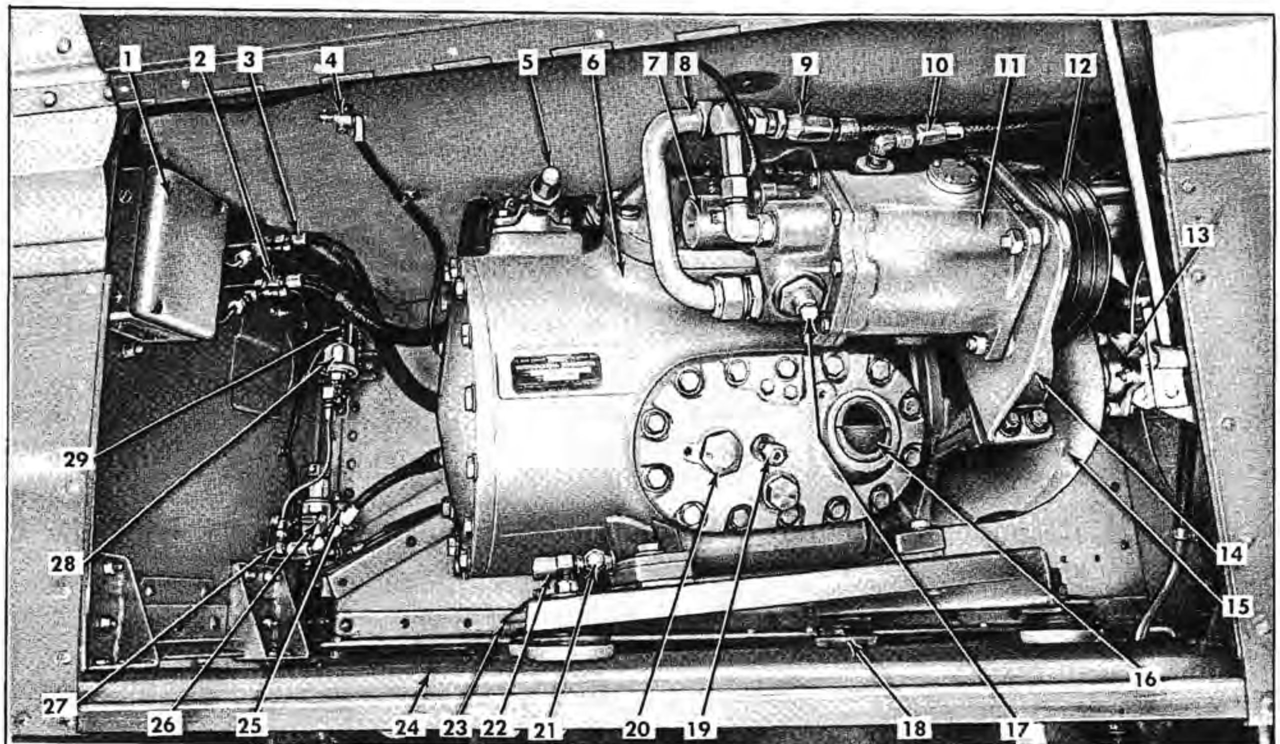
OPERATION OF ELECTRICAL CONTROL UNITS

Refer to "HEATING SYSTEM" (SEC. 3) for operating information on controls such as: Grad-U-Stat, air pressure regulating valve, blower motors, blower motor relays, water modulation valve and heating system water pump.

"VENTILATION" CONTROL SWITCH

Control switch marked "VENTILATION" on control panel at left of driver is a four-position rotary-type switch.

With switch in "AIR CONDITION" position, the circuit to underfloor blowers is energized causing



1 Refrigerant HI-LO Pressure Switch
2 Refrigerant Low Pressure Test Gauge Fitting
3 Refrigerant High Pressure Test Gauge Fitting
4 Heating System Water Line Drain Cock
5 Refrigerant Suction Valve Assy.
6 Refrigerant Compressor Assy.
7 Pump Solenoid Assy.
8 Fan Drive Low Pressure Return Line
9 Fan Drive High Pressure Supply Line
10 Fan Drive Vent Line
11 Fan Drive Pump Assy.
12 Fan Drive Pump Drive Belts
13 Compressor Drive Shaft Assy.
14 Fan Drive Pump Mounting Bracket
15 Compressor Clutch Unit
16 Compressor Oil Level Sight Glass
17 Compressor Fan Speed Control
18 Compressor Mounting Cushion Assy.
19 Compressor Oil Pressure Test Fitting
20 Compressor Cylinder Unloading Valve Adjustment
21 Compressor Oil Drain Valve Line Protector Cap
22 Compressor Oil Drain Valve Stem Protector Cap
23 Compressor Base Plate
24 Compressor Mounting Platform
25 Clutch Control Air Pressure Switch Assy.
26 Clutch Control Air Solenoid Valve Assy.
27 Restriction Fitting
28 Condenser Fan Drive Pump Air Pressure Switch
29 Air Dome

T-084

Figure 7—Refrigerant Compressor Compartment (Typical)

them to operate at high speed, and circuit is completed through the "HI-LO" refrigerant pressure switch. Circuits are shown in figure 3.

AIR CONDITIONING CONTROL RELAY

Air conditioning drive control relay is located in the apparatus box at right rear of coach as shown in figure 5 in "WIRING AND MISCELLANEOUS ELECTRICAL" (SEC. 7).

Relay serves to close electrical circuit to compressor drive clutch air solenoid valve causing valve to open, allowing air pressure to clutch.

SYSTEM OPERATION

Relay is a lock-in type unit; that is, after operating coils are energized and contacts close, contacts will remain closed as long as the circuit through the contacts is not broken. Either of five conditions can break the circuit and cause relay contacts to open:

1. Excessive high or low refrigerant pressure.
2. Engine stops running.
3. Low air pressure (below 65 psi).
4. "VENTILATION" switch not in "AIR CONDITION" position.
5. Generator system fails.

The purpose of the lock-in feature of the air conditioning control relay is to maintain circuit to air conditioning clutch solenoid valve after the oil pressure safety switch opens. Oil pressure safety switch opens at 15 psi oil pressure.

ENGINE OIL PRESSURE SAFETY SWITCH

Engine oil pressure safety switch is mounted in manifold on engine bulkhead (fig. 5).

With engine running and oil pressure at 15 psi or more, contacts of safety switch are opened. Purpose of switch is to prevent engagement of air conditioning compressor drive clutch if driver should turn control switch to "AIR CONDITION" position with engine running above 600 rpm.

CLUTCH CONTROL AIR PRESSURE SWITCH

Air pressure switch is mounted at left end of bulkhead forward of the refrigerant compressor (fig. 6). Purpose of switch is to prevent compressor drive clutch slippage which could be caused by insufficient operating air pressure.

Contacts of switch close when the air pressure in coach air system exceeds 65 psi. Switch completes circuit from No. 4 terminal of "VENTILATION" switch on control panel at left of driver, through the engine oil pressure safety switch, the refrigerant "HI-LO" pressure switch, and to the air conditioning control relay as shown in figure 3.

COMPRESSOR DRIVE CLUTCH AIR SOLENOID VALVE

Compressor drive clutch solenoid valve (fig. 6) is mounted on bulkhead forward of the refrigerant compressor.

Air valve is an electrically-operated valve which controls flow of air pressure for the operation of compressor drive clutch. Circuit to valve is controlled by the air conditioning control relay mounted in apparatus box at right rear of coach, as shown in figure 5 in ELECTRICAL (SEC. 7) (item 9).

With valve coil energized, air pressure is permitted to pass through valve and flexible line to engage the compressor clutch mechanism. When valve is de-energized by action of control relay, air pressure is exhausted from clutch drive mechanism to disengage clutch.

"HI-LO" REFRIGERANT PRESSURE SWITCH

Definite high and low refrigerant pressures are established at which the system will operate efficiently and safely. "HI-LO" pressure cutout switch is provided to prevent operation of system when pressures exceed these limits. The switch is located in compressor compartment. On all models 4502, 4518, and 4519, switch is located on side of compressor, whereas on all models 5302, 5303, 5304, the switch is mounted to bulkhead forward of compressor as typically shown in figure 7. Switch is connected to high and low refrigerant pressures at the compressor. Current from "VENTILATION" switch is routed through the "HI-LO" pressure switch. Whenever the high or low refrigerant pressure exceeds limits, switch interrupts compressor clutch controls to stop compressor. When this occurs, another set of contacts within control relay close to complete circuit from "VENTILATION" control switch to the A/C stop telltale on driver's panel. Telltale, when illuminated indicates that compressor is not operating. When refrigerant pressures normalize to the switch cut-in point, compressor clutch control circuit is again completed and the compressor becomes operative.

Switch adjustment procedures are explained later under "SYSTEM MAINTENANCE" - See "Refrigerant HI-LO Pressure Switch."

> NOTE: Other than the fundamental principles of refrigeration which are the same in most conventional refrigeration systems, the control and "reheat" phase of system as used on GM Coaches is relatively new to the field. Therefore, a thorough knowledge of the system and service procedures by maintenance personnel will assure long and efficient operation of air conditioning system.

System Maintenance

CONTENTS OF THIS SECTION

HI-LO PRESSURE SWITCH

The HI-LO pressure switch (fig. 8) is a dual pressure control switch connected in series with the air conditioning control circuit, and actuated by the high side and low side refrigerant pressures. The control unit consists basically of two bellows, both of which are connected through spring-loaded toggle linkage to a set of contact points, all enclosed within a dust-proof case.

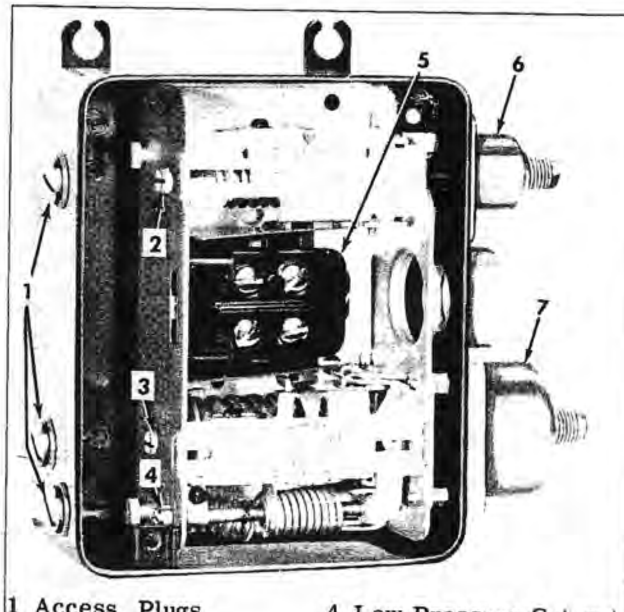
Low pressure cut-out and cut-in points are adjustable; high pressure cutout point is adjustable but the differential on the high pressure side of switch is fixed and nonadjustable. Openings are provided in side of case to permit making adjustments with a straight screwdriver.

All four wire terminals, L1, L2, M1, and M2 are used on this installation. Either of the two bellows assemblies and the contact assembly are replaceable. When connecting lines to either bellows, it is extremely important to use a wrench on hex portion of bellows element while tightening hose fitting to prevent damaging bellows.

The HI-LO pressure cut-out switch is properly set at the factory and should not normally require adjustment in the field. However, in the event of improper operation, switch operation can be tested and adjusted, if necessary, as follows:

LOW PRESSURE TEST AND ADJUSTMENT

Low pressure cut-out is an extremely important adjustment. System will not function satisfactorily and possible damage to compressor may result if switch points fail to open near the designated pressure. In making the following test, an accurate compound (pressure and vacuum) gauge should be used. Gauge set can be obtained from local refrigeration sales and service dealer.

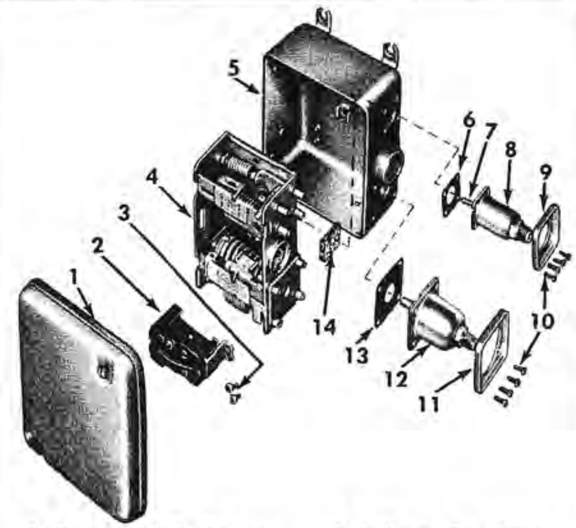


1 Access Plugs
2 High Pressure Cut-out Adjustment
3 Low Pressure Range Adjustment
4 Low Pressure Cut-out Adjustment
5 Contact Assembly
6 High Pressure Bellows
7 Low Pressure Bellows

TPM-1325

Figure 8—Refrigerant Hi-Lo Pressure Switch

SYSTEM MAINTENANCE



1 Cover and Seal Assy.
2 Switch Contact Assy.
3 Attaching Screws
4 Switch Actuating Assy.
5 Switch Box
6 Gasket
7 Plunger Shaft
8 High Pressure Bellows Assy.
9 Bellows Retainer
10 Attaching Screws
11 Bellows Retainer
12 Low Pressure Bellows Assy.
13 Gasket
14 Anti-rattle Pad

TPM-9453

Figure 9—Exploded View of Hi-Lo Pressure Switch

1. Remove cap from suction pressure line test gauge fitting (2, fig. 7); then connect pressure gauge line to valve. Have an assistant close suction valve slowly on top side of compressor by turning valve stem in (clockwise) until valve seats.

2. Start coach engine and operate compressor, then observe pressure reading on gauge at the instant compressor clutch becomes disengaged and compressor stops. Switch points should open to disengage clutch at 10 psi gauge pressure.

3. Next allow pressure to build up until compressor clutch becomes engaged. Pressure reading on gauge when switch points close and complete circuit to compressor clutch drive should be 30 psi.

4. If switch points do not open and close at gauge readings specified in Steps 2 and 3, adjust as follows:

a. Remove switch cover, and remove adjusting hole plugs from case.

b. If only the cut-out point requires adjustment, turn adjusting screw (4, fig. 8). Indicator is calibrated in increments of 5 psi.

c. If the cut-in point requires adjustment, turn adjusting screw "3," which changes the cut-in and cut-out points an equal amount, then re-adjust cut-out point by turning screw "4."

d. After adjusting, recheck operation of unit, then open suction valve at top of compressor.

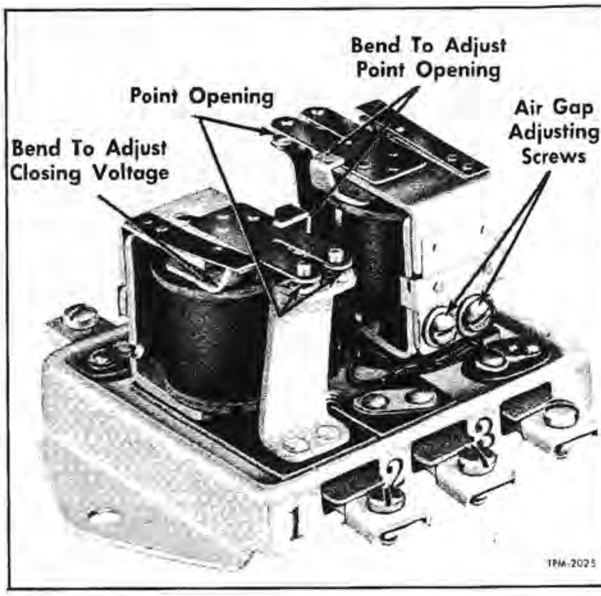


Figure 10—Air Conditioning Control Relay

HIGH PRESSURE TEST AND ADJUSTMENT

The high pressure side of the switch should open the points and disengage the compressor clutch at 375 psi gauge pressure, and should permit the points to close when pressure drops to 300 psi. The point at which the switch cuts out is adjustable, but the cut-in point is not adjustable. Test switch and adjust if necessary as follows, using an accurate high pressure gauge:

1. Remove cap from discharge pressure line test gauge fitting (3, fig. 7), then connect pressure gauge line to valve.

2. With both the suction and discharge valves in operating position, operate compressor. Have an assistant slowly close the discharge valve by turning valve stem clockwise and observe pressure reading on gauge the instant the compressor stops. If gauge reading when compressor stops is more or less than 375 psi, adjust by turning adjusting screw (2, fig. 8).

CAUTION: If high pressure switch fails to disengage compressor clutch when pressure reaches 400 psi, stop engine, as pressures in excess of this amount may damage other units.

3. Have assistant open discharge valve, then repeat test 2 above to recheck cut-out adjustment.

4. When pressure cut-out switch stops the compressor at correct pressure, continue to operate coach engine and air conditioning system until pressures equalize, then observe reading on pressure gauge when circuit is completed to compressor clutch drive. If switch does not permit points to close at 300 psi gauge pressure, the complete control unit should be replaced.

5. After completing tests and adjustments, install cover and install access plugs in case.

PRESSURE SWITCH ASSEMBLY REPLACEMENT

1. Pump down system as directed later under "SYSTEM SERVICES AND TESTS."

2. Disconnect refrigerant pressure lines at switch and immediately cap lines to seal moisture and air from system.

3. Reverse the above procedure to install pressure switch.

4. After installing switch assembly, place system back in operating position, then vent or crack line connections at switch. Tighten connections firmly after venting.

PRESSURE SWITCH BELLOWS AND CONTACT REPLACEMENT

NOTE: Three subassemblies of HI-LO pressure switch are available for service; the high and low pressure bellows (8 and 12, fig. 9), and the switch contact (2, fig. 9). The following describes replacement procedure of above mentioned parts. Bellows should be replaced if refrigerant is leaking into switch box, which may be due to a broken diaphragm within bellows. The switch contact unit should be replaced if arcing is noted when switch contacts open and close, or if current flow check indicates failure of current to pass through switch.

Disassembly

NOTE: Key numbers in text refer to figure 9.

1. Remove four screws (10) which attach high and low pressure bellows (8 and 12) to switch box (5). Remove bellows retainers (9 and 11), the bellows, and gaskets (6 and 13).

NOTE: Be careful not to lose plunger shaft (7) from inside of high pressure bellows (8).

2. Remove cover (1) with cover seal from switch box.

3. To remove the switch contact assembly (2), remove two small screws (3) which attach contact mounting bracket to switch box. Lift switch contact assembly from box.

Installation

NOTE: Key numbers in text refer to figure 9.

1. Attach switch contact assembly (2) to box with two small screws (3). Tighten screws firmly.

2. NOTE: A square shape soft rubber pad (14) is located between switch box and switch actuator assembly (4) at the high pressure bellows. Bellows plunger shaft (7) must be inserted through hole in pad when installed.

3. Install high and low pressure bellows (8 and 12), gaskets (6 and 13), and retainers (9 and 11) with small screws (10). Tighten screws firmly.

IMPORTANT: Cap openings of bellows line fittings until such time switch assembly is installed.

AIR CONDITIONING CONTROL RELAY

Air conditioning control relay, mounted on electrical panel at right rear of coach, controls the compressor clutch solenoid valve. Relay installed is shown in figure 5 of WIRING AND MISCELLANEOUS ELECTRICAL (SEC. 7). Figure 10 shows relay with cover removed.

Terminal No. 2 is fed through both air conditioning control engine oil pressure switch and the 65 psi air pressure switch from the "VENTILATION" control switch located on panel at left of driver when switch is in "AIR CONDITION" position.

Terminal Nos. 1 and 6 are fed by same circuit except that circuit does not flow through the engine oil pressure switch.

Terminals Nos. 3 and 4 are connected to relay operating coils. Terminals are fed from the No. 2 terminal of relay after current flows through closed contacts of first the low air pressure switch and then the refrigerant HI-LO pressure switch.

Relay circuits are shown on figure 3 or on Wiring Diagram in back of this manual. Terminal identification numbers shown on Wiring Diagram are stamped on base of relay at side of terminals. Relay adjustment points are shown in figure 10.

RELAY ADJUSTMENTS

Air Gap (Fig. 10)

Disconnect wires from terminal Nos. 2 and 5 and remove cover from relay. Press armature down until points just close, then measure air gap between armature and center of core. Air gap should be 0.014". Adjust air gap, if necessary, by loosening two screws and moving armature up or down as required.

Point Opening (Fig. 10)

With wires still disconnected from terminal Nos. 2 and 5, measure clearance between points with armature up against stop. Clearance should measure 0.028". Adjust point opening, if necessary, by bending the armature stop. Make sure opening at both points are equal and that points close simultaneously when armature is depressed. After completing adjustment, connect wires to terminal Nos. 2 and 5.

Closing and Opening Voltage (Fig. 10)

Check each unit separately by connecting an accurate reading voltmeter parallel with each operating coil circuit. Connect voltmeter from No. 3 terminal to ground for one unit and from No. 4 terminal to ground for the other unit. Also connect a variable resistance unit in series with the operating coil circuit at the same terminal to which the

SYSTEM MAINTENANCE

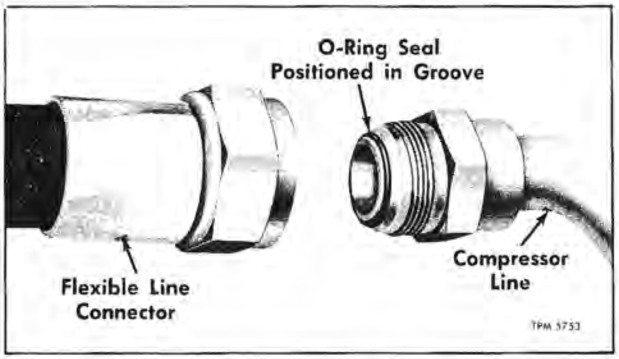


Figure 11—Refrigerant Line O-Ring Seal Installed

voltmeter is connected. Close the switch which controls the operating coil circuit of the unit being checked. Slowly decrease resistance and note voltmeter reading when points close. Points should close between 8.5 to 10.5 volts. If not within the range adjust by bending the armature spring post. Increase spring tension to increase closing voltage and decrease spring tension to decrease the closing voltage. After correct closing voltage adjustment is obtained, slowly increase resistance and note voltmeter reading when points open. If opening voltage is below 4.3 or if either unit fails to operate, replace the complete relay assembly.

REFRIGERANT CONNECTIONS

THREADED CONNECTIONS

A rubber O-ring seal (fig. 11) is used at line threaded connections to assure positive seal. Break line connection using two wrenches as shown in figure 12. After breaking connection, remove old O-ring seal and install new seal in seal groove.

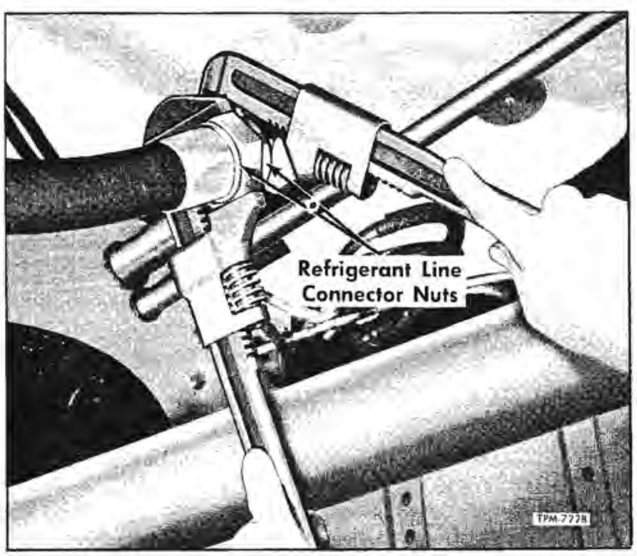


Figure 12—Using Two Wrenches At Line Connection

Before line is connected, apply clean compressor oil to O-ring seal to facilitate connection. Tighten line nut firmly. Check for leaks as explained later under "SYSTEM SERVICES AND TESTS."

SOLDERED JOINTS

Clean surfaces to be soldered using No. 00 steel wool, then apply thin coat of "Nokorode" flux. Sweat connection with special 95% tin and 5% antimony solder.

> IMPORTANT: Use GM replacement rubber lines - type 2603 or a brand of equal quality. When replacing any connection, either threaded or soldered, DO NOT use cast fittings - due to the porosity of castings, refrigerant gas will leak through the pores.

CLUTCH CONTROL AIR SOLENOID VALVE

Solenoid valve assembly is constructed as shown in figure 13. Foreign substances, present in compressed air system, may enter solenoid valve and injure valve faces and seats sufficiently to permit air leakage past valve rubber inserts when valves are seated. This condition may be detected easily on vehicle or on bench by testing valve ports with soap suds.

Valve assembly can be readily disassembled for cleaning, inspection, and replacement of parts.

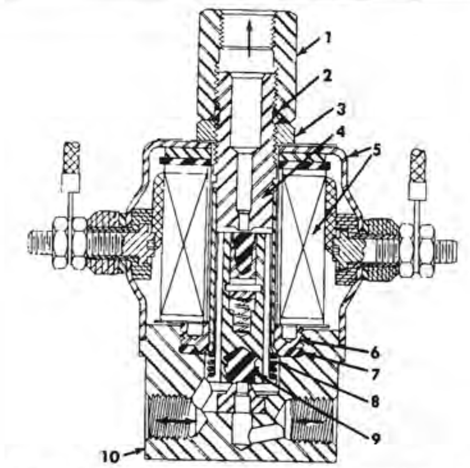
DISASSEMBLY

NOTE: Key numbers in text refer to figure 13.

1. Remove threaded adapter (1) and seal (2) from sleeve assembly (4), then remove thin nut (3) which retains housing and coil assembly (5) to sleeve assembly.
2. Remove housing and coil assembly (5) by sliding off upper end of sleeve assembly.
3. Using special spanner wrench (skinner No. VO-233), unscrew sleeve retaining nut (6) from valve body (10), then remove sleeve assembly (4), plunger assembly (9), and plunger spring (8) from valve body.
4. Remove sleeve nut seal (7) from valve body. Discard seals (2 and 7) and obtain new parts for assembly.

CLEANING AND INSPECTION

Wipe all parts clean with a clean cloth. Do not clean housing and coil assembly or plunger assembly in cleaning solvent. Examine rubber inserts in plunger assembly for wear or deterioration. Replace plunger assembly if damaged. Make sure valve seats on sleeve and in body are clean and smooth.



1 Adapter	6 Sleeve Retaining Nut
2 Adapter Seal	7 Sleeve Nut Seal
3 Thin Hex Nut	8 Plunger Spring
4 Sleeve Assembly	9 Plunger Assembly
5 Housing and Coil Assy.	10 Valve Body TPM-5756

Figure 13—Clutch Control Air Solenoid Valve

ASSEMBLY

NOTE: Key numbers in text refer to figure 13.

1. Assemble plunger spring (8) on plunger assembly (9) and position plunger in valve body.
2. Place new seal (7) in body, then install sleeve assembly (4) in body and secure with sleeve retaining nut (6). Use special spanner wrench to tighten sleeve nut.
3. Install housing and coil assembly (5) over sleeve, then install thin nut (3). Tighten nut only as necessary to seat parts solidly; overtightening will place excessive strain on sleeve assembly.
4. Place new seal (2) in groove of adapter, then install adapter (1) on sleeve. Hold nut (3) while tightening adapter.

LIQUID REFRIGERANT RECEIVER TANK

Liquid receiver (fig. 14) serves as a reservoir for a constant supply of liquid refrigerant ready for use in the evaporator. Two sight glasses are provided at left end of receiver; one in end of tank and one in side of tank. A light bulb, installed over side sight glass is illuminated by operating switch located inside of sight glass access door. With light on, level of refrigerant can be readily seen in end sight glass. After unit has been running for 30 minutes or more, refrigerant level should be at center of end sight glass. In no case should the refrigerant level be above the sight glass or below it with the system operating. Refrigerant can be added to the system at the compressor suction valve line to pressure switch test gauge fitting as

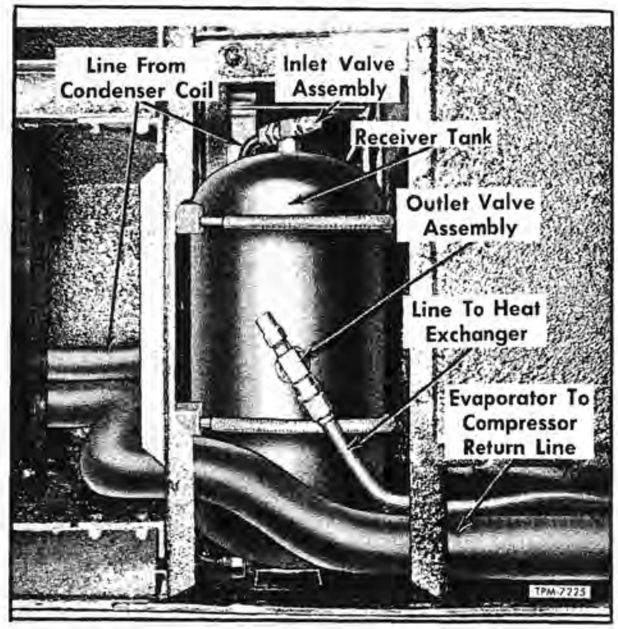


Figure 14—Refrigerant Receiver Tank Installed

directed in "SYSTEM SERVICES AND TESTS" later.

During operation of the system, both the receiver inlet and outlet valves must be fully open. To determine if valves are fully open, remove valve stem caps and turn valve stems counterclockwise to the limit of their travel. If air conditioning system fails to function, receiver valves

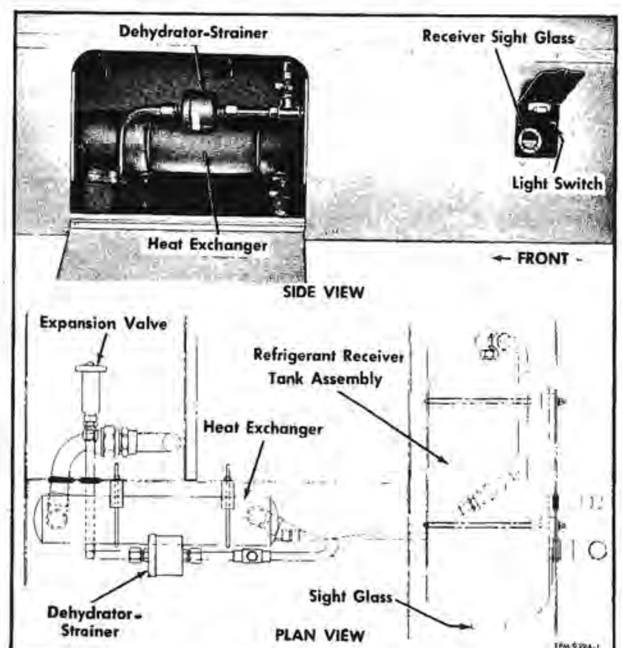


Figure 15—Dehydrator-Strainer, Heat Exchanger, and Receiver Tank Sight Glass Location

SYSTEM MAINTENANCE

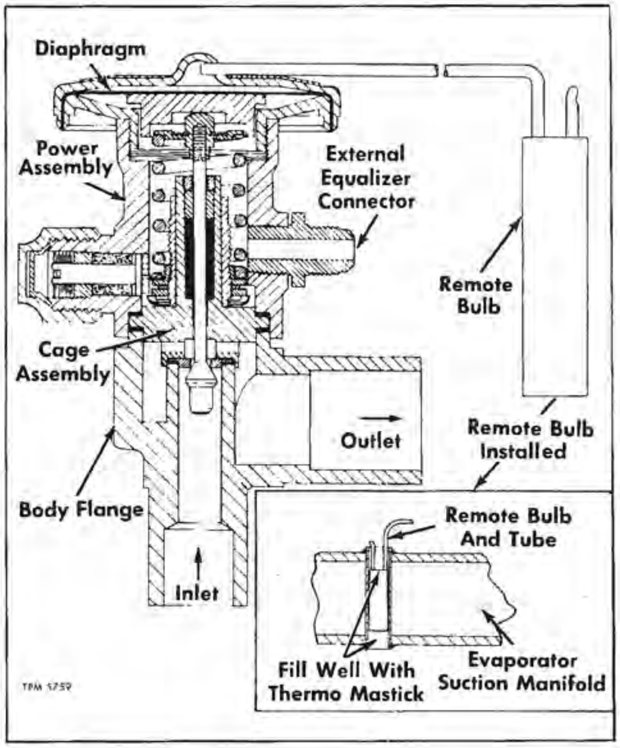


Figure 16—Sectional View of Expansion Valve

should be the first place to check. The system positively will not function unless both of the receiver valves are open. A fusible safety plug (212^{o}F.) is installed in top of receiver tank.

REFRIGERANT DEHYDRATOR—STRAINER

The refrigerant dehydrator-strainer, installed in the liquid line at left side of coach (fig. 15), removes foreign matter and moisture from the refrigerant before it reaches the expansion valve.

Strainer is of the disposable type, charged with activated alumina. The complete unit is discarded and replaced with a new unit.

Chemical used in unit has a high moisture absorbing capacity. Any moisture which has been inadvertently admitted into system will be absorbed by the chemical. This does not mean that the system should not be evacuated when air and moisture has been admitted.

Whenever the system has been opened for any reason, the dehydrator-strainer should be again replaced after a few hours of operation. Also, it is recommended that unit be replaced at beginning of air conditioning season; when the system has been inoperative during winter operation, and after every six months of air conditioning operation.

Instructions for replacing unit are explained later in this group under "SYSTEM SERVICES AND TESTS."

EXPANSION VALVE

Expansion valve (fig. 16) is installed in the underfloor compartment at left end of evaporator coil as shown in figure 17. Valve is accessible for servicing or replacement only after the evaporator coil is removed. Expansion valve is set at the factory to provide the most efficient operation of the system, and should not normally require adjustment in the field. However, in the event a new evaporator coil and valve assembly or a new expansion valve power or cage assembly is installed, valve must be adjusted to provide the correct superheat at the evaporator outlet. In any event, do not adjust the expansion valve to compensate for insufficient cooling until all other possible causes are checked for and corrected.

EXPANSION VALVE OPERATION

Expansion valve is a manifold type thermo valve with external remote control bulb and external equalizer. Expansion valve regulates the flow of liquid refrigerant into the evaporator coils. Valve is primarily operated by the temperature of the suction gas leaving the evaporator, and is further controlled by the pressure in the evaporator through the equalizer tube. The combined effect of these two factors automatically control the quantity of liquid admitted into the evaporator. See figure 18, which shows schematic view of valve operation.

Outlet end of valve is of manifold type, which is connected by several small distributor tubes to the evaporator coils. Liquid line is connected to inlet port which extends through the center of the body flange. The remote bulb is inserted into the hollow end of the evaporator coil outlet manifold, where it is subjected to the temperature of the suction gas as it leaves the evaporator. Bulb is charged with gas refrigerant which expands and contracts in accordance with the temperature of the suction gas. Expansion of refrigerant in bulb applies pressure against diaphragm in valve power assembly, causing valve to open.

Bulb tends to operate valve toward its open or closed position to regulate the flow of refrigerant into the evaporator as required. If too much liquid is admitted into the evaporator, all of it does not evaporate and some liquid approaches the remote bulb, lowering its temperature. This will cause the liquid in the bulb to contract, relieving pressure on diaphragm, and spring moves valve toward its closed position. If there is not enough liquid in the evaporator, the resulting increase in temperature of the suction gas raises temperature of bulb, causing valve to operate in its opening direction.

EXTERNAL EQUALIZER

The purpose of the equalizer is to prevent flooding the evaporator coils when temperature of

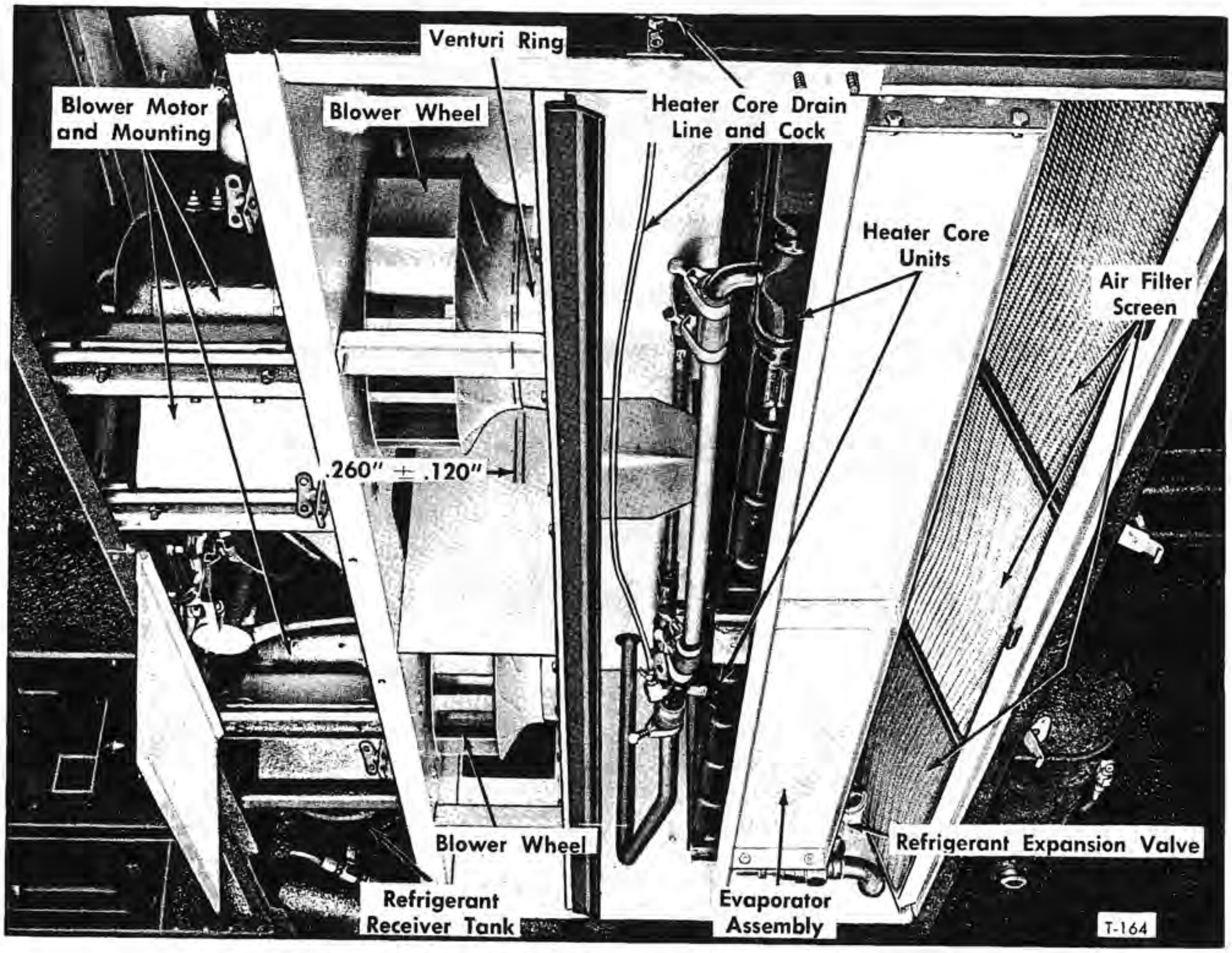


Figure 17—Cooling and Heating Compartment Closure Panels Removed

evaporator suddenly rises. Equalizer tube is connected into the evaporator coil outlet manifold and to the cavity below the diaphragm in the valve power assembly. Thus, when valve is suddenly opened wide by a high temperature in the suction gas, the heavy flow of liquid into the evaporator creates a high pressure which is carried to the underside of the diaphragm through the equalizer tube. This pressure below the diaphragm counteracts the pressure from the remote bulb and tends to move the valve toward its closed position.

CONSTRUCTION (Fig. 16)

The expansion valve has three basic component parts: The power assembly, cage assembly, and body flange. There are no working parts in the body flange. The outlet body flange is soldered to evaporator by tubes and a tube distribution manifold. Power assembly and cage assembly can be removed from the body flange without breaking any soldered connections.

Always make sure the system is clean and dry before installing the expansion valve.

SUPERHEAT

Superheat is the temperature increase of a gas, above the saturation point. When the liquid refrigerant boils or evaporates in the evaporator, heat is absorbed from the air passing through the evaporator coils, but the temperature of the gas does not rise above the boiling point until all the liquid has changed to gas. The heat thus absorbed is the latent heat of vaporization, producing a change in state with no change in temperature.

After the refrigerant has changed to gas, the temperature of the gas is still lower than the temperature of the air passing through the evaporator, so the gas will continue to absorb heat from the air and its temperature will rise a few degrees. This amount of rise above the saturation temperature is called "superheat."

Example: At 69 psi gauge pressure, the saturation temperature of refrigerant is 40°F.; that is, the liquid changes to gas at 40°F. If the temperature of the refrigerant gas at 69 psi gauge pressure is 48°F., the gas contains 8°F., of superheat. Superheating takes place after all the liquid

SYSTEM MAINTENANCE

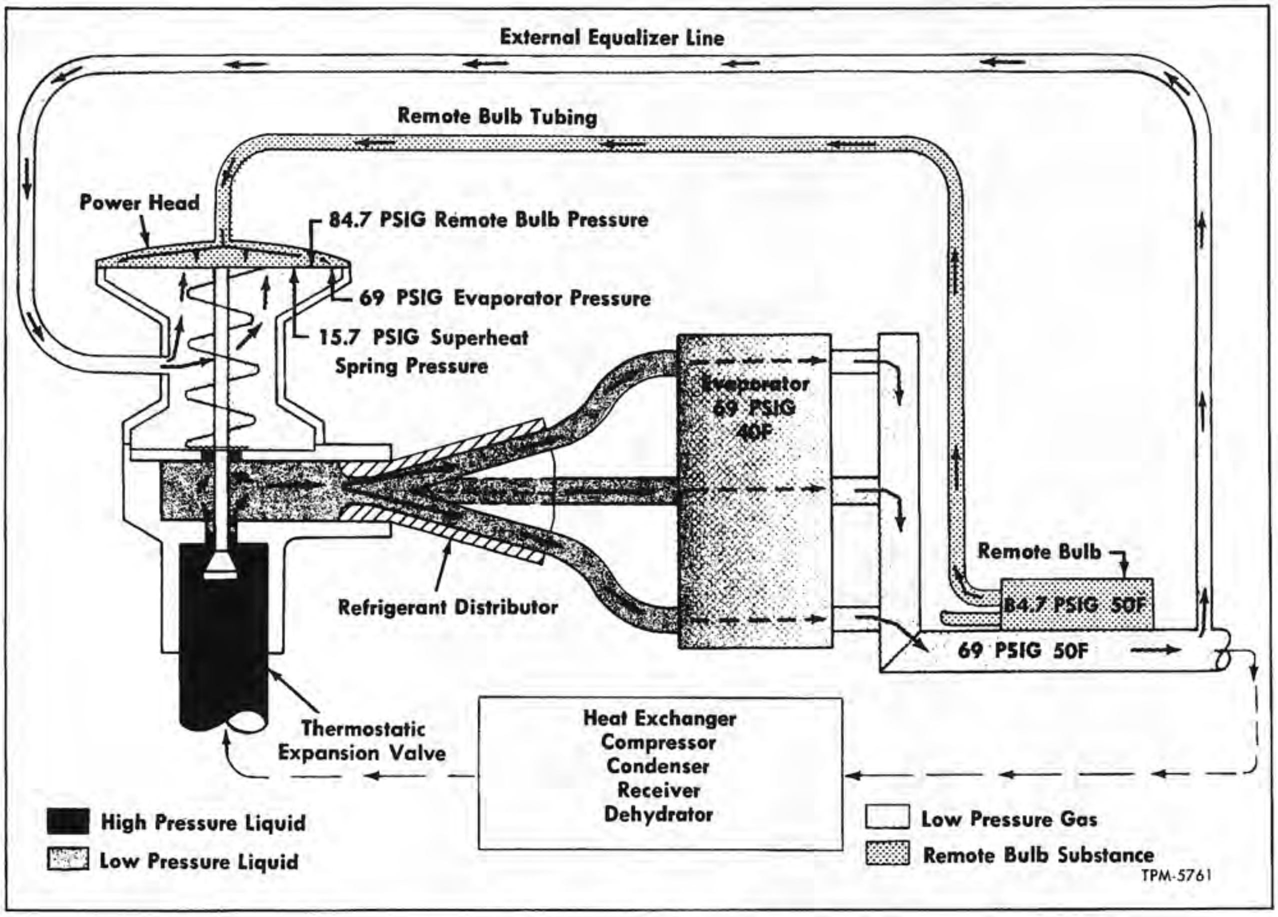


Figure 18—Simplified Diagram of Expansion Valve Operation

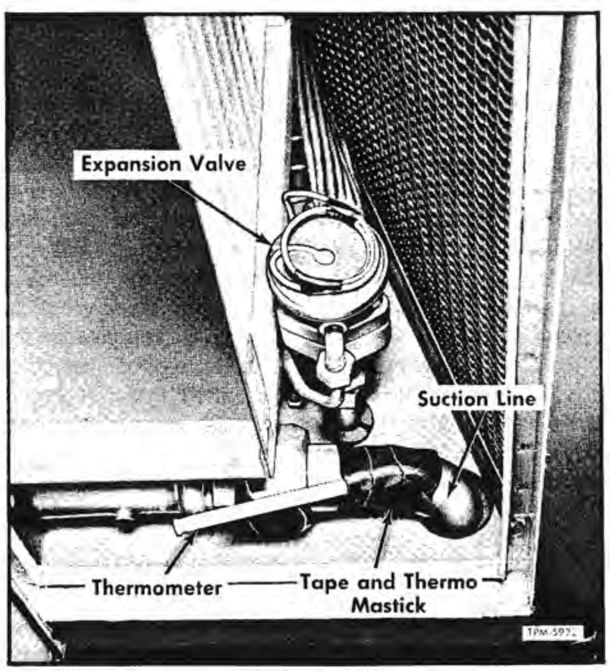


Figure 19—Checking Superheat

has changed to gas, usually near the outlet end of the evaporator coils.

PRESSURE - TEMPERATURE

Pressure has a very definite relationship to the boiling point of any substance. There is a definite temperature at which a liquid will boil for every definite pressure exerted upon that liquid. Water, which boils at 212°F. under zero gauge pressure (atmospheric pressure at sea level), will boil at approximately 232°F. under 10 psi gauge pressure.

Likewise, refrigerant boils at -41°F. (-41°F., below zero) under atmospheric pressure, and at 40°F. under 69 psi gauge pressure. An increase in pressure causes a rise in the boiling point.

The pressure temperature relationships shown in the table on page 423 are usedfor two purposes: for adjusting the expansion valve and for checking for air in the system. Method of checking for air in the system is described in "SYSTEM SERVICES AND TESTS" later in this group.

EXPANSION VALVE ADJUSTMENT

Valve should be adjusted to obtain 8° to 12°

superheat with moderately heavy internal load. Refer to pressure-temperature chart.

1. Apply small quantity of a thermo-type mastick to a remote-reading thermometer and attach to evaporator coil outlet, as shown in figure 19. Thermo-mastick may be available at a local refrigeration service establishment, or it can be obtained from the Alco Valve Company, St. Louis, Missouri.

2. Connect a low pressure gauge at the compressor suction valve test gauge fitting. Loosen line connection at gauge and expel air from line.

3. Compare pressure reading on gauge with temperature reading on thermometer against corresponding pressure in table. If necessary, remove cap from expansion valve adjusting stem; turn valve stem clockwise to decrease flow of refrigerant and increase superheat; turn valve stem counterclockwise to increase refrigerant flow and lower superheat. Two complete turns of valve stem will change the actuating superheat approximately 1^{o}F.

4. After adjusting, wait about 30 minutes to check results.

5. Remove gauge and line, then install protector cap on test gauge fitting.

NOTE: If superheat is lower than recommended, check the following:

a. Temperature in coach may be too low.
b. Expansion valve adjustment necessary.

If superheat is higher than recommended, check the following:

a. Expansion valve adjustment necessary.
b. Defect in expansion valve.
c. Low on refrigerant.
d. Obstruction in system low pressure side circuit.

REFRIGERANT PRESSURE - TEMPERATURE RELATIONSHIP - For F-22

Temp. ^{o}F.	Gauge Pressure Psi	Temp. ^{o}F.	Gauge Pressure Psi
30	55	96	187
32	58	98	192
34	61	100	198
36	63	102	204
38	66	104	210
40	69	106	216
42	72	108	222
44	75	110	229
46	78	112	235
48	81	114	242
50	85	116	249
52	88	118	256
54	92	120	263
56	95	122	284
58	99	124	292
60	103	126	299
62	106	128	306
64	110	130	313
66	114	132	321
68	118	134	329
70	123	136	337
72	127	138	345
74	131	140	353
76	136	142	361
78	140	144	370
80	145	146	379
82	150	148	389
84	155	150	399
86	160	152	407
88	165	154	416
90	170	156	426
92	175	158	437
94	181	160	448

SERVICING THE EXPANSION VALVE (Fig. 16)

When necessary to clean, inspect, or replace parts, the power assembly and cage assembly may be removed without disconnecting any soldered joints.

1. Pump down the system as directed in "SYSTEM SERVICES AND TESTS," later in this group.

2. Disconnect the external equalizer line from power assembly. Pull remote bulb out of end of evaporator coil outlet manifold. Use care to prevent kinking or otherwise damaging capillary tubing.

3. Remove two cap screws attaching power assembly to body flange, remove power assembly, then lift out cage assembly.

4. When assembling valve, replace gaskets in proper places, and be sure the retaining pin on the valve cage enters the slot in the body flange.

5. Make sure the two lugs on the valve cage fit into grooves in the power assembly, and that the gear wheel on cage assembly meshes with adjusting gear in side of power assembly. Do not force the valve together - make the cage fit properly before tightening to the body flange.

CAUTION: If necessary to make soldered connections at body flange, first remove power assembly, cage assembly, and all gaskets. Keep heat away from all valve parts except the body flange.

6. Insert remote bulb into end of evaporator coil outlet manifold, making sure there are no sharp bends or kinks in the capillary tube.

EXPANSION VALVE FREEZES

Expansion valve trouble caused by moisture in system may be usually detected by an intermittent hissing sound at the expansion valve at high temperatures. Do not confuse this hissing sound with the hissing caused by a shortage of refrigerant. Excessive refrigerant causes a hissing sound ac-

SYSTEM MAINTENANCE

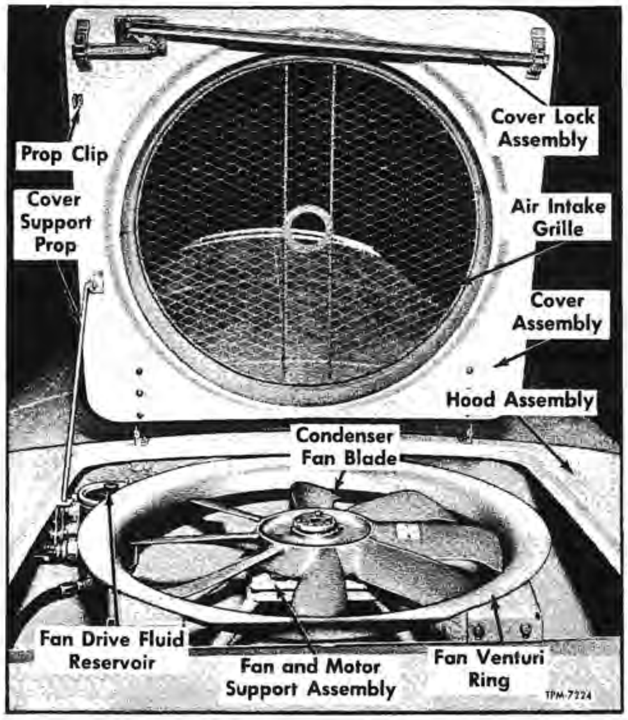


Figure 20—Access To Condenser Compartment

companied by a pounding vibration. When operating at low temperatures, moisture is indicated by the above, and by the fact that when the compressor is shut down and the valve warms up, it will become operative again for a short time.

If there is moisture in the system, it is necessary to evacuate the system with a vacuum pump, then replace the dehydrator-strainer. If moisture is still evident after one hour of operation, the dehydrator-strainer must be replaced again. Repeat until all moisture has been eliminated. Moisture trouble is caused by moist air entering piping when system is open, or from water in refrigerant container. Piping should be blown out with refrigerant before making final connections, particularly if piping has been open to air with high humidity content. After system has been pumped down and system opened, moisture is almost certain to be introduced. Always replace the dehydrator-strainer whenever the system has been opened and service again after a few hours of operation.

Many chemical preparations to be added to the refrigerant are now offered commercially for correcting moisture trouble. These preparations are anti-freeze solutions and are not suitable for use in compressor used in the system. The best practice is to always replace the dehydrator-strainer whenever the system has been opened. This absorbs the moisture rather than preventing it from freezing, and also eliminates the danger of corrosion of internal parts of system caused by the presence of moisture.

EVAPORATOR

Finned tube type evaporator is mounted in heating and cooling compartment under floor (fig. 17). If the underfloor air filter screens installed ahead of the evaporator are serviced frequently enough, there should be no maintenance required on the evaporator. However, if servicing the filters is neglected, some particles of dust, lint, etc., may pass through the filter; since the evaporator coils and fins are moist, these particles will cling to them. Dirt on the coils and fins acts as insulation and reduces the efficiency of the system, and when operating in humid climates, objectionable odors may develop caused by a mold-like formation or growth. In the event the evaporator does become dirty, it must be cleaned with air pressure and water and some cleaning agent which is not harmful to the aluminum tubes and fins. Since the location of the evaporator is not conducive to thorough cleaning in the vehicle, and considerable time is required for removing the evaporator for cleaning, the importance of cleaning or changing the air filters at frequent intervals should be impressed upon all maintenance personnel.

AIR FILTER SCREENS

AIR FILTER SCREENS, LOCATED IN THE UNDERFLOOR COOLING AND HEATING COMPARTMENT, MUST BE KEPT CLEAN FOR SATISFACTORY OPERATION OF THE AIR CONDITIONING SYSTEM.

Instructions for cleaning screens are explained under "HEATING AND VENTILATION" (SEC. 3).

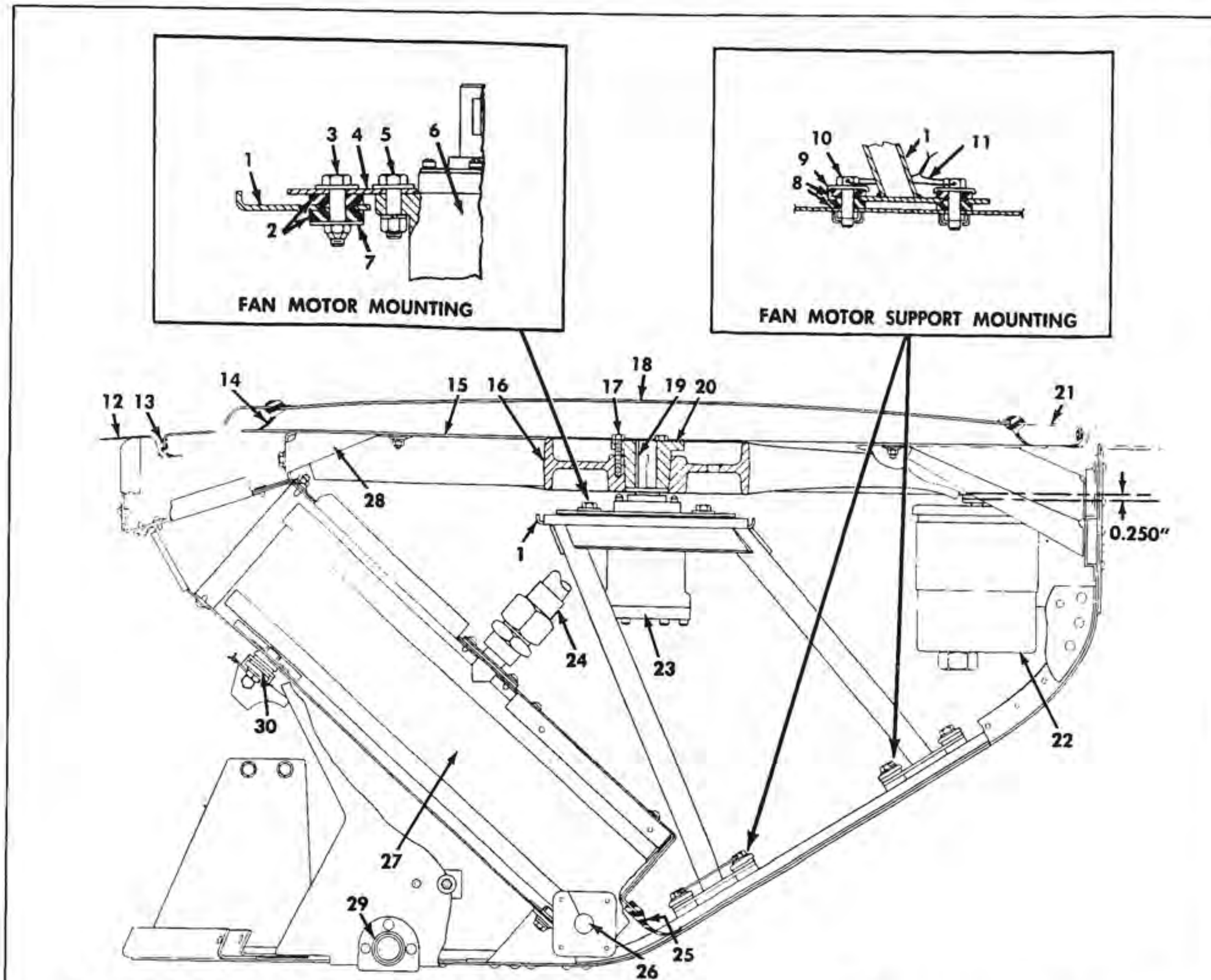
UNDERFLOOR BLOWERS AND MOTORS

Complete maintenance instructions on the underfloor blowers and motors are covered earlier under "HEATING AND VENTILATION" (SEC. 3) of this manual.

CONDENSER COMPARTMENT

Condenser compartment is located in roof at rear of coach and is covered by hood as shown in figure 20. Compartment contains the condenser coil, condenser cooling fan, fan motor, and motor drive hydraulic fluid reservoir. Figure 21 shows sectional view of compartment.

Compartment cover is equipped with an air intake grille. The compartment hood is equipped with an exhaust grille at rear. Both grilles are rubber insert retained in hood and cover opening. Hood cover is hinge-mounted to hood structure at front and is latched in closed position at rear.



1 Fan Motor Support Assembly
2 Rubber Mountings
3 Mounting Bolt
4 Mounting Plate
5 Mounting Bolt
6 Fan Motor Assembly
7 Flat Washer
8 Mounting Cushion
9 Mounting Cushion Retainer
10 Mounting Bolt
11 Lock Wire
12 Compartment Hood
13 Hood Cover Seal
14 Cover Air Intake Grille Seal
15 Venturi Ring
16 Fan Blade Assembly
17 Cap Screw
18 Air Intake Grille
19 Drive Key
20 Fan Blade Hub
21 Compartment Cover Assembly
22 Fluid Reservoir Assembly
23 Fan Drive Motor Assembly
24 Refrigerant Gas Line
25 Condenser Coil Lower Seal
26 Refrigerant Liquid Line
27 Condenser Coil Assembly
28 Venturi Ring Bracket
29 Compartment Drain
30 Coil Rubber Mounting TPM-7262

Figure 21—Sectional View of Condenser Compartment

Hood cover hinge brackets can be adjusted to provide proper cover-to-hood opening fit. A square shank key is used to unlock hood cover (fig. 22). With hood closed, compartment is rubber sealed completely around perimeter to assure full air flow through condenser coil.

Cover and hood grilles must be kept clean at all times as leaves, bits of paper, or other obstructions will restrict air flow through condenser coil. Check and clean screens and grilles daily when operating air conditioning system.

Hood attached to coach structure with screws can be removed for purpose of replacing condenser coil after removing attaching screws around bottom of hood.

Moisture drain holes in rear corners of compartment must be kept clean and open.

Hood cover air intake grille opening should be kept covered during the off season. Instructions for covering openings are explained later under "SYSTEM SERVICES AND TESTS."

SYSTEM MAINTENANCE

CONDENSER

The condenser coil (27, fig. 21) is the medium through which the heat picked up by the refrigerant in the evaporator and the heat of compression is dissipated to the air. Since the heat in the gas must be dissipated through the walls of the coils and the fins, it is of extreme importance that the condenser be kept clean. THE IMPORTANCE OF KEEPING THE CONDENSER CLEAN CANNOT BE OVER-EMPHASIZED. When condenser becomes clogged or coated with dirt and road film, high head pressure occurs and extra operating power is required. Condenser must be cleaned at regular intervals.

Access to condenser is attained after raising hood cover which can be propped in raised position. Figure 20 shows view of the condenser compartment. Figure 21 shows sectional view of compartment.

Clean condenser coil as directed later under "SYSTEM SERVICES AND TESTS."

CONDENSER FAN AND DRIVE

CONDENSER FAN

Condenser fan is of eight-blade propeller type and is mounted above condenser coil in roof compartment at rear of coach (fig. 20). Fan pulls 9,000 cfm of air from above roof and pushes it through the condenser coil and discharges it out through expanded metal grille above rear window.

Fan is driven at constant speed (1800 rpm $\pm$25 rpm) by a hydraulic motor which receives a constant flow of oil from a varying displacement pump. Pump is belt-driven from compressor flywheel.

Fan is adjustable vertically and the venturi ring around blades is also adjustable. Proper adjustment is obtained when lower edge of fan blade (16, fig. 21) extends 0.250" below edge of venturi ring (15, fig. 21).

FAN BLADE REPLACEMENT

NOTE: Key numbers in text refer to figure 21.

Removal

NOTE: Mark relationship of fan hub (20) and shaft of motor (23) to assure original positioning of parts when reinstalled.

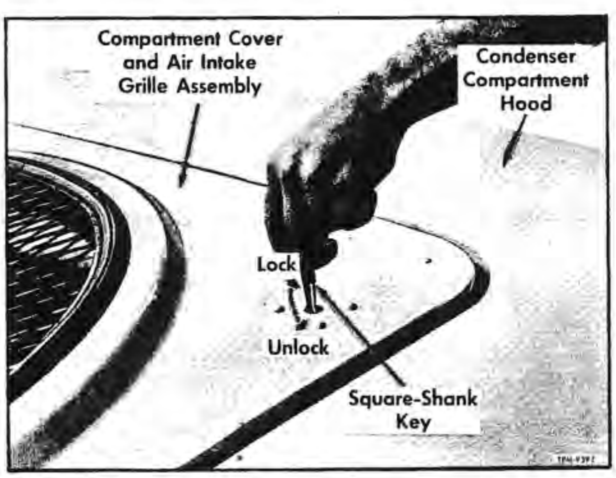


Figure 22—Unlocking Compartment Hood Cover

1. Loosen three cap screws (17) which secure fan blade (16) to fan hub (20). Screws should be loosened to relieve clamping effect of fan hub on motor shaft.
2. Install same three screws in tapped holes of fan hub, then tighten screws evenly to separate fan from hub and to force hub from motor shaft. Remove hub and fan blade.

CAUTION: Handle fan blade carefully.

Installation

NOTE: Fan hub should be opened slightly (wedge and press) to permit installation over hub.

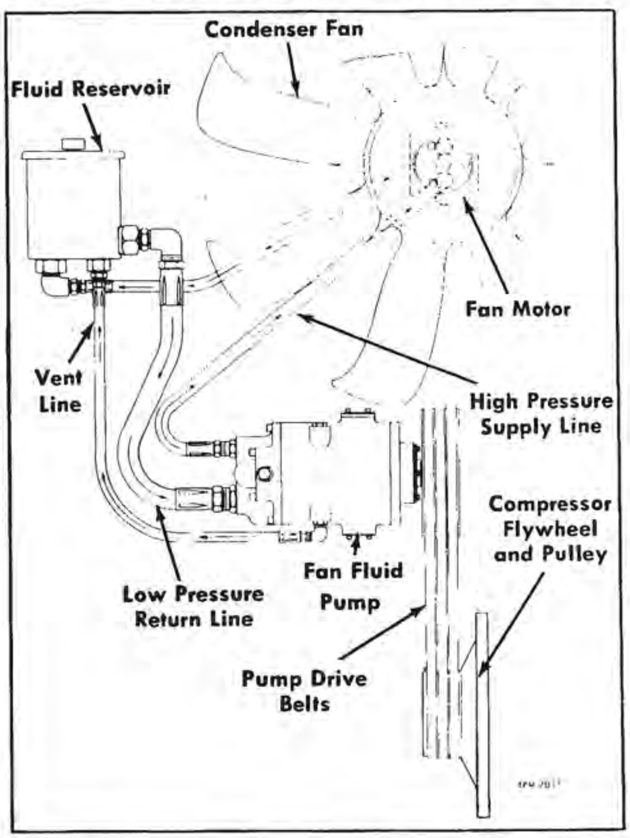


Figure 23—Schematic of Condenser Fan Drive Lines, and Units

1. Position fan blade (6) over taper of fan hub (20) and secure loosely with three attaching cap screws (17).

2. Locate drive key (19) into keyway of motor shaft, then slowly lower fan blade and hub down over motor shaft and into alignment with shaft key. Lower fan hub on shaft to marks made prior to fan removal, then tighten cap screws (17) alternately to 7-10 foot-pounds torque.

CONDENSER FAN DRIVE

Condenser fan drive units consists of a hydraulic motor, an oil reservoir, a hydraulic pump, and connecting lines. These units are shown schematically in figure 23. The pump hydraulically governs fluid flow to the fan motor to give a constant output speed. Fan motor is rubber mounted to motor support as shown in figure 21. Oil reservoir in same compartment is also rubber mounted (fig. 24).

Figure 25 shows a schematic of the condenser fan drive system. Figure 26 shows sectional view of fan pump and figure 27 shows sectional view of fan motor. The fan drive pump is belt driven from compressor flywheel. Drive belts must be kept to tension specified later under "Belt Tension Adjustment."

Oil in reservoir must be kept to level specified later under "SYSTEM SERVICES AND TESTS."

A "Trouble Shooting Chart" on page 447 describes a malfunction or condition of system, the possible causes, and recommendations for making correction. Reference to this chart may supply information whereby it may not be necessary to remove, replace, or repair units.

DESCRIPTION AND OPERATION

The pump (fig. 26) is a rotating cylinder block type containing nine pistons in the block, whereby the block itself is keyed to the shaft by a spline. The pistons are spring-loaded to keep them constantly against the thrust plate, which is held in the casting of the swash plate. Swash plate is held so that a change in angle of piston stroke on the pistons in the cylinder block can be made. This angle is controlled by the power piston at the top of the pump which bears against the swash plate. It is by pressurizing with oil pressure or dumping the power piston area in accordance with input speed that a constant fluid flow is obtained at pump outlet. This assures constant speed of fan motor.

The actual starting of the fan pump is momentarily delayed (1 to 1-1/2 seconds) from the starting of the compressor, both of which are driven by the same clutch. This delay which is brought about by action of solenoid (7, fig. 7) mounted on fan pump, serves to reduce the initial clutch load and to eliminate rapid surge of hydraulic fluid to fan

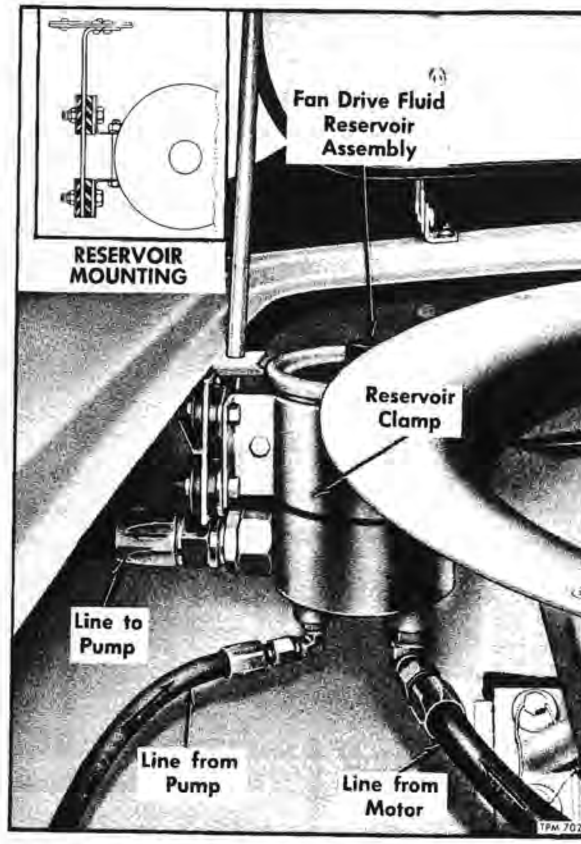


Figure 24—Fan Drive Fluid Reservoir Installed

motor when system starts to operate.

Refer to figure 25 which shows the solenoid location in the system fluid circuits.

When clutch engagement first occurs, pump solenoid is energized. Solenoid plunger is pulled from fluid passage seat to dump the high fluid pressure from pump power piston chamber into the pump low pressure circuit. When pressure is dumped the angle of pump swash plate is moved to the no-load or neutral position.

After a short delay, solenoid becomes de-energized and spring-loaded plunger within solenoid seats to close fluid passage through circuit. This permits build-up of fluid pressure to move pump swash plate to operating position.

Pump solenoid operation occurs as follows: When compressor clutch control air solenoid valve (26, fig. 7) releases air pressure to engage clutch, air pressure is also allowed to pass slowly through a 1/64" restriction fitting (27, fig. 7) from clutch control solenoid through line to air dome (29, fig. 7) on bulkhead. When the air pressure reaches 55 psi in this branch line the normally closed contacts of the pump air switch (28, fig. 7) in same line open to break circuit to pump solenoid (7, fig. 7). Pump solenoid valve becomes de-energized to cause operation of fluid pump.

SYSTEM MAINTENANCE

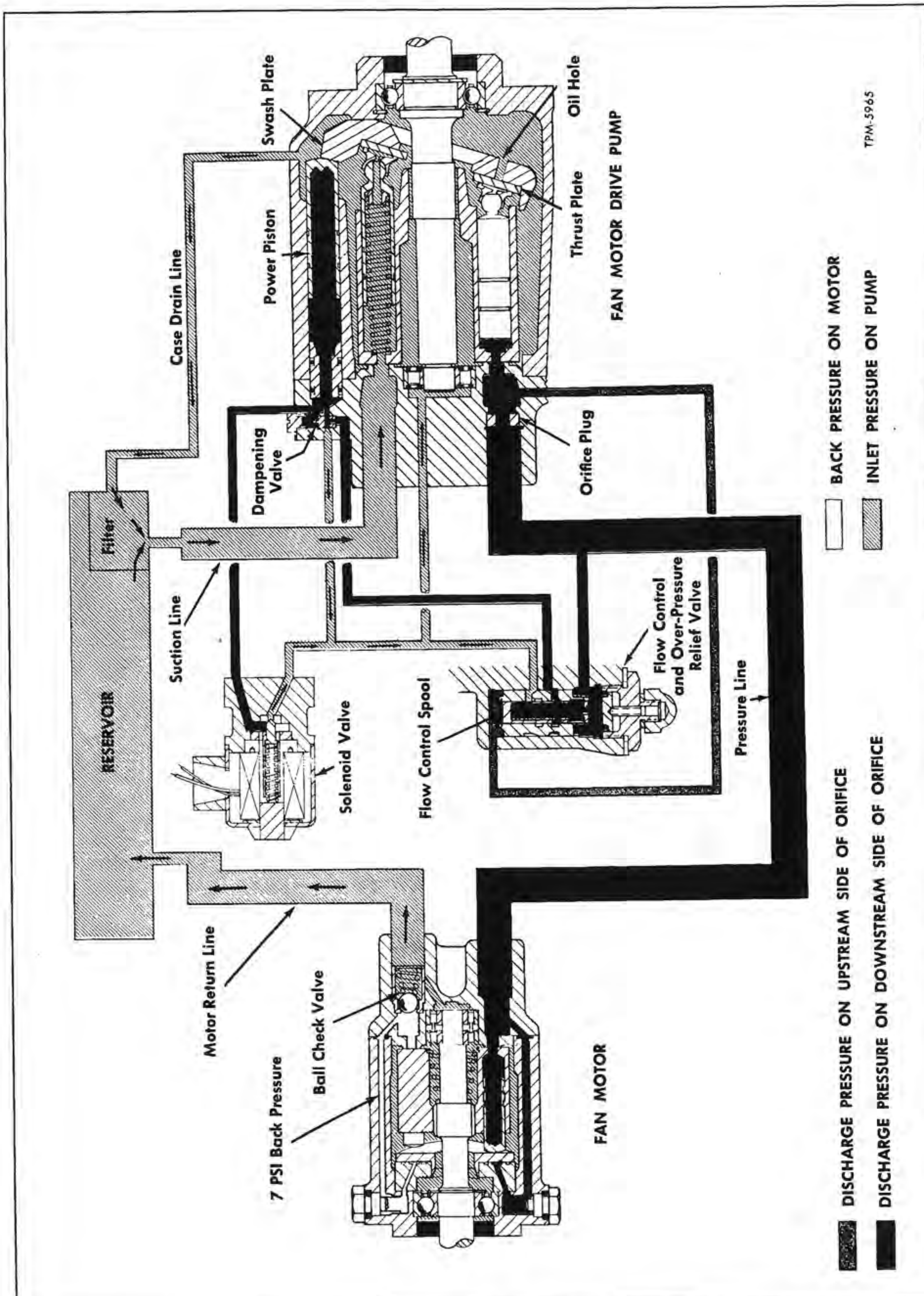


Figure 25—Schematic of Condenser Fan Hydraulic Drive System

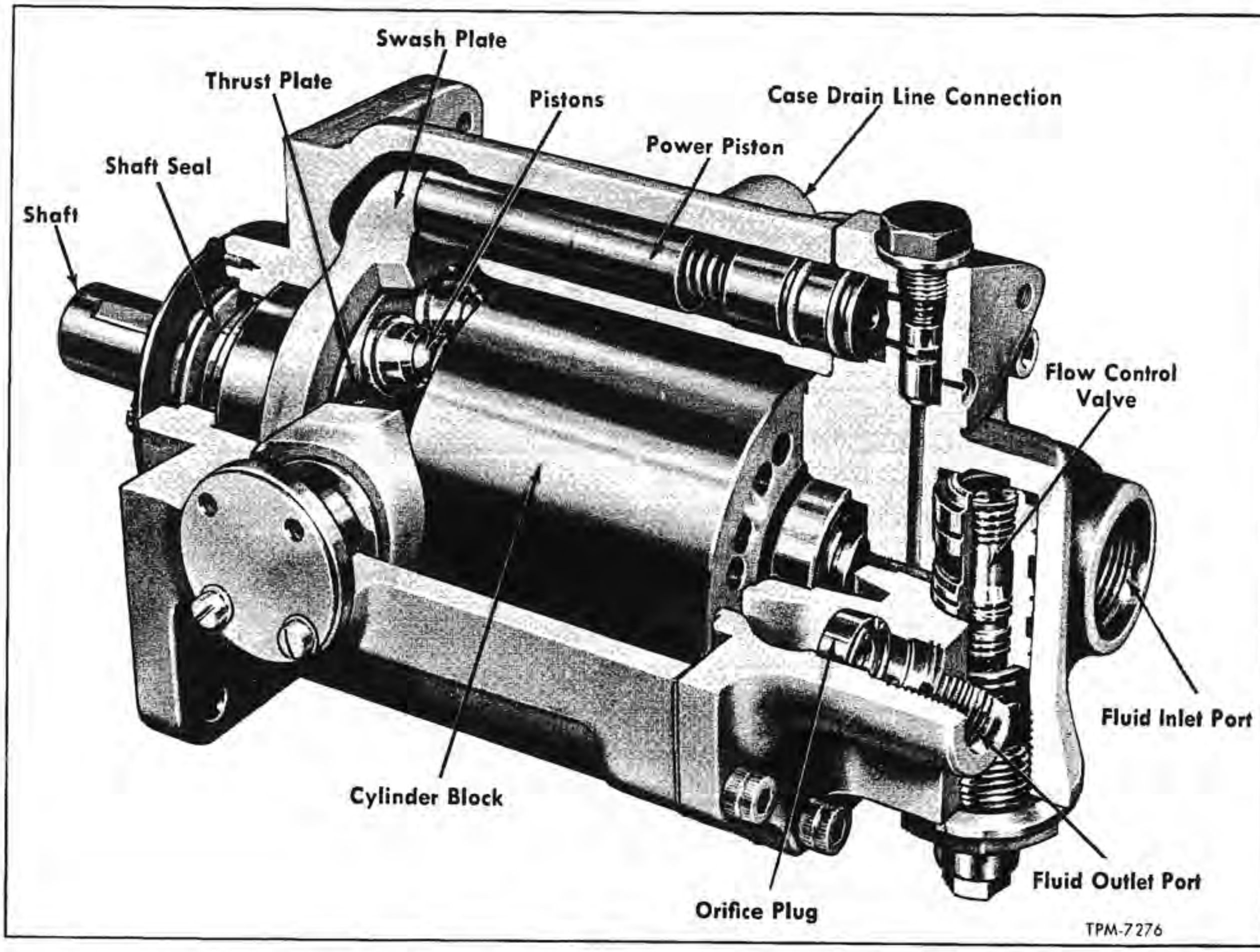


Figure 26—Cut-Away View of Condenser Fan Drive Pump

Pump Operation at Fast Idle or Above

NOTE: Refer to figure 24 which shows a schematic of the fan drive hydraulic system.

With compressor operating at fast idle or above, the pump components are positioned as shown. Since fast idle input speed on the pump will approximate 450 rpm, the greater angle of the swash plate increases stroke of pistons sufficiently to obtain 6 gallons per minute flow. As engine speed is increased with swash plate at this given angle a tendency to pump more than 6 gallons per minute flow occurs. As an attempt is being made to pass more than 6 gallons per minute through this 6 gallon orifice, a higher pressure on the upstream side of the orifice than on the downstream side of orifice occurs. This pressure buildup is reflected by internal coring to the top of flow control spool.

NOTE: The flow control spool is spring-loaded from the bottom.

Pressure build-up overcomes the spool spring and starts moving the flow control spool in a downward direction, closing the inlet line to the power piston chamber. As the spool moves downward, line to power piston is closed off and line to the pump case port is opened. Oil pressure is thereby relieved to the pump case and travels back to the reservoir through the case drain line. This dumps the power piston area, which allows the piston forces in the cylinder block to move the power piston back toward a shorter angle. Even through input speed on the pump has increased, the angle on the piston cylinder block is decreased, maintaining 6 gallon per minute flow.

Pump Operation When Decelerating

NOTE: Refer to figure 25 which shows a schematic of the fan drive hydraulic system.

When operating at a fast speed, a small angle exists on the pistons in the cylinder block. When decelerating, the rpm input at the cylinder block is slowed down and the pumping action is also slowed down, thus pump tends to pump less than 6 gallons per minute. Because of this, the pressure on upstream side of orifice decreases to approach the pressure in the downstream side of the orifice. Accordingly, the pressure across the flow control spool tend to approach each other as well. When

SYSTEM MAINTENANCE

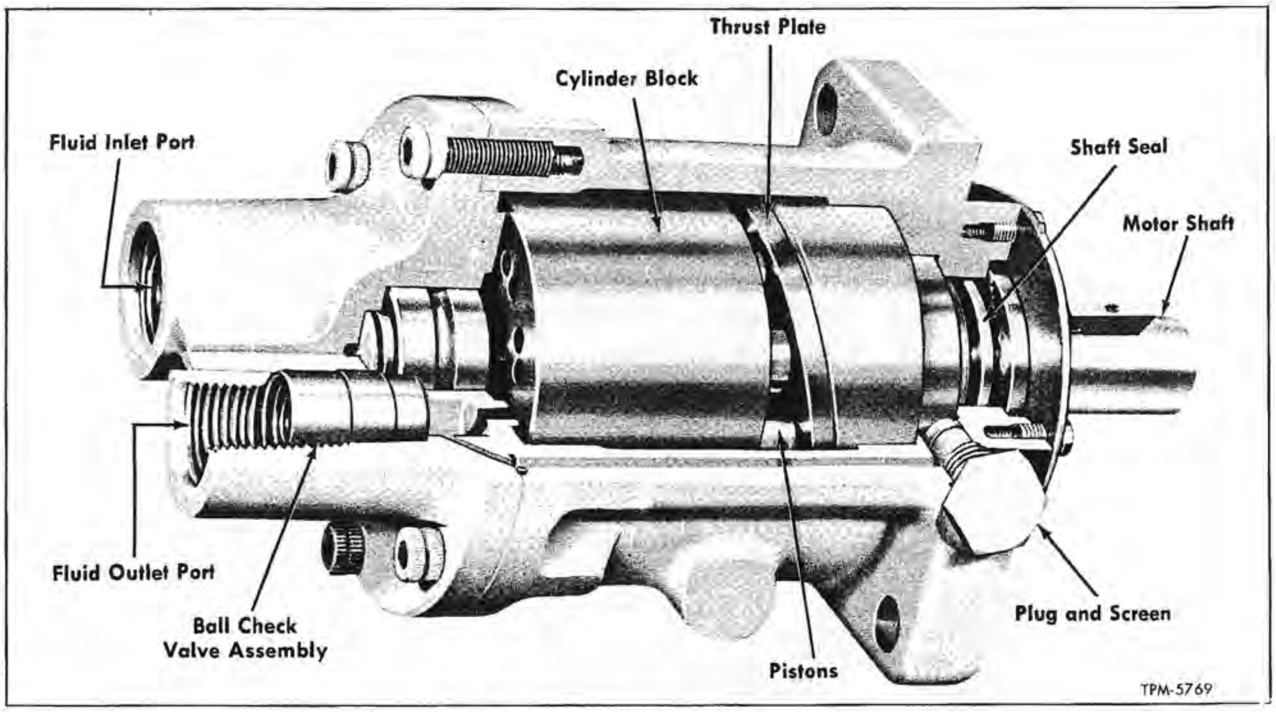


Figure 27—Cut-Away View of Condenser Fan Motor

this occurs, the spring at the bottom takes over and moves spool in an upward direction, opening the port into the power piston so that power piston becomes pressurized, forcing swash plate to a greater angle. Once again, pump provides 6 gallons per minute even though input speed has decreased when decelerating. The power piston pressure is pumped in accordance with input speed.

Fan Motor Operation (Refer to Fig. 25)

The fan motor is a constant displacement piston type motor containing nine pistons. The oil under pressure from the pump enters the motor and travels behind the motor pistons to force them up against the constant angle thrust plate. This forcing action of the pistons transmits a turning movement to the cylinder block, which is keyed to the motor shaft by a spline. The cylinder block then revolves and in turning drives the motor shaft and condenser fan.

The purpose of the ball check valve in the outlet port of the motor is to provide a back pressure which will prevent the pistons of motor from unloading as they cross over the valving from the pressure to discharge side. This action must occur since the pistons are not spring-loaded, and if check valve were not present, a piston clatter would develop and pistons would tend to wear on piston heads.

Both the pump and motor are hydrostatically balanced. The pump accomplishes this by the hollow pistons which transmits oil up to the slipper heads which are bearing against the face of the thrust plate. In the motor, same effect is accomplished by cored lines. Thus whatever pressure is in a given piston at any time is also placed behind the piston head and thrust plate so that the piston is hydrostatically balanced.

FAN DRIVE MAINTENANCE

CONDENSER FAN HYDRAULIC DRIVE FLUID

The condenser fan hydraulic fluid level should be checked at regular coach lubrication intervals. Fluid level check is made at the system fluid reservoir which is mounted in the condenser compartment on coach roof. Fluid level should be to "OIL LEVEL" mark on reservoir screen. If necessary, add fluid.

IMPORTANT: DO NOT OVERFILL.

Filter element in reservoir should be changed at beginning of operation season. Instructions for replacing element are explained later in this section under "Condenser Fan Fluid Reservoir."

Instructions for changing system fluid is explained later under "SYSTEM SERVICES AND TESTS."

At regular intervals all hydraulic lines and line connections should be checked for leakage. Inspect lines for possible chafing at supports to coach body. If this condition is found, lines should be repositioned and insulated. NOTE: Well insulated lines will reduce system noise.

FAN VENTURI RING ALIGNMENT

Fan venturi ring (15, fig. 21) should be located concentric with fan blade and should be positioned in relation to end of fan blade to height shown in figure 21. Height adjustment is made at mounting brackets which support venturi ring. Adjust bracket position by loosening screws which attach brackets to supports. Raise or lower venturi ring to dimension shown. Make sure specified dimension is obtained at all brackets. Tighten bracket attaching screws firmly after making adjustment.

PUMP DRIVE BELTS

Drive belts must be kept at proper tension. A loose or broken belt will affect pump operation. Belts adjusted too tight will strain and cause rapid wear of bearings in pump assembly. A regular periodic inspection is recommended to check condition and tension of drive belts (figs. 28 and 29). Replace if frayed or worn.

IMPORTANT: When replacing triple V-type belts, it is essential that entire set be replaced at same time. Belts are available in matched sets only. Belts can be replaced as explained later under "SYSTEM SERVICES AND TESTS."

NOTE: On a new vehicle or after having installed new belts, check tension of belts twice in first 48 hours of system operation.

PUMP DRIVE BELT TENSION ADJUSTMENT

Pump is pivot-mounted on one attaching bolt at uppermost mounting, and belt tension adjustment is accomplished by means of slotted holes in pump bracket at remaining three attaching bolts (View A, fig. 28). A 1/4 to 3/8 inch deflection, midway between pulleys on belts (View A, fig. 28) is satisfactory.

To make adjustment, loosen nuts of all four pump attaching bolts. View B, figure 28 shows the wrench arrangement which will readily facilitate reaching the pump rear mounting bolt. Using a small pry bar as shown (View C, fig. 28), force pump outward to increase tension on belts. Tighten all four attaching bolt nuts firmly after proper tension is obtained.

PUMP DRIVE BELT ALIGNMENT

At regular intervals pump drive belt alignment should be checked as misalignment could cause rapid wear on belts. Figure 29 shows pump mounted and belts properly aligned. Proper alignment exists when pump pulley belt grooves are squared with belt grooves on compressor flywheel pulley within clutch housing. This alignment can be made by moving pulley and tapered hub in or out on pump motor shaft. Pulley and hub are retained to shaft with three screws. Move pulley and hub on shaft as necessary, then retighten screws to 80 inch-pounds. Also, proper alignment exists when pulley

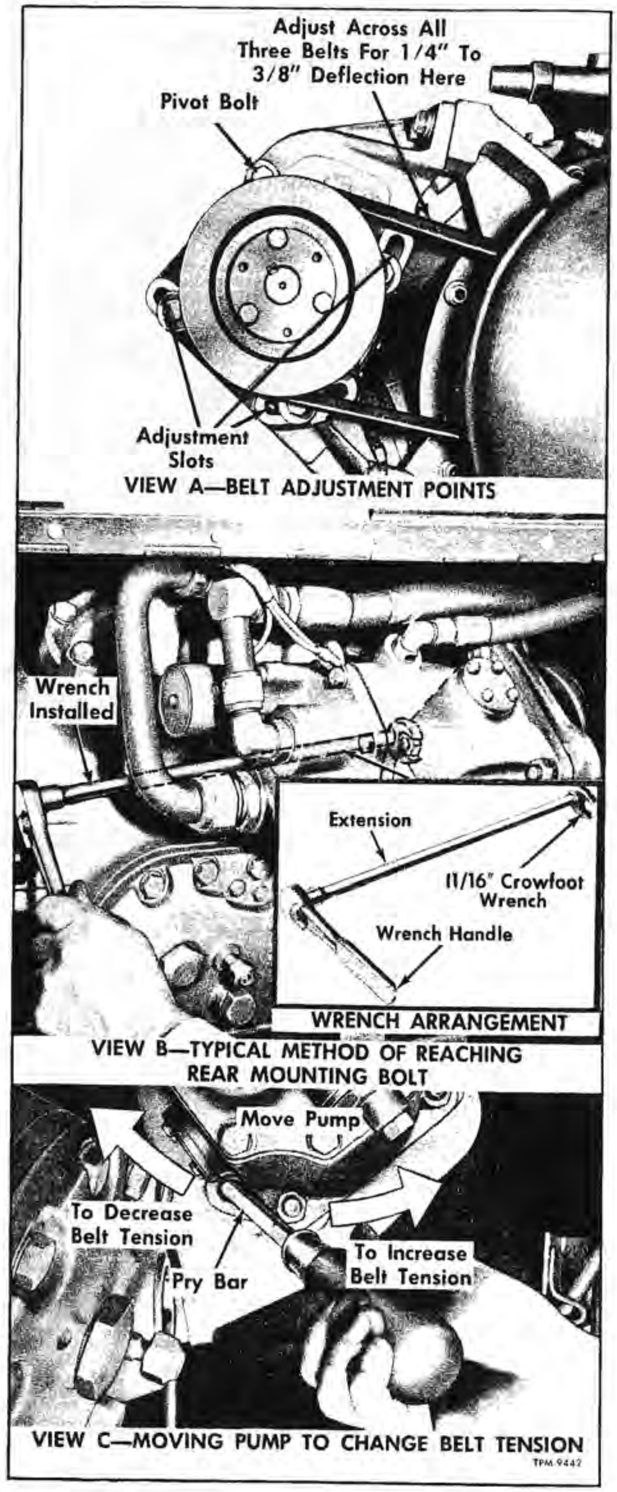


Figure 28—Adjusting Fan Drive Pump Belt Tension

grooves are on same plane. Misalignment here could occur if the four bolts which attach pump mounting bracket to the clutch housing should loosen. Bolt holes in mounting bracket are larger than bolt diameters to allow adjustment (fig. 29) and

SYSTEM MAINTENANCE

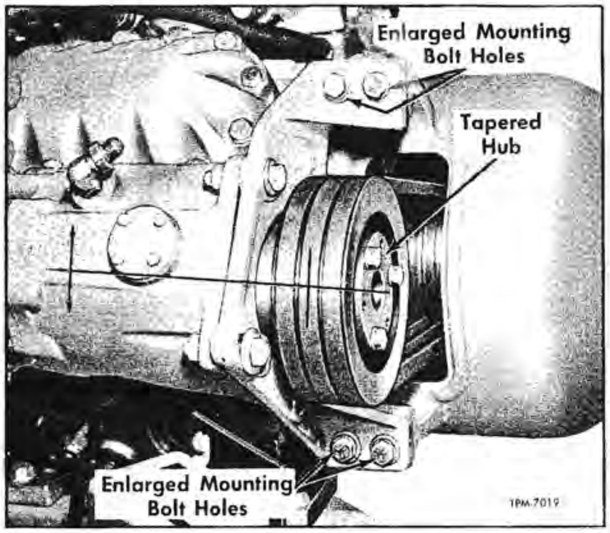
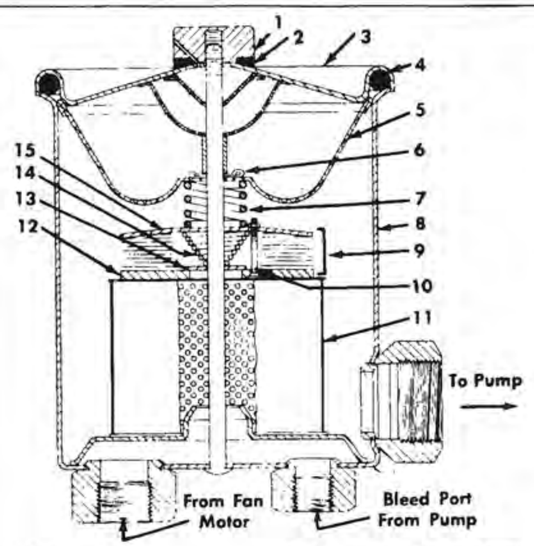


Figure 29—Pump and Drive Belt Alignment Points

loosened bolts could allow entire pump and bracket unit to shift on clutch housing. Raise or lower line end of pump as necessary, then tighten all four bracket-to-clutch housing bolts firmly.

FAN SPEED ADJUSTMENT

Refer to "SYSTEM SERVICES AND TESTS" later in this group for adjustment procedures. See "Condenser Fan Speed Check and Adjustment"



1 Nut	9 By-pass Filter Assy.
2 Nut Gasket	10 Filter Screw
3 Reservoir Cover Assy.	11 Filter Element
4 Cover O-ring Seal	12 By-pass Filter Plate
5 Strainer Screen	13 By-pass Valve Disc
6 Cotter Pin	14 Valve Disc Spring
7 Spring	15 By-pass Filter Cover
8 Reservoir Housing	

TPM-5689

Figure 30—Sectional View of Fluid Reservoir

CONDENSER FAN FLUID RESERVOIR

Fluid reservoir is used in the fan hydraulic drive system to retain sufficient supply of fluid in system and to filter the fluid. Reservoir is rubber-mounted and is located in the condenser compartment (fig. 24). A disposable type filter element is located in bottom of reservoir (fig. 30) with a fluid by-pass filter and valve located directly on top of element. Purpose of the by-pass valve is to allow passage of fluid through reservoir in the event the filter element becomes clogged.

The system fluid and the disposable type element should be replaced annually, preferably at beginning of the operating season.

DISASSEMBLY

NOTE: Key numbers in following text refer to figure 30.

1. Remove nut (1) with gasket (2) then lift cover (3) from reservoir housing (8). If necessary, remove cover O-ring seal (4) from cover.

2. Using thin-nose pliers as shown in figure 31, remove small cotter pin (6) which retains strainer screen (5) in housing. CAUTION: Do not poke hole in screen with pliers when cotter pin releases from thru bolt. Lift screen from housing.

3. Remove spring (7), by-pass filter assembly (9) and filter element (11) from reservoir housing. Discard element.

4. Disassemble by-pass filter assembly (9) by removing three filter screws (10) and nuts. Disassemble filter assembly completely.

CLEANING

Clean all removed components in cleaning solvent and allow to dry thoroughly. Using a clean lint-free cloth, swab out reservoir housing.

ASSEMBLY

NOTE: Key numbers in following text refer to figure 30.

1. Referring to figure 30 for positioning of parts, assemble by-pass filter assembly (9). Tighten filter attaching screw nuts evenly.

2. Place new filter element (11) into reservoir housing (8), then place by-pass filter assembly (9) on top of element.

IMPORTANT: Make sure filter assembly is positioned as shown. Screw nuts should be located at top side of filter.

3. Locate spring (7) over reservoir thru bolt, then install strainer screen (5). Secure screen with cotter pin (6). NOTE: Carefully press screen down in center to permit the installation of cotter pin.

4. Place O-ring seal (4) in groove of cover (3), then position cover on housing.

5. Before installing cover nut (1) and nut gas-

ket (2), prod small diameter wire into vent holes in cover (3) and cover nut (1). See figure 32 which shows nut removed and vent holes exposed.

6. With gasket (2) located in groove of cover nut (1), install nut.

NOTE

Hand tighten nut, do not use wrench.

FAN MOTOR AND SUPPORT REPLACEMENT

NOTE: Key numbers in text refer to figure 21.

REMOVAL

1. Remove condenser fan blade from motor shaft as explained previously under "Fan Blade Replacement."

2. Drain hydraulic fluid from system to level slightly below fan motor line connections. Break high and low pressure line connection at pump and allow fluid to drain into a clean container.

3. Mark fluid lines at fan motor ports, then disconnect lines. Cap ends of lines to prevent dirt from entering.

4. While supporting motor, remove four bolts (5) which attach fan motor to motor mounting plate (4), then lower motor from motor support (1).

5. If it is necessary to remove fan motor support (1), refer to right upper view of figure 21, which shows construction of support at coach roof mounting. Remove lock wire and attaching bolts, then remove fan venturi ring (15) attached to brackets. Lift support from compartment.

INSTALLATION

1. Lower fan motor support (1) into position at coach roof, then referring to upper right view of figure 21, install mounting components under each leg of motor support. Secure heads of all bolts with lock wire (11).

2. Raise fan motor into position under motor support and attach with four bolts (5) inserted from top. See upper left view of figure 21.

NOTE

Make sure motor is positioned with port marked "OUT" toward front of compartment. Tighten attaching bolts firmly. Install fluid lines.

3. Install fan blade assembly as instructed previously under "Fan Blade Replacement."

4. Lower fan venturi ring (15) to condenser mounting brackets and install attaching bolts loosely. Locate venturi ring concentric with fan blade as instructed previously under "Fan Venturi Ring Alignment."

5. Refill fan drive fluid system as instructed later under "SYSTEM SERVICES AND TESTS."

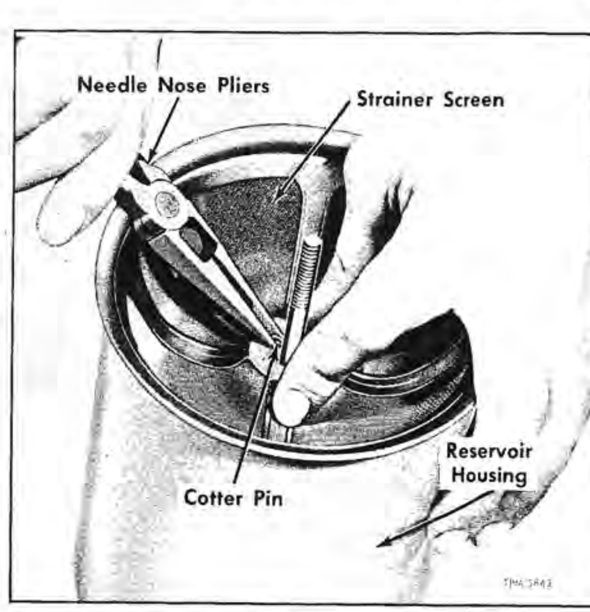


Figure 31—Method of Replacing Fluid Reservoir Screen and Cotter Pin

FAN DRIVE PUMP REPLACEMENT

REMOVAL

1. Drain condenser fan fluid system by disconnecting all three fluid lines at pump. Drain fluid into clean container, then cover container. Cap ends of lines and holes in pump to prevent dirt from entering system.

2. Remove drive belts from pump pulley. Instructions explained previously under "Pump Drive Belt Tension Adjustment" will apply.

3. Mark upper and lower end of pump mounting bracket in relation to flange on clutch housing.

Figure 32—Vent Hole Locations In Reservoir Cover and Nut

SYSTEM MAINTENANCE

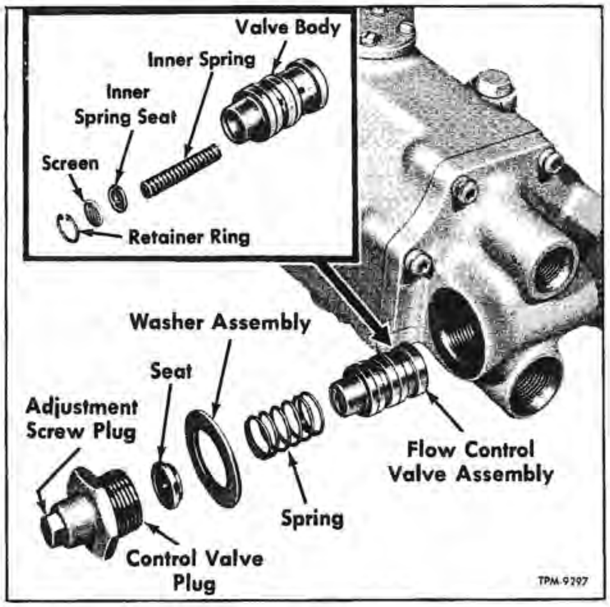


Figure 33—Pump Flow Control Valve Components

This will assure installation of pump in original position.

4. While supporting pump, remove four bolts which attach pump bracket to clutch housing. Remove pump with mounting bracket and pulley.

5. Pulley and hub are attached to pump shaft with three screws. Mark pulley position (distance of pulley on shaft) in relation on shaft, then using hub screws as puller screws, remove hub and pulley.

6. Remove pump bracket after removing four attaching bolts and nuts.

Figure 34—Cleaning Flow Control Valve Using Air Pressure

INSTALLATION

1. Position pump bracket over pump shaft and attach to pump flange loosely with four bolts and nuts. Install pulley and hub with drive keys to mark made prior to removal on shaft. Tighten three hub screws evenly to 7-10 foot-pounds torque.

NOTE: Pump pulley should be located on pump shaft to align exactly with compressor flywheel pulley.

2. Mount pump and mounting bracket to clutch housing flange with four bolts. Align marks on upper and lower flanges made prior to removal, then tighten bolts firmly.

3. Install drive belts in respective pulley grooves. Tighten belts to proper tension as instructed previously under "Pump Drive Belt Tension Adjustment."

4. Connect fluid lines to pump ports. Tighten connections firmly.

5. Fill fluid system and bleed as instructed later under "SYSTEM SERVICES AND TESTS."

SERVICING FAN DRIVE PUMP FLOW CONTROL VALVE

NOTE: Usually one of the first indications of system malfunction is erratic operation of the condenser fan motor or of motor operating at a slower speed than specified. Placing of a tachometer on the fan motor will indicate the motor speed, which should be 1800 $\pm$ 25 rpm. Speed check should be made with engine at fast idle (460 rpm - min.) and with fan motor fluid at normal operating temperature. Instructions for checking fan speed are explained later under "SYSTEM SERVICES AND TESTS."

Possible cause of erratic fan motor operation could be a sticking flow control valve.

1. Drain hydraulic fluid from system. Disconnect lines at pump and allow to drain.

2. Remove flow control valve plug which is the large hex plug having a small adjustment screw cover plug at the end. See figure 33. DO NOT REMOVE SMALL END PLUG.

IMPORTANT: Do not allow parts to drop out of pump cavity, as lands of valve could be damaged by contacting other parts.

3. Referring to figure 33, remove seat, washer assembly, valve outer spring and valve assembly from pump. Use extreme care not to damage valve.

4. Being careful not to damage small screen in small end of valve body, remove retainer ring, screen, inner spring seat, and the inner spring from valve body. NOTE: Do not remove expansion plug at opposite end of valve body. Valve plunger within valve body should not be removed.

5. Dip valve body into cleaner solvent, then wearing safety glasses, blow solvent and foreign matter from valve. Use air pressure as shown in

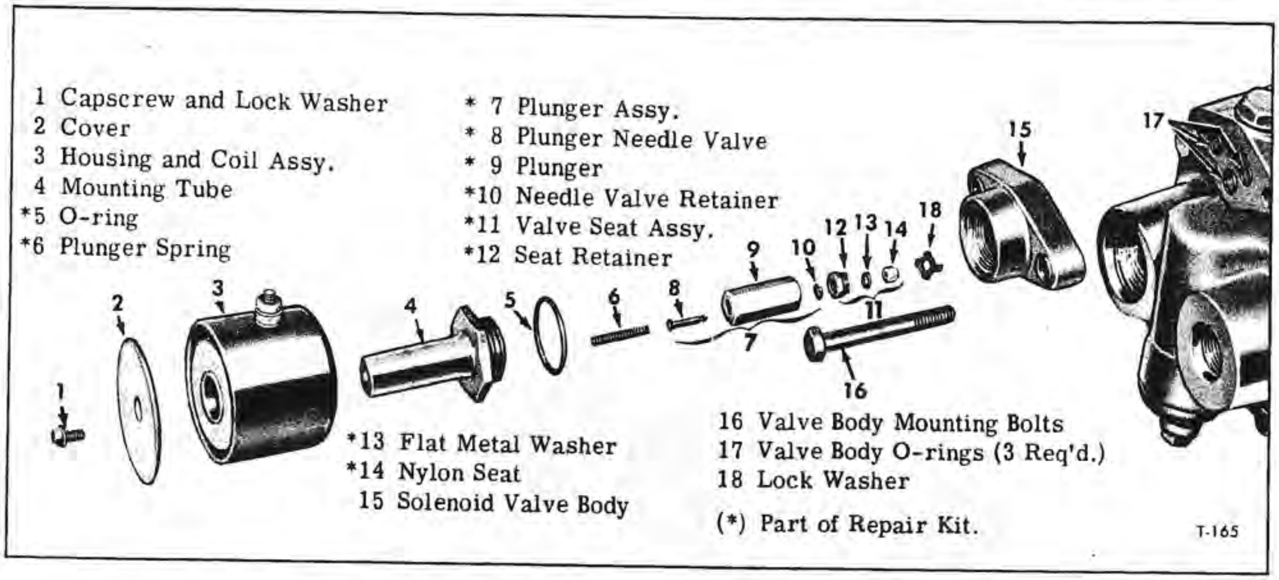


Figure 35—Pump Solenoid Valve Components

figure 34 directing air stream into valve side ports. Dip all other valve components in solvent, then wipe and blow dry. Inspect valve body for worn or scored condition. If body is badly scored, the complete end cap assembly should be replaced.

NOTE: Before installing new end cap assembly the piston block within the pump should be lapped. See lapping procedure under overhaul procedures explained later under "Fan Drive Pump Overhaul."

6. Reinstall inner spring, spring seat, screen and retainer ring in valve body.

7. Carefully insert flow-control valve assembly into pump. NOTE: Do not attempt to force valve into valve bore. Also make sure proper end of valve is inserted first; refer to figure 33 for position of parts. If valve temperature is higher than temperature of pump it may be impossible to install valve. Wait until temperature of both parts equalize.

8. Referring to lower view of figure 33, install spring, washer assembly, spring seat, and control valve plug assembly. Tighten plug firmly.

9. Fill system with fluid, then operate the system until system fluid is hot; check fan motor operation.

10. If necessary, the fan speed can be adjusted as explained later under "SYSTEM SERVICES AND TESTS."

PUMP SOLENOID VALVE REPLACEMENT AND REPAIR

NOTE: A defective solenoid valve or a solenoid valve having a loose valve seat or an obstruction at seat may cause pump to stop producing pressure. Repair solenoid valve as follows:

REMOVAL

NOTE: Key numbers in text refer to figure 35.

1. Drain fluid from system. Disconnect lines at pump and allow to drain.

2. Disconnect wire from solenoid terminal.

3. Referring to figure 35, remove cap screw (1) and cover (2) from solenoid housing (3). Slide housing from mounting tube (4).

4. Remove mounting tube from valve body (15), then remove spring (6) and plunger assembly (7) from tube. Also remove the O-ring (5) from threads of tube. NOTE: The plunger assembly can be disassembled after removing needle valve retainer.

5. Using wrench, remove valve seat assembly (11) and lock washer (18) from valve body.

6. If necessary to remove valve body, remove two attaching bolts, then separate body from pump. Remove three O-rings (17) from recesses in pump flange.

INSPECTION AND REPAIR

NOTE: Key numbers in text refer to figure 35. All items identified by an asterisk (*) in figure 35 are part of valve seat plunger kit.

IMPORTANT

DO NOT ATTEMPT TO USE OLD PARTS WITH NEW PARTS. INSTALL ALL PARTS OF NEW KIT.

1. Check bore of mounting tube (4) for dirt. Clean, using a solvent and blow dry with air pressure.

2. Visually check coil within housing (3) for broken wiring and for cracked insulation. Circuit through coil can be checked using a 12-volt power source and a low candle-power test light.

3. Clean out fluid passages in valve body (12).

SYSTEM MAINTENANCE

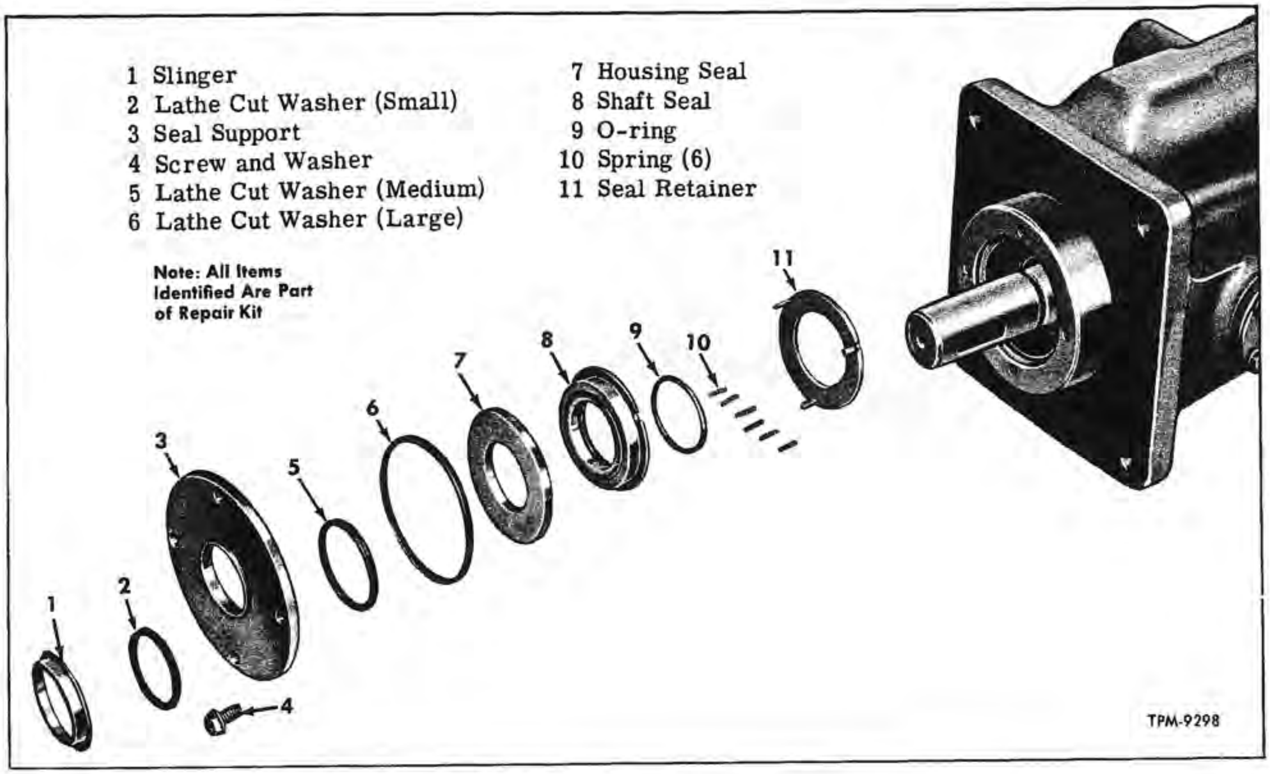


Figure 36—Pump Shaft Seal Components

ASSEMBLY

NOTE: Key numbers in text refer to figure 35.

1. Install three O-rings (17) in pump flange recesses, then attach valve body (15) to pump flange with two bolts (16). NOTE: Make sure passages in body and pump are aligned. Tighten bolts evenly and firmly.

2. Insert small flat metal washer (13) in seat retainer (12), then position nylon seat (14) against washer making up valve seat assembly (11). Locate lock washer (18) properly on seat retainer, then thread assembly in finger tight. Using a wrench, tighten retainer an additional quarter turn.

IMPORTANT: NYLON SEAT (14) WILL BE DESTROYED IF TIGHTENED MORE THAN ONE QUARTER TURN.

3. If plunger assembly (7) was disassembled, position needle valve (8) into plunger (9), then clamp retainer (10) into groove at pointed end of valve.

4. Place O-ring (5) over threads of mounting tube (4), then with spring (6) located in plunger, insert plunger assembly into tube and thread tube assembly to valve body.

5. Slide housing and coil assembly (3) over end of tube, then with housing terminal located for easy attachment of wire, install cover (2) with capscrew and lock washer (1). Tighten screw firmly.

6. Connect wiring to terminal, fill fluid system, then check pump and solenoid operation.

PUMP SHAFT SEAL REPLACEMENT

NOTE: It is necessary to drain fluid from system and then remove pump assembly from coach before replacing pump shaft seal.

All items identified by an asterisk (*) in figure 36 are components of shaft seal service kit.

NOTE: INSTALL ALL PARTS OF SERVICE KIT. DO NOT MIX OLD PARTS WITH NEW PARTS.

REMOVAL

Key numbers in text refer to figure 36.

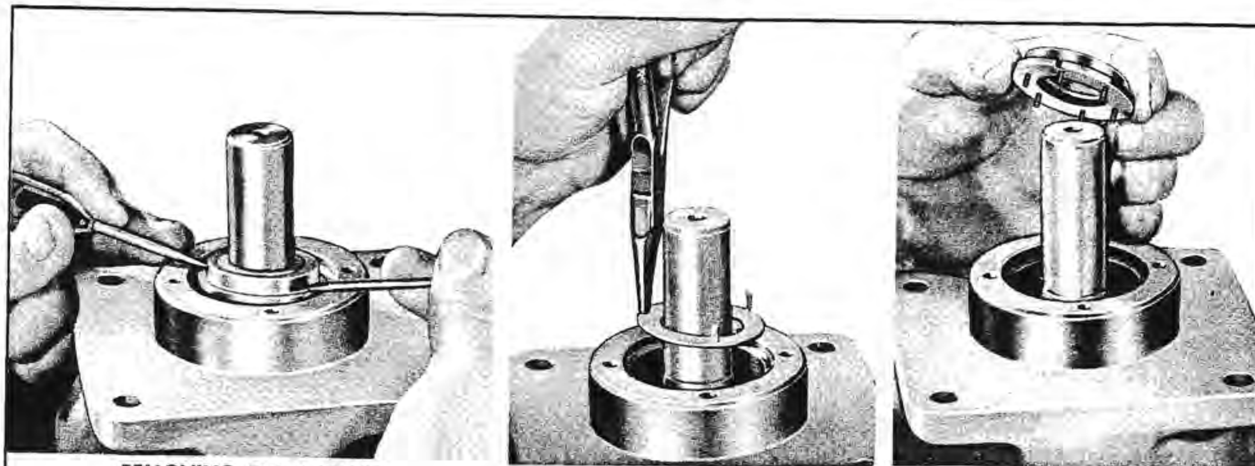
1. Remove drive key from end of pump shaft.

2. Slide small metal slinger (1) and small lathe cut washer (2) from pump shaft. Separate washer from slinger.

3. Remove four screws (4) and washers which attach seal support (3) to pump housing. Lift support from housing, then remove lathe cut washers (5 and 6) from underside of support.

4. Remove housing seal (7) and pump shaft seal (8) using flats of two small screwdrivers as shown in left view of figure 37. Be careful not to lose six small springs (1) in shaft seal. Remove O-ring (9) from internal groove of shaft seal (8).

5. Grasp pump shaft seal retainer (11) by one of its prongs with needle nose pliers and lift out as shown in center view of figure 37.



REMOVING PUMP SHAFT SEAL — REMOVING SEAL RETAINER — INSTALLING PUMP SHAFT SEAL AND SPRINGS

TPM-5981

Figure 37—Pump Shaft Seal Replacement Views

INSTALLATION

NOTE: Pump shaft seal components are serviced in a kit only. DO NOT USE OLD PARTS.

IMPORTANT: APPLY CLEAN HYDRAULIC FLUID TO ALL COMPONENTS OF SEAL KIT PRIOR TO INSTALLING.

1. Examine and clean recess in pump housing.
2. Lower seal retainer (2) over shaft and rotate until retainer flats seat or align with flats on pump shaft.
3. Install O-ring (9) into internal groove of pump shaft seal (8). Fill six spring cavities in shaft seal (8) with clean grease to retain springs (10). Place springs in seal cavities. Referring to right view of figure 37, install seal with springs over shaft end and match three slots on seal collar with three prongs of seal retainer (11).
4. Making sure clean film of fluid covers seal contact surfaces, place pump housing seal (7) over shaft to shaft seal.
5. Install lathe cut washer (6) into groove between outer circumference of housing seal and pump housing seal opening. IMPORTANT: DO NOT STRETCH WASHER. Use of shim stock will facilitate installing of washer.
6. Position lathe cut washer (5) into groove at back side of seal support (3), then position seal support over shaft to housing. Make sure housing seal (7) and washers (5 and 6) remain in position. Install seal support attaching screws with washers (4) loosely.
7. Insert small lathe cut washer (2) into pump slinger (1), then locate slinger with washer over end of shaft and up against seal support (3). Making sure slinger washer is contacting support, final tighten the four seal support attaching screws.
8. Install pump assembly as directed previously.
9. Operate system until normal operating temperature of oil is reached (5 to 10 min.), then check for leakage at seal.

MOTOR SHAFT SEAL REPLACEMENT

NOTE: Motor shaft seal components can be replaced without having to remove motor from coach.

IMPORTANT: All items identified by an asterisk (*) in figure 38 are components of motor shaft seal service kit. INSTALL ALL PARTS OF SERVICE KIT. DO NOT MIX OLD PARTS WITH NEW PARTS.

REMOVAL

NOTE: Key numbers in text refer to figure 38.

1. Remove fan from motor as directed previously under "Fan Blade Replacement."
2. Remove fan drive key from end of motor shaft.
3. Slide small metal slinger (13) and lathe cut washer (12) from motor shaft.
4. Remove four screws (14) with washers (15) which attach seal support (11) to motor. Lift seal support from motor, then remove lathe cut washers (10 and 9).
5. Referring to figure 39, press downward around outer surface of housing seal (8) and shaft seal (7). Seals should pop up out of motor recess. Left view of figure 37 shows method of removing seals using flats of two small screwdrivers.
6. Remove O-ring (6) from internal groove of shaft seal (7).
7. Remove seal spring (5) from housing recess.
8. Using No. 2 Tru-Arc snap ring pliers, remove retaining ring (4) and remove thrust washer (3) from motor shaft. Using needle-nose pliers, lift spring retainer (2) from shaft.

SYSTEM MAINTENANCE

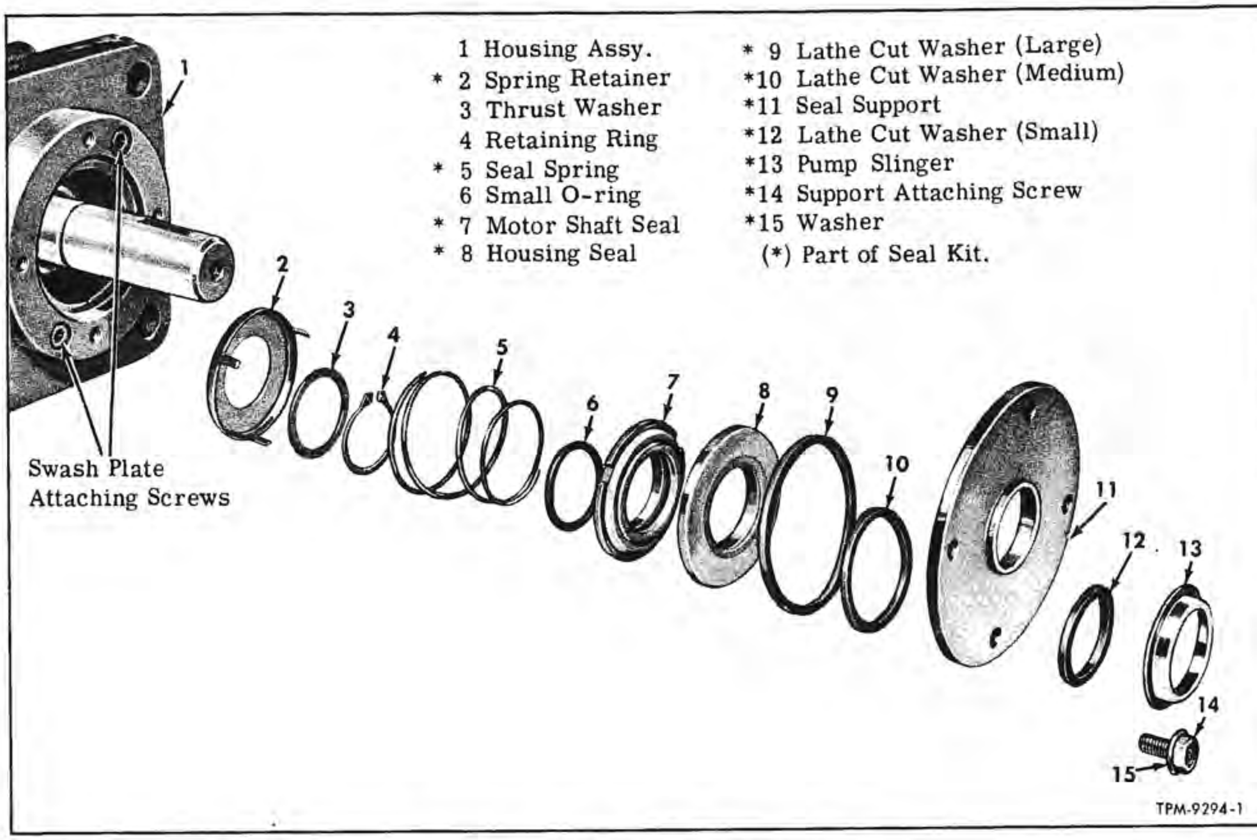


Figure 38—Motor Shaft Seal Components

INSTALLATION

NOTE: Motor shaft seal components are serviced in a kit only. DO NOT USE OLD PARTS.

IMPORTANT: APPLY CLEAN HYDRAULIC FLUID TO ALL COMPONENTS OF SEAL KIT PRIOR TO INSTALLING.

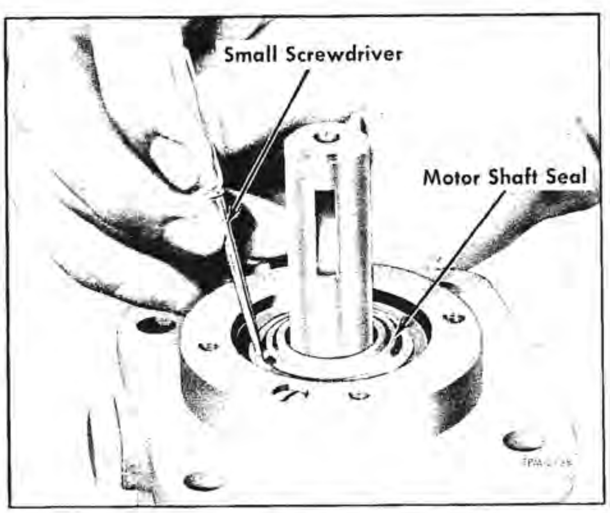


Figure 39—Method of Removing Motor Shaft Seal

NOTE: Key numbers in text refer to figure 38.

1. Examine and clean recess in motor housing.

2. Lower spring retainer (2) over shaft, into housing recess. IMPORTANT: Rotate retainer until it drops in place on flats of shaft.

3. Install thrust washer (3) and retaining ring (4). Make sure ring is fully seated in shaft groove.

4. Install seal spring (5) into recess.

NOTE: Make sure large end of spring is inserted first.

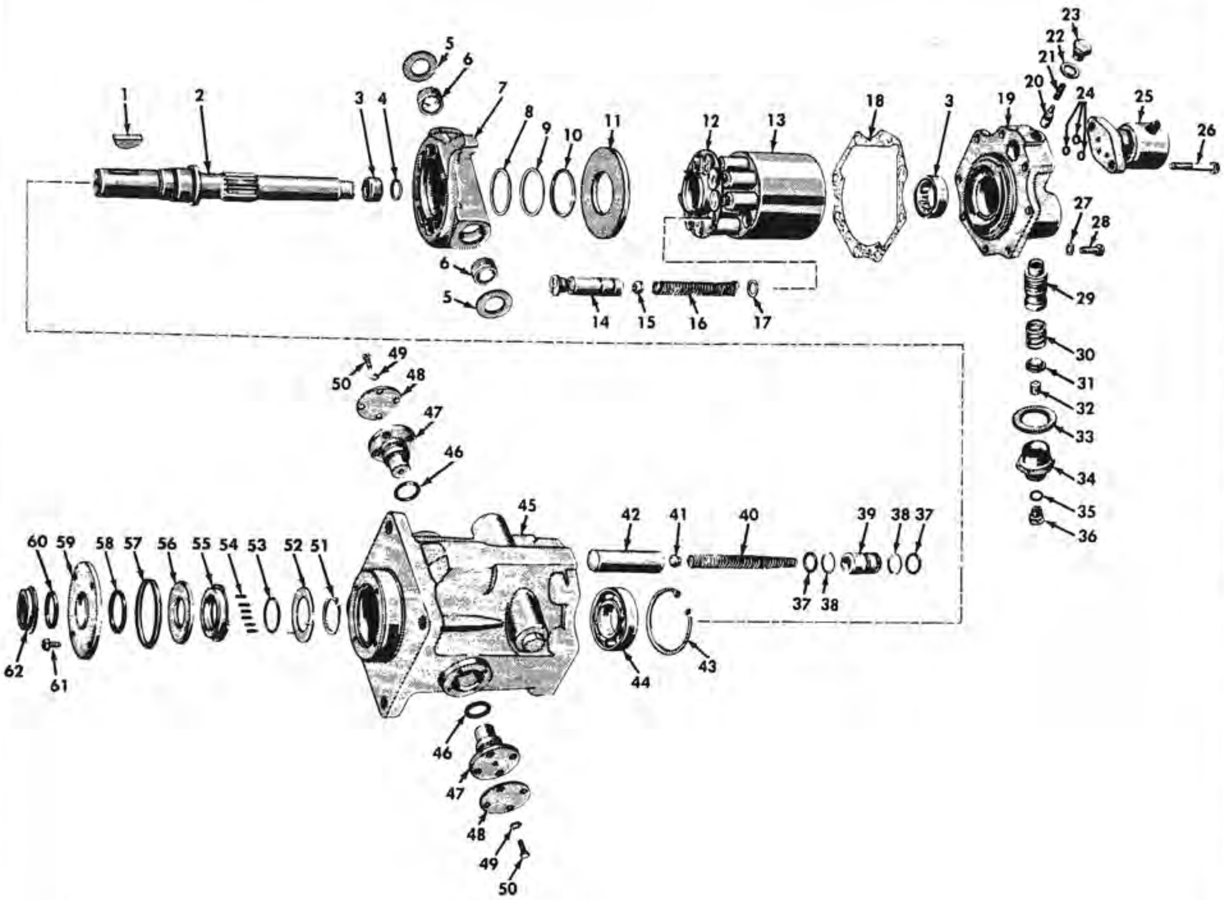
5. Insert O-ring (6) into internal groove of shaft seal (7), then apply grease to I.D. of O-ring.

6. Carefully lower shaft seal (7) with installed O-ring (6) over seal spring (5). Make sure sealing surface of seal (7) is located upward. Match three slots of seal with three prongs of spring retainer (2).

7. Position lathe cut washer (9) on O.D. of housing seal (8) with washer flush with surface opposite sealing face. Place a film of oil on O.D. of washer.

8. Place housing seal assembly (8) over shaft. Be sure sealing surface of seal is in the downward position. Center the seal assembly on shaft.

9. Put a small amount of clean grease into annular groove of motor seal support (11). Press lathe cut washer (10) into support groove.



1 Pulley Drive Key
2 Pump Drive Shaft
3 Shaft Rear Bearing Inner Race (Part of Complete Bearing Assy.)
4 Retaining Ring
5 Trunnion Thrust Washer
6 Trunnion Bushing
7 Swash Plate
8 Lock Ring (Spiral Type)
9 Shims (As Req'd.)
10 Thrust Washer
11 Thrust Plate
12 Piston Slipper Retainer
13 Cylinder Block
14 Piston Assy.
15 Piston Spring Seat
16 Piston Spring
17 Spring Washers
18 End Cap Gasket
19 End Cap Assy.
20 Dampening Valve
21 Dampening Valve Spring
22 Washer Assy.
23 Dampening Valve Plug
24 O-ring
25 Pump Solenoid Valve Assy.
26 Valve Attaching Bolt
27 End Cap Attaching Bolt
28 Bolt Washer
29 Flow Control Valve Assy.
30 Valve Outer Spring
31 Seat
32 Adjustment Screw Assy.
33 Plug Washer Assy.
34 Flow Control Valve Plug
35 Plug Gasket
36 Plug
37 O-ring
38 Back-up Washer
39 Transfer Bushing
40 Power Piston Spring
41 Spring Seat
42 Power Piston
43 Bearing Snap Ring
44 Shaft Front Bearing Assy.
45 Pump Housing
46 Trunnion O-ring
47 Swash Plate Trunnion
48 Trunnion Plate
49 Lock Washers
50 Screws
51 Snap Ring
52 Shaft Seal Retainer
53 O-ring
54 Spring
55 Pump Shaft Seal
56 Housing Seal
57 Lathe Cut Washer (Large)
58 Lathe Cut Washer (Medium)
59 Seal Support Assy.
60 Lathe Cut Washer (Small)
61 Screw and Washer
62 Shaft Slinger

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Figure 40—Disassembled View of Hydraulic Pump Assembly

SYSTEM MAINTENANCE

10. Position seal support assembly (11) to motor housing, pressing downward on support to seat the seal and washers, then attach support loosely with four screws (14) and washers (15).

11. Insert small lathe cut washer (12) into motor slinger (13). Place slinger with washer on shaft and press downward until washer contacts face of seal support.

12. Final tighten support attaching screws evenly. Check to see that slinger washer (12) is contacting support.

13. Install fan assembly as directed previously under "Fan Blade Replacement."

14. Operate system until fluid reaches normal operating temperature (5 to 10 min.). Fill, then check for leakage at seal.

FAN DRIVE PUMP OVERHAUL

NOTE

As unit is being disassembled, inspect for dirt, sludge, metallic shavings and for any other material or condition which may determine the cause of failure.

If during overhaul, internal failure is found and any metallic particles or impurities are present, it will be necessary to flush all fluid lines with kerosene and air pressure mixture before installing repaired or new unit.

IMPORTANT: ALL TOOLS, WORKING AREA, AND APPAREL MUST BE CLEAN WHEN SERVICING UNITS. IF WIPING CLOTHS ARE USED, MAKE SURE THEY ARE OF LINT-FREE TYPE. DIRT OR FOREIGN MATTER IN SYSTEM WILL CAUSE SHORT LIFE OF UNITS AND MAY CAUSE COMPLETE FAILURE OF SYSTEM.

CLEAN EXTERIOR SURFACES OF UNIT TO BE OVERHAULED BEFORE STARTING DISASSEMBLY PROCEDURES.

DISASSEMBLY OF FAN DRIVE PUMP

NOTE: Key numbers in text refer to figure 40.

1. Place the pump in a vise with shaft downward, grasping the pump by the hub. Using a 1-7/16 inch wrench, remove pump flow control valve plug and components (fig. 33) as directed previously under "Servicing Fan Drive Pump Flow Control Valve."

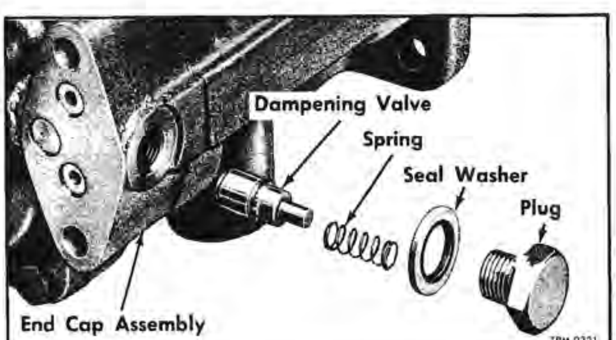


Figure 41—Pump Dampening Valve Components

2. Using a 3/4" wrench, remove dampening valve components (fig. 41) from pump end cap assembly. NOTE: Use needle-nose pliers to remove valve (20) from bore.

3. Remove solenoid valve components (fig. 35) from pump as instructed previously under "Pump Solenoid Valve Replacement and Repair."

4. Before removing pump end cap assembly (19), tool shown in right view of figure 42 should be made available. Tool can be improvised locally using dimensions shown. Use of this tool is necessary as end cap, which is under excessive spring pressure will follow heads of attaching bolts when being removed and may cause bolt threads to become stripped. Use tool as shown in left view of figure 42.

> **CAUTION**
> End cap valving or sealing surface that mates on the pump cylinder block (13) is a lapped surface. It should be relapped and cleaned thoroughly before reassembly.

5. SLIDE end cap (19) off cylinder block face. See figure 43 which shows cover removed. End cap gasket (18) can be removed from pump housing (45).

6. Referring to figure 43, pull or twist transfer bushing assembly (39) from end cap. Also lift power piston spring (40) from bore in housing.

7. Pour a small amount of solvent or kerosene into pump housing to break the hydrostatic seal on slipper heads of pistons (14).

8. While holding cylinder block from sliding out of housing, tip housing to drain off excess fluid. Place the pump horizontally on work bench. Turn the cylinder block (13) carefully out, then remove from housing as shown in figure 44.

9. Using a small screwdriver or a knife blade, remove lock ring (8) from groove of slipper retainer (12) as shown in figure 45. Shims (9), thrust washer (10), thrust plate (11) and slipper retainer (12) may then be removed. See figure 46 which shows parts removed.

10. Lift pistons (14), piston spring seats (15), piston springs (16), and spring washers (17) from

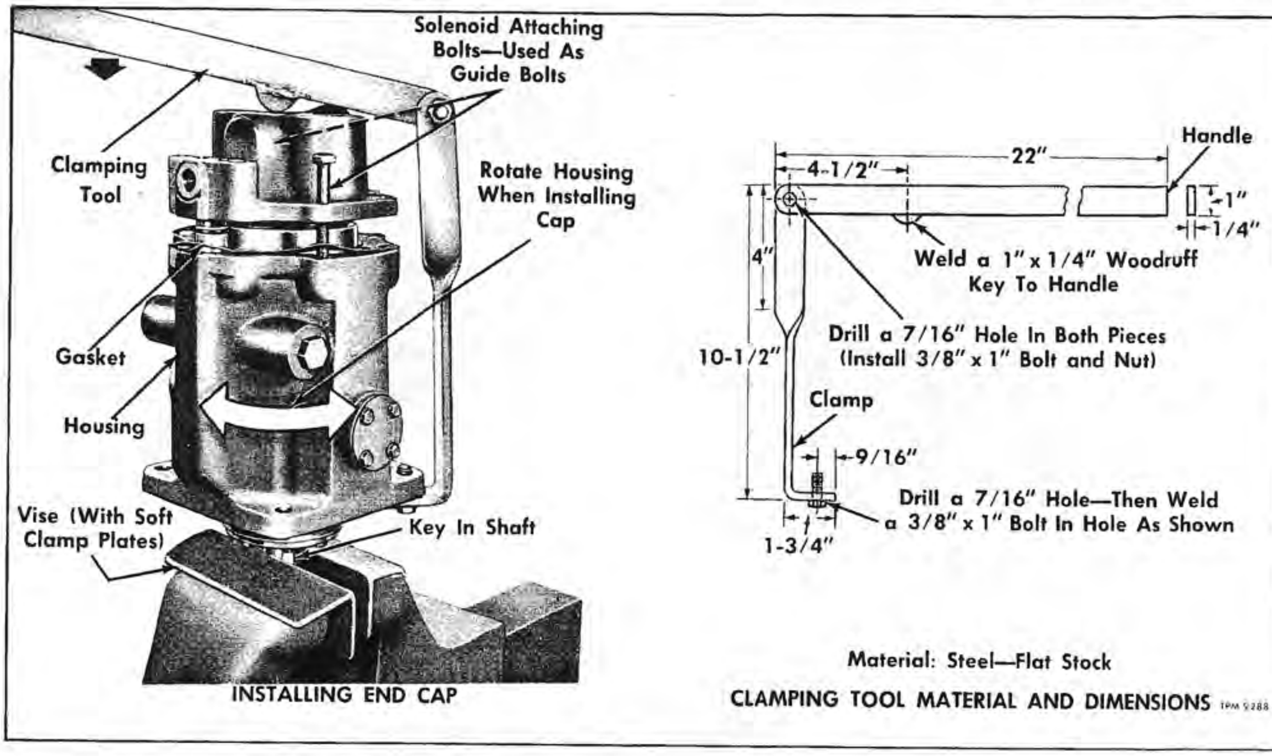


Figure 42—Using Clamp Tool To Replace Pump End Cap

cylinder bores.

11. If power piston (42) and spring seat (41) stayed in housing bore, tip housing to allow parts to slide from bore. NOTE: If power piston (42) is slightly sticky, it can be lightly polished and the power piston bore in housing cleaned. If piston is tightly stud in bore, solvent may be used to free piston. If piston can not be removed, a new housing and power piston assembly will be required.

IMPORTANT: After piston is removed, do not allow piston contact lug of swash plate (7) to contact piston bore within housing.

12. Remove pump shaft seal components (fig. 36) from pump and shaft as directed previously under "Pump Shaft Seal Replacement."

13. Using Tru-Arc pliers No. 2, remove drive shaft front bearing snap ring (43). With a soft hammer, tap keyway end o shaft (2) after making sure that swash plate (7) within housing will not interfere. Remove shaft assembly.

14. Remove four screws (50) which attach swash plate trunnion (47) and trunnion plate (48) on each side of pump housing.

IMPORTANT: Before removing trunnions, mark

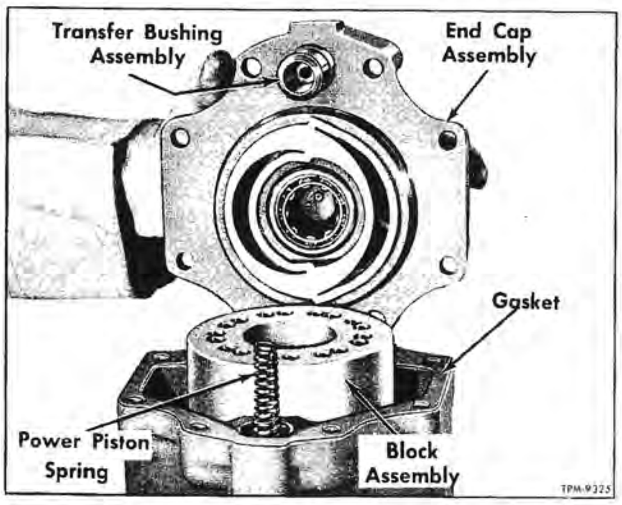


Figure 43—Pump End Cap Assembly Removed

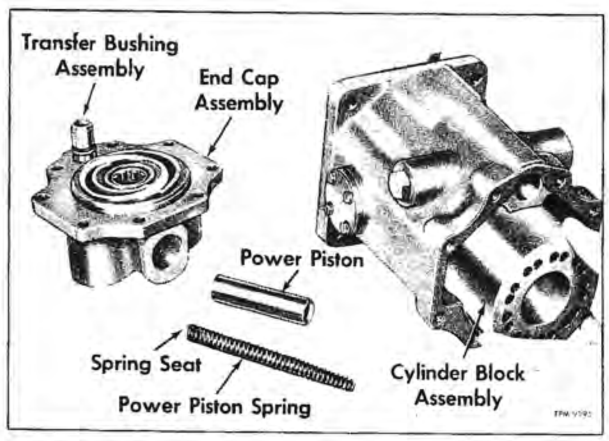


Figure 44—Replacing Pump Cylinder Block

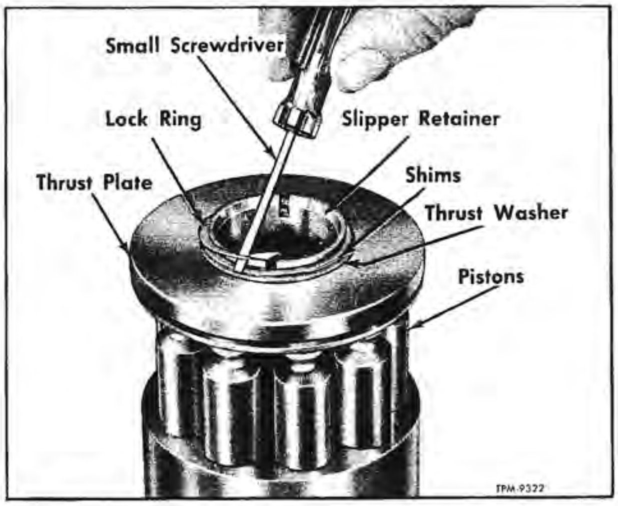


Figure 45—Removing Lock Ring From Pump Slipper Retainer

trunnion flange in relation to housing to assure original position when reassembling. Using a spanner wrench or similar tool, remove trunnions (47) being careful to support swash plate (7) while this is being done. Remove trunnion thrust washers (5) and swash plate from housing. The swash plate will have to be tipped slightly forward and turned while in an upright position, then rotated to be removed. See figure 47.

15. Remove O-rings (46) from each swash plate trunnion (47).

REPAIR OF FAN DRIVE PUMP

NOTE: Key numbers in text refer to figure 40.

1. If cylinder block (13) or end cap (19) sealing surfaces are grooved or scored, it will be necessary to lap surfaces of both parts in manner shown in figure 48. Use fine lapping compound. Use

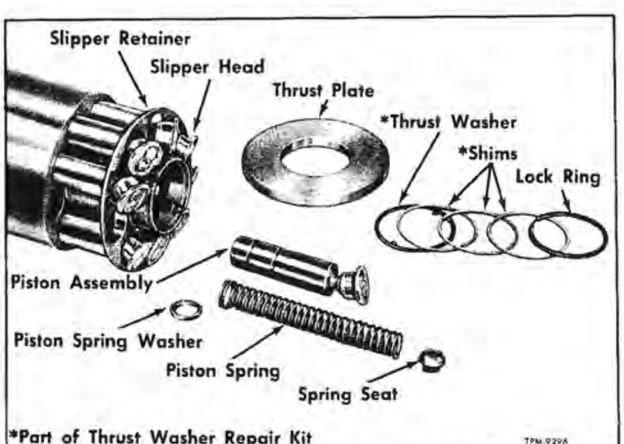


Figure 46—Pump Cylinder Block Disassembled

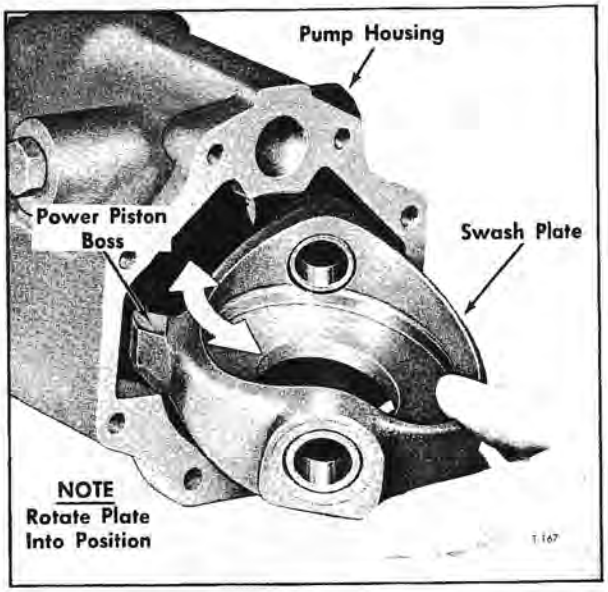


Figure 47—Replacing Pump Swash Plate

kerosene or solvent to thoroughly wash and clean parts including bores. Remove any lapping compound that may be present.

IMPORTANT: Do not remove over .005" stock from face of end cap. If necessary to remove more than this amount, it is recommended that end cap assembly be replaced with a new one.

2. Thrust plate (11) can be lapped in same manner if scored or grooved.

3. If pump shaft front support bearing (44) indicates wear or excessive play, it can be readily pressed from shaft and replaced after removing snap ring (51). If original bearing is to be used at assembly it should be thoroughly washed and cleaned with solvent or kerosene. Secure reinstalled bearing with snap ring (51).

4. If shaft rear bearing inner and outer race (3) are worn, replace bearing assembly by pulling old bearing outer race from end cap and pressing in a new bearing outer race in manner shown in figure 49.

IMPORTANT: DO NOT DAMAGE LAPPED SEALING SURFACES OF END CAP.

To replace the bearing inner race on pump shaft, remove race retaining ring (4) from shaft groove, then replace bearing race. NOTE: Make sure retaining ring is seated fully in shaft groove when reinstalling.

NOTE: Bushings (6) in swash plate should not be replaced as it would be necessary to line-ream after replacing. Install new swash plate assembly.

5. Clean, inspect, and if necessary replace any part which shows wear or scoring.

IMPORTANT: Wearing safety glass, direct high pressure air stream into all fluid passages and cavities of end cap (19) and housing (45).

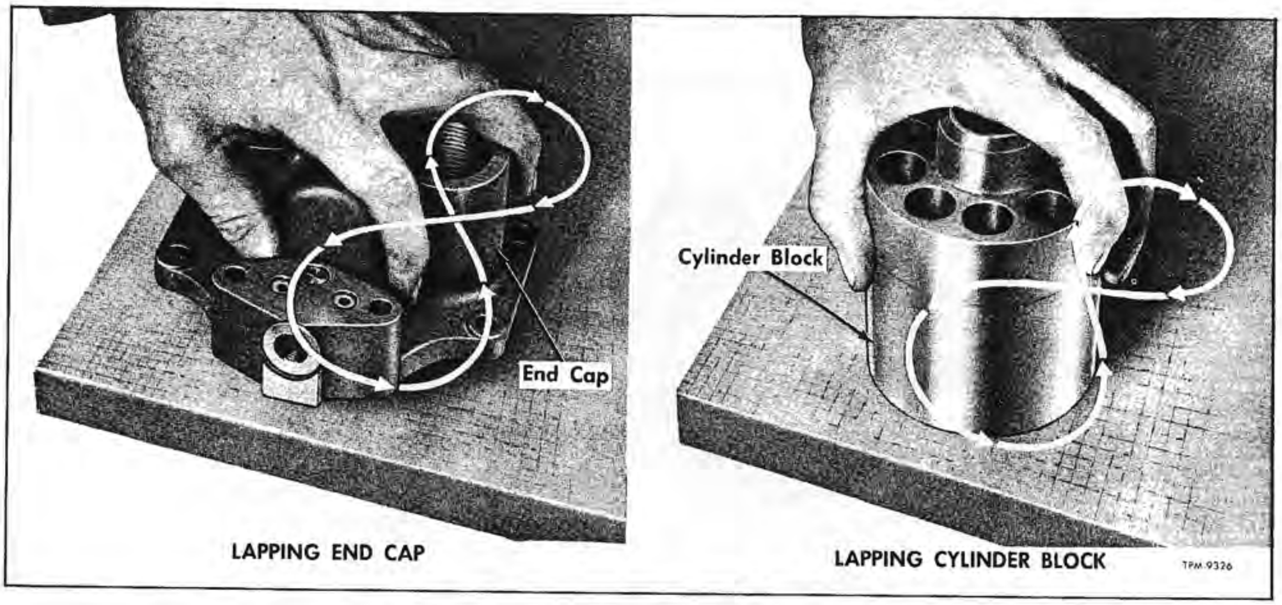


Figure 48—Lapping Pump Cylinder Block and End Cap

ASSEMBLY OF FAN DRIVE PUMP

NOTE: Key numbers in text refer to figure 40.

IMPORTANT: Make sure all parts and passages are absolutely clean before assembling pump.

1. Place swash plate (7) with assembled trunnion bearings (6) into pump housing as shown in figure 47. Note position of power piston lug on swash plate - must be facing up.

2. Inspect O-ring (46) on trunnions and replace if any nicks or scratches are present. Place O-ring on trunnion.

3. Note that trunnion (47) wear pattern is on one side of trunnion, and in reassembly this wear pattern should be placed so it faces the pulley end of the pump housing (45). This was the reason trunnions were marked prior to removal. Turn trunnions through thrust washers (5) and into swash plate bearings. Rotate trunnions to alignment marks made prior to removal, then install trunnion plate (48), and attach both with screws (50) and lock washers (49). Tighten screws evenly and firmly.

4. Place pump housing (45) into vise with hub downward grasping housing by the housing hub, then place pump shaft (2) into housing. Line up shaft for squareness and tap gently with soft hammer to drive the shaft and bearing into housing recess.

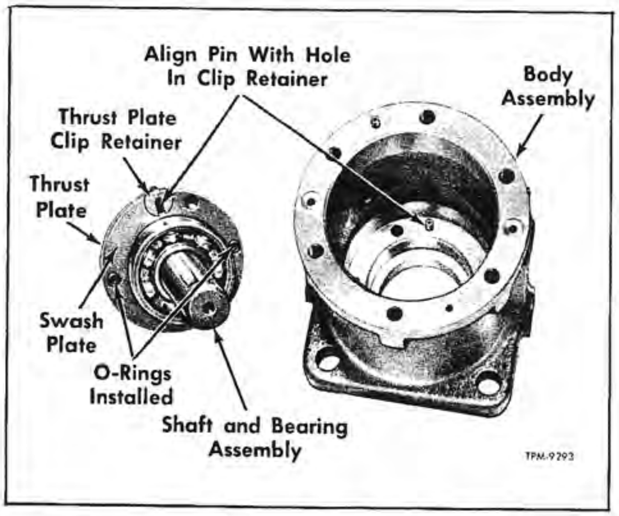


Figure 49—Installing New Bearing In End Cap

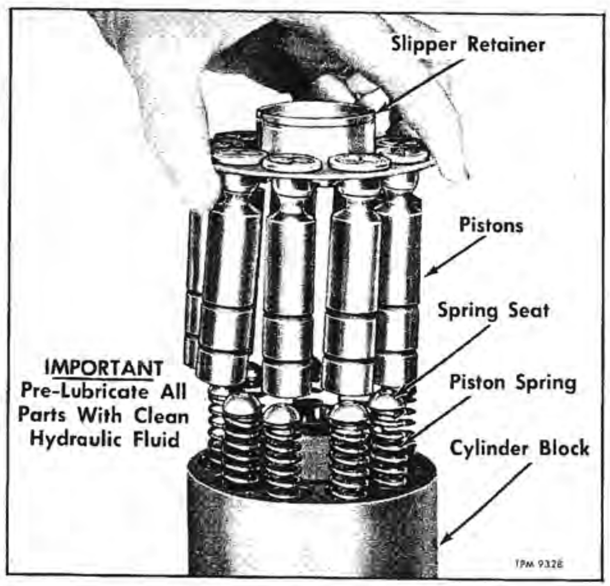


Figure 50—Installing Pump Pistons In Cylinder Block

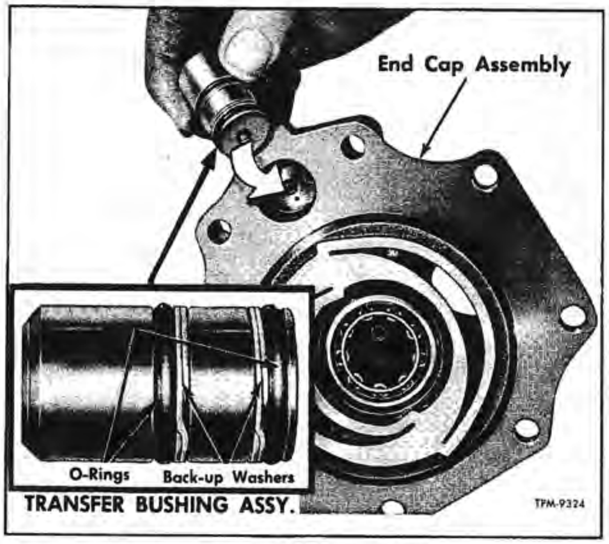


Figure 51—Installing Pump Transfer Bushing Assembly

IMPORTANT: Do not drive the shaft beyond the point of positioning. Install bearing snap ring (43). Make sure snap ring is fully seated in groove.

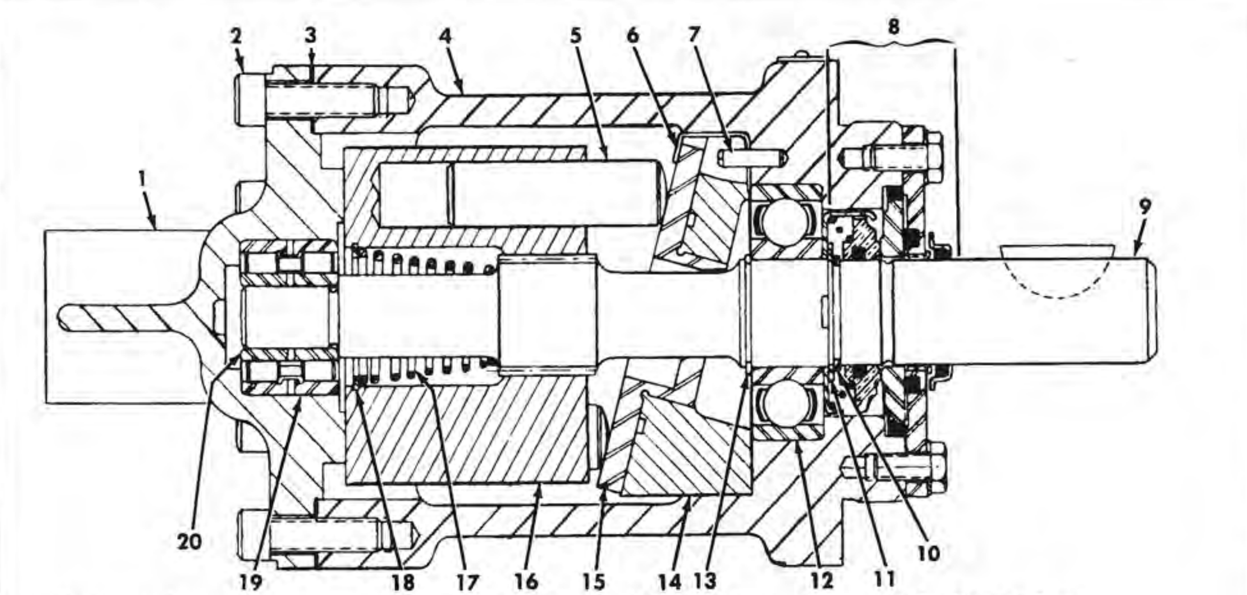
5. Prior to assembling pistons into block, oil all parts. Referring to figure 50, assemble piston springs (16) and spring seats (15), into cylinder block (13), then with pistons located in slipper retainer (12) as shown, lower pistons over springs and down into cylinder block. IMPORTANT: Pistons and block should be of same temperature, otherwise it may be impossible to install pistons in cylinder bores. DO NOT ATTEMPT TO FORCE PISTONS IN BLOCK.

6. Referring to figure 46, assemble thrust washer (10), shims (9), and spiraloc snap ring (8) over end of slipper retainer. NOTE: Thrust washer tangs must engage slots on slipper retainer (12).

IMPORTANT: Shims (9) are available in .005" and .015" thickness. Select shims to obtain a clearance of .001" to .005" between thrust washer (10) and thrust plate (11).

7. Insert cylinder block assembly (13) into pump housing (45) with the pump placed on the work bench in a horizontal position. As cylinder block is placed into housing, turn shaft so that splines will engage splines of cylinder block. Press block into housing.

8. With pump housing still in horizontal position, insert power piston spring seat (41) into end of spring (40), then place power piston (42) over seat and spring. Insert piston assembly into housing bore.



1 End Cap Assy.
2 Screws
3 Cap Gasket
4 Motor Housing
5 Pistons
6 Thrust Plate Clip Retainer
7 Pin (locating)
8 Shaft Seal Components
9 Motor Drive Shaft
10 Retaining Ring
11 Thrust Washer
12 Main Bearing Assy.
13 Snap Ring
14 Swash Plate
15 Thrust Plate
16 Cylinder Block Assy.
17 Tension Spring
18 Retainer Ring
19 End Cap Bearing Assy.
20 Bearing Inner Race

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Figure 52—Sectional View of Drive Motor Assembly

9. Referring to figure 51, inspect transfer bushing O-rings (37) and back-up washers (38) for collapsed or scuffed condition. Replace if necessary. Install O-rings and back-up washers on bushing, then insert transfer bushing assembly into end cap as shown.

10. Place pump in vise with shaft downward. Clamp vise jaws on pump shaft. Assemble housing gasket (18) to pump housing. Grease rollers in end cap bearing (3) packing grease to the outside to allow clearance for inner bearing race on the shaft.

11. CAREFULLY place end cap (19) against cylinder block (45).

IMPORTANT: DO NOT SCRATCH OR NICK SEALING OR VALVING SURFACES OF EITHER PART.

12. Using the two solenoid attaching bolts (26) as guide bolts, compress cap assembly slowly downward using improvised compressing tool (fig. 42). NOTE: Rotate pump housing slightly. This will facilitate alignment of shaft with bearing in the end cap. Install and tighten end cap attaching screws evenly and firmly.

13. Install flow control valve components (fig. 33) into bore of end cap assembly as instructed previously under "Servicing Fan Drive Pump Flow Control Valve."

14. Referring to figure 41, reassemble dampening valve components into bore of end cap. Tighten valve plug firmly.

15. Install pump shaft seal components to housing and shaft as instructed previously under "Pump Shaft Seal Replacement."

16. Install pump solenoid components (fig. 35) as instructed previously under "Pump Solenoid Valve Replacement and Repair."

FAN DRIVE MOTOR OVERHAUL

NOTE

As unit is being disassembled, inspect for dirt, sludge, metallic shavings and for any other material or condition which may determine the cause of failure.

If during overhaul internal failure is found and any metallic particles or impurities are present, it will be necessary to flush all fluid lines with kerosene and air pressure mixture before installing repaired or new unit.

IMPORTANT: ALL TOOLS, WORKING AREA, AND APPAREL MUST BE CLEAN WHEN SERVICING UNITS. IF WIPING CLOTHS ARE USED, MAKE SURE THEY ARE OF LINT-FREE TYPE. DIRT OR FOREIGN MATTER IN SYSTEM WILL CAUSE SHORT LIFE OF UNITS AND MAY CAUSE COMPLETE FAILURE OF SYSTEM.

CLEAN EXTERIOR SURFACES OF UNIT TO BE OVERHAULED BEFORE STARTING DISASSEMBLY PROCEDURES.

DISASSEMBLY OF FAN DRIVE MOTOR

NOTE: Key numbers in text refer to figure 52.

1. Place motor with shaft downward in a vise, then remove six screws (2) (using 3/16" hex-wrench) which attach end cap assembly (1) to motor housing (4). Carefully lift end cap from motor housing. DO NOT SCUFF OR DAMAGE SEALING SURFACES OF CAP OR CYLINDER BLOCK. Figure 53 shows end cap assembly separated from housing.

2. Remove end cap gasket (3) and two small O-rings from recesses in housing at fluid passages. See figure 53 which shows rings installed.

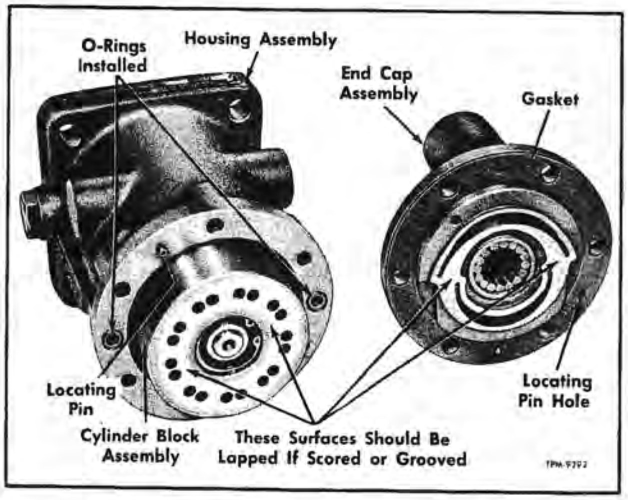


Figure 53—Motor End Cap Assembly Removed

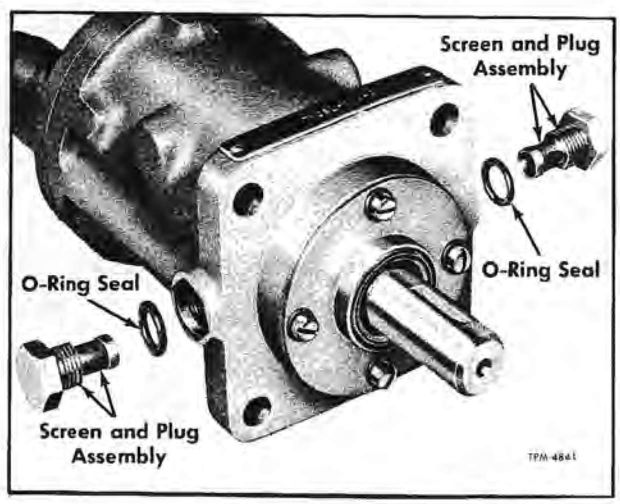


Figure 54—Motor Oil Strainer Plugs and Screens Removed

SYSTEM MAINTENANCE

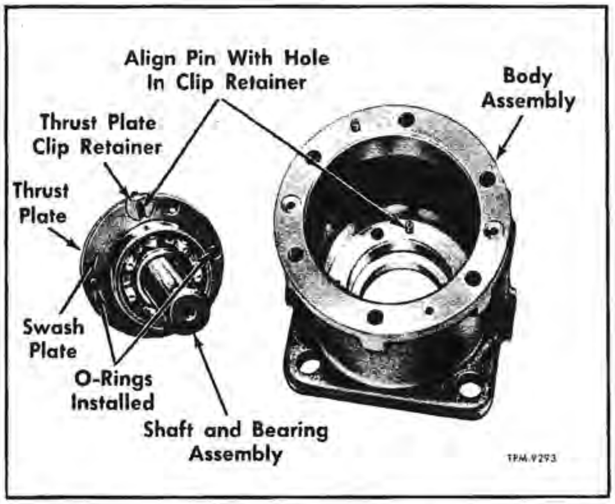


Figure 55—Motor Shaft Assembly Removed

3. With motor housing in horizontal position, slide cylinder block assembly (16) from housing.

NOTE: Pistons (5) in cylinder block are all the same size and are interchangeable.

4. Using a Tru-Arc pliers, remove retainer ring (18) and tension spring (17) from cylinder block.

5. Referring to figure 54, remove oil strainer plug and screen assemblies from sides of motor housing.

IMPORTANT: Make sure that any grit present is not left in motor housing.

6. Remove seal components (8) from motor shaft as previously explained under "Motor Shaft Seal Replacement."

7. Using a 3/16" hex-wrench, remove two screws and copper washers from shaft end of housing which retain swash plate (14) and drive shaft within the housing. Attaching screws are shown installed in figure 38.

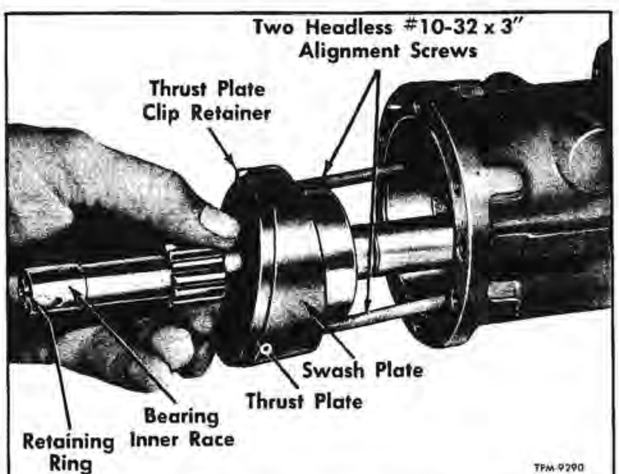


Figure 56—Installing Motor Shaft Assembly

8. Using a soft hammer, tap on fan end of motor shaft to drive the shaft with thrust plate (15) and swash plate (14) as an assembly from motor housing. Figure 55 shows shaft assembly separated from housing.

9. Remove clip retainer (6) which retains thrust plate (15) to swash plate (14), then remove thrust plate and swash plate from over shaft splines.

10. Press shaft bearing assembly (12) from motor shaft.

REPAIR OF FAN DRIVE MOTOR

NOTE: Key numbers in text refer to figure 52.

1. If cylinder block (16) or end cap (1) sealing surfaces are grooved or scored, it will be necessary to lap surfaces of both parts as shown typically in figure 48. Use fine lapping compound. Use kerosene or solvent to thoroughly wash and clean parts including bores, and remove any lapping compound that may be present on the sealing or valving surfaces.

IMPORTANT: Do not remove over .005" stock from face of end cap (1). If necessary to remove more than .005" it is recommended that end cap assembly be replaced with a new one.

2. The motor thrust plate (15) can be resurfaced in similar manner as cylinder block and end cap. Remove all lapping compound before assembling.

3. Check small O-rings on back of swash plate (fig. 55) for nicks and scratches, then lightly grease for reassembly making sure they are completely in recess.

4. If bearing (19) in end cap or bearing inner race (20) on motor shaft is worn it will be necessary to replace the end cap assembly (1).

ASSEMBLY OF FAN DRIVE MOTOR

NOTE: Key numbers in text refer to figure 52.

IMPORTANT: Make sure all parts and passages are absolutely clean before assembling motor.

1. Press bearing assembly (12) on shaft against snap ring (13).

2. Referring to figure 56, position swash plate (14) and thrust plate (15) over shaft spline and assemble clip retainer (6) as shown.

3. Cut off heads of two No. 10-32 x 3 inch screws and install into screw holes on back side of swash plate as shown in figure 56. These screws will serve as guide pins to align mounting bolt holes and fluid passages.

4. Refer to figure 55 which shows alignment pin (7) at bottom of motor housing. Pin must align with thrust plate clip retainer hole. Assemble shaft assembly into motor housing. Remove one guide screw at a time and install regular attaching screws

with copper washer. Tighten screws evenly. Tap end of shaft to seat bearing in housing recess, then final tighten screws firmly.

5. After cleaning pistons (5) lubricate, then install in cylinder block (16) as shown infigure 57.

6. Assemble complete cylinder block assembly into the housing, turning the motor shaft (9) to engage the spline arrangement.

7. Align new gasket (3) onto housing face using holes for line up.

8. Clean and inspect the two small O-rings and insert into recess on housing face (see fig. 53). Check to see if check valve assembly is in place in the outlet part of end cap assembly. Install end cap (1) using guide pin in face of housing for proper line-up.

9. Assemble seal components (8) over shaft and into housing recess as described previously under "Motor Shaft Seal Replacement."

10. Clean oil strainer plug and screen assemblies, then with O-ring on each plug, install plugs in sides of pump housing. See figure 54.

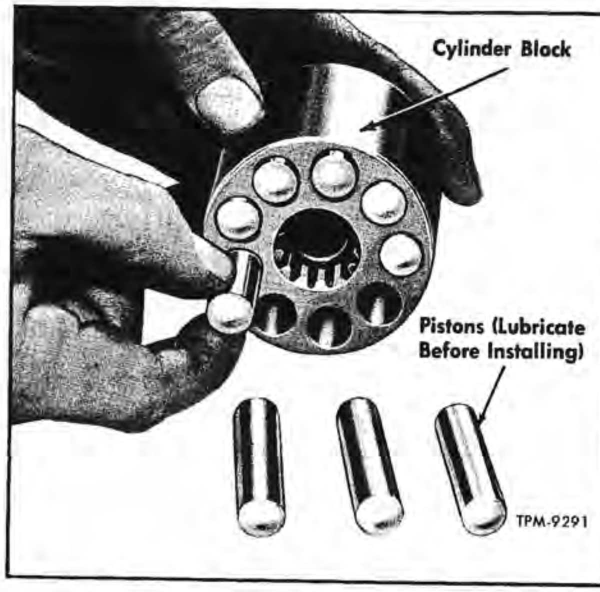


Figure 57—Installing Motor Pistons

CONDENSER FAN DRIVE SYSTEM TROUBLESHOOTING CHART

Condition	Possible Cause	Recommendation
Pump stops operating	1. Air bound pump.	1. Make sure fluid reservoir is full to "OIL LEVEL" mark and that fluid is free of impurities. IMPORTANT: DO NOT OVERFILL.
		2. Crack pump outlet line connection to vent air out of hollow pistons within pump, then disconnect wire from pump solenoid terminal. Operate system until fluid only appears at line connection. IMPORTANT: Be sure solenoid wire is disconnected.
	2. Loose drive belts.	Tighten belts to obtain 1/4" to 3/8" deflection across all three belts, midway between pulleys. IMPORTANT: DO NOT OVERTIGHTEN BELTS AS FAILURE OF PUMP SHAFT BEARING COULD RESULT.
	3. Electrical circuit to pump solenoid closed.	With system in operation, disconnect wire from terminal on pump solenoid valve. Pump should build up pressure. If pressure builds up, the malfunction is electrical. Check wiring diagram since solenoid must be "dead" for pump to operate. NOTE: Contacts of pump air pressure switch may be frozen or burned together. If this is the case, replace air pressure switch. Switch is located on forward bulkhead in air conditioning compressor compartment.

SYSTEM MAINTENANCE

TROUBLESHOOTING CHART (CONT.)

Condition	Possible Cause	Recommendation
Pump stops operating (Cont'd.)	4. Needle valve in pump solenoid held open by an obstruction.	Valve should close in a short period of time (1 to 1-1/2 seconds) after system is placed in operation. If valve does not close, the build-up of pump pressure will not occur. Disconnect wire at solenoid terminal, then remove and repair solenoid valve assembly as instructed previously under "Pump Solenoid Valve, Replacement and Repair." NOTE: After installing solenoid valve components, it will be necessary to vent fluid system at pump.
Fan motor will not operate	1. Insufficient fluid in system.	Fill reservoir to "OIL LEVEL" mark.
	2. Dirt or foreign particles in system fluid.	Drain, flush, and refill system with CLEAN fluid. NOTE: System can be flushed out using a mixture of kerosene and air pressure. Final flush lines using air pressure only.
	3. Defective fluid pump or motor.	Repair and/or replace pump or motor assembly.
	4. Defective pump solenoid valve air pressure switch.	Replace switch. A defective switch (contacts stuck closed) will cause solenoid valve to stay open, thus permitting pump to operate in no-pressure position.
Fan motor noisy	1. Dislodged check valve in motor.	Replace pump end cap assembly. NOTE: Check valve is not serviced separately.
	2. Air in fluid system.	1. Check fluid level in reservoir. Add fluid if necessary to "OIL LEVEL" mark.
		2. Clean out small vent holes in fluid reservoir cover and cover nut.
		3. Vent all lines at pump connections.
Fan motor operates below 1775 rpm - or motor surges	1. Insufficient fluid in system.	Replenish fluid to "OIL LEVEL" mark in fluid reservoir.
	2. Clogged or restricted fluid return line to pump.	Remove restriction or if necessary, replace line. NOTE: Check inner lining of all hoses for possible deterioration.
	3. Sticking flow control valve at fluid pump.	Remove and clean valve components. Refer to "Servicing Fan Drive Pump Flow Control Valve," explained previously.
	4. Worn pistons or valving surfaces in either the pump or motor.	Overhaul or replace defective unit.

REFRIGERANT COMPRESSOR

The refrigerant compressor, platform-mounted under rear of coach (fig. 58) is a four-cylinder reciprocating type unit. It is self-lubricated and self-contained. The shaft seal is of the rotary type, consisting of a stationary lapped seal face ring pressed into the seal cover, with a spring-loaded rotating carbon nose ring sealing against the seal face of the stationary ring.

A neoprene seal ring between the carbon nose ring and spring acts as a seal around the shaft. The seal faces are flood-oiled under pressure at all times. A sight glass on the side of the compressor shows the oil level. Shut-off valves are provided at the compressor suction and discharge ports.

Compressor is also equipped with an integral and completely internal mechanism which allows the compressor to start with two of the four cylinders unloaded. Loading and unloading of these two cylinders is actuated by suction pressure variations, but the unloader mechanism operates hydraulically on power from the oil pressure of the compressor lubricating system. Without oil pressure the unloader mechanism holds suction valves open and individual cylinders operate unloaded. Under oil pressure the unloader permits suction valves to function normally and cylinders to operate at full capacity.

After shut-down and without oil pressure, the two cylinders will start and operate unloaded until oil pressure is supplied to the unloader mechanism. For detail information on unloading operation refer to "Cylinder Unloading Operation" explained later.

Compressor is shaft driven from coach engine by an air-operated clutch. Clutch can be engaged

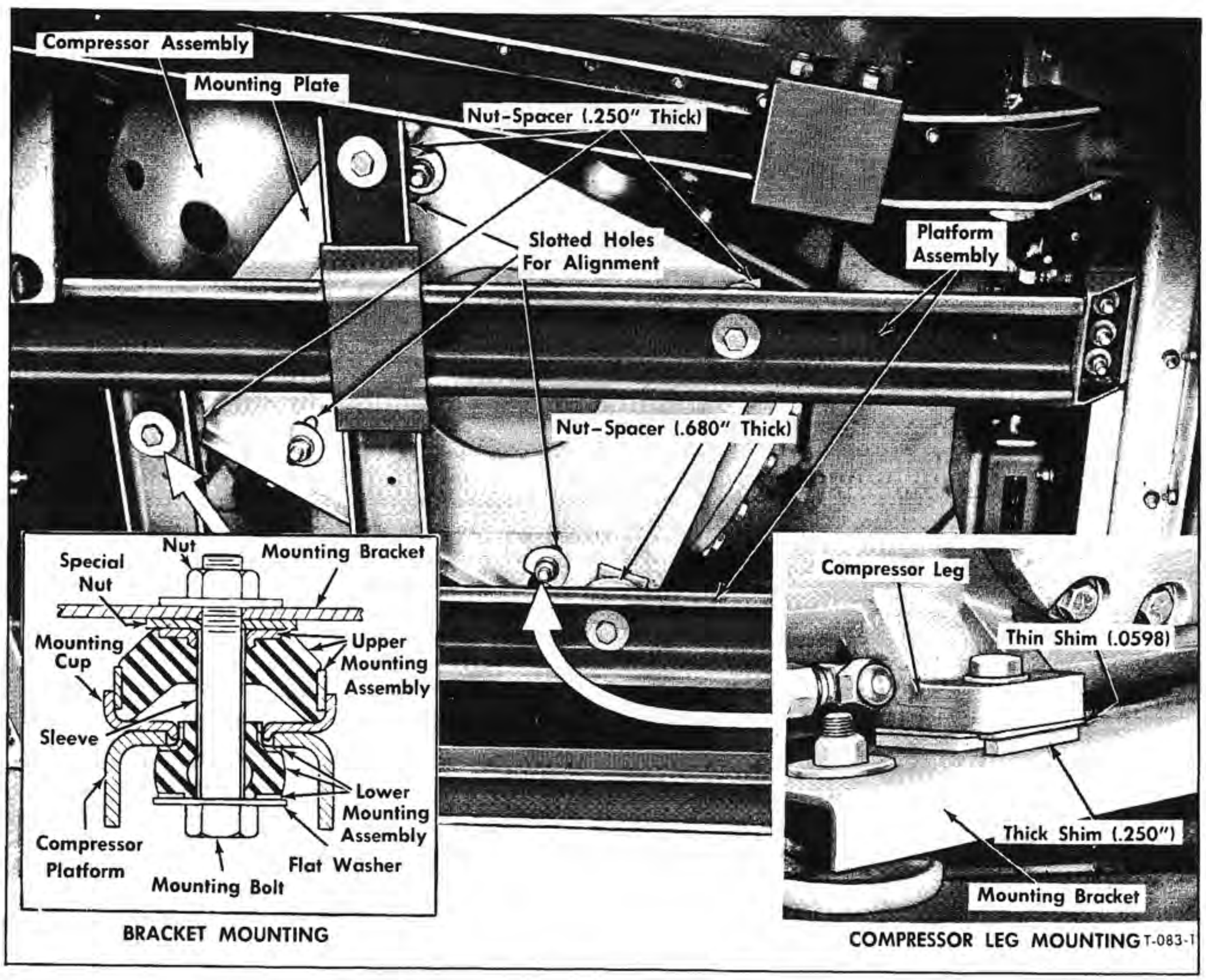


Figure 58—Compressor and Platform Mounting (Typical)

SYSTEM MAINTENANCE

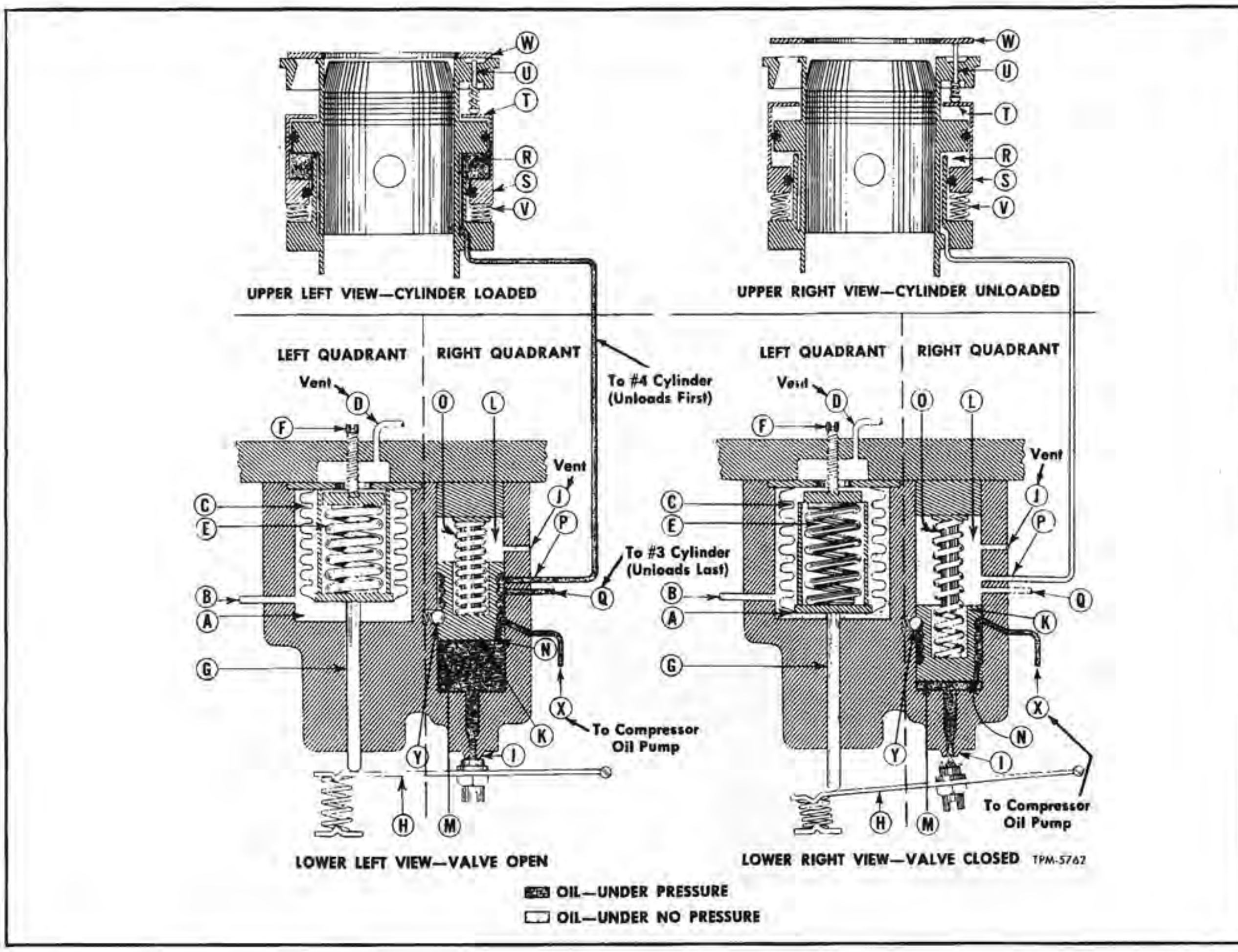


Figure 59—Compressor Capacity Control and Unloader Starting System

when engine is operating in a range between 3 psi and 15 psi oil pressure. The clutch operation and maintenance information is explained later under respective headings.

Compressor can be removed from coach with clutch mechanism attached. Removal procedures are explained later under "Compressor Replacement." Compressor overhaul instructions are also explained later under "Refrigerant Compressor Overhaul."

COMPRESSOR OPERATION

NOTE: Figure 65 shown later under "Refrigerant Compressor Overhaul" shows sectional view of compressor.

The aluminum body of the compressor is divided into three main sections -- the discharge or high pressure gas cavity, the suction or low pressure gas cavity, and the crankcase.

Low pressure refrigerant gas is drawn into the compressor from the suction line. As the refrigerant gas enters the compressor it passes through fine mesh strainer screens and then into the suction cavity. In the suction cavity, oil entrained with the refrigerant separates from the refrigerant and passes into the crankcase through a check valve. The low pressure refrigerant is drawn into the cylinder during the down-stroke of the piston through the cylinder suction valve which is mounted on the top of the cylinder liner. During the suction stroke of the piston, the cylinder discharge valve in cage on top of cylinder liner is closed. As the piston begins its compression stroke, the cylinder suction valve closes and compression begins. As the piston moves up on the compression stroke, the cylinder discharge valve opens, and the high pressure refrigerant gas passes through the valve into the discharge cavity. The gas then passes through the discharge cavity to the high pressure refrigerant line. A spring-loaded safety relief valve is mounted in the wall which divides the high and low sides of the compressor. This valve serves to relieve or bypass discharge pressure to the low side of the compressor should the discharge pressure build up normally high or above the set point of the high to low relief valve. Such a condition would occur if the compressor was operated with the discharge line shut-off valve closed. No. 3 and 4 cylinders of compressor are equipped with unloader mechanism. Operation of mechanism is explained as follows:

CYLINDER UNLOADING OPERATION

The cylinder unloading control mechanism consists of two distinct groups of components: The capacity control actuator and the cylinder unloader components. These two components are schematically shown in figure 59. Upper views show the cylinder unloader mechanism and the lower views show the capacity actuator components.

Capacity Control Actuator

The capacity control actuator reacts to variations of refrigeration load requirements and transmits them to the cylinder unloader mechanisms which act to load and unload two of the four compressor cylinders. To perform this dual function, the capacity control actuator consists of a pressure sensing device which is sensitive to variation in suction pressure, and valving mechanism which regulates the oil pressure to the various cylinder unloader mechanisms.

Pressure Sensing Device (Refer to Left Quadrant in Lower Views on Figure 59)

The pressure sensing device consists of a chamber A, connected to suction pressure through line B, and a bellows C, the inside of which is connected to atmospheric pressure through vent D. The tendency of the pressure sensing device is to maintain as nearly as possible a predetermined suction pressure. This pressure is the maximum pressure required to satisfy the system and may range from 0 to 50 psi. The specific point is maintained by a balance of forces - suction pressure balanced against a combination of atmosphere pressure and force from spring E. The amount of tension is adjustable by set screw F. When the system requires less than full refrigeration load, the suction pressure will fall below the predetermined point, causing an unbalance within the device, and the unloading cycle will commence. The drop in suction pressure permits bellows C to expand, forcing plunger G against lever H moving it downward. The downward movement of this lever opens the regulated orifice I. The opening and closing of this orifice controls the action of the valving mechanism.

Valving Mechanism (Refer to Right Quadrant in Lower Views on Figure 59)

The function of the valving mechanism is to supply each of the cylinder unloaders with oil under pump pressure when full compressor capacity is required and to relieve this pressure when cylinders are to operate unloaded. This valving mechanism consists of a hydraulic cylinder containing an annularly grooved, floating piston K. The annular grooves are constantly connected to oil pump pressure through line X.

Above the piston is a chamber L which is vented to the crankcase through orifice J. Below the piston is another chamber M connected to the annular grooves in the piston by orifice N and connected to crankcase pressure through regulated orifice I. Located within the hydraulic cylinder is a spring O which tends to move the floating piston toward the lower chamber.

Under full capacity operation, as shown in lower left view of figure 59, regulated orifice I is shut off; oil pressure in lower chamber M increases because oil under pump pressure is being supplied through orifice N. This pressure overcomes the force of spring O and floating piston K rises in the cylinder. As it rises, the annular grooves in the floating piston coincide in sequence with lines P and Q to the cylinder unloaders, providing them with full oil pressure and permitting them to operate at full capacity.

When full compressor capacity is not required, regulated orifice I is opened through movement of lever; oil bleeds through and pressure within lower chamber approaches crankcase pressure as shown in lower right view of figure 59. Under these circumstances, the force of spring O overcomes the pressure in the lower chamber and floating piston K is moved downward so that lines P and Q become connected in sequence to crankcase pressure through orifice J. The spring-loaded detent ball Y permits the piston to move only in distinct detents; one groove at a time.

In this manner, the valving mechanism supplies or withdraws from each cylinder unloader the oil pressure that operates the unloader mechanism.

Unloader Cylinder Mechanism

When oil from the forced feed lubricating system flows through line P, from the valving mechanism to the cylinder unloader, it enters annular chamber R. The inner wall or unloader cylinder is firmly anchored to the cylinder liner; the unloader piston S, however, is free to move. The up and down movement of this unloader piston raises and lowers take-up ring T which raises and lowers suction valve lift pins U.

Under full capacity operation as shown in lower left view of figure 59, oil flows into annular chamber R under pressure sufficient to contract the unloader piston springs V. When oil pressure forces springs to contract, the unloader piston S moves down and take-up ring T and the suction valve lift pins U move with it. This permits the suction valve W to function normally and the cylinder operates at full capacity. When the compressor is to operate

SYSTEM MAINTENANCE

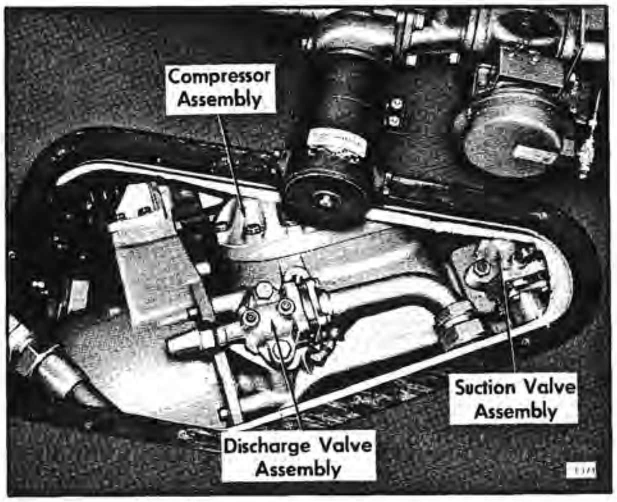


Figure 60—Access Opening To Compressor Valves (All Transit Model Coaches)

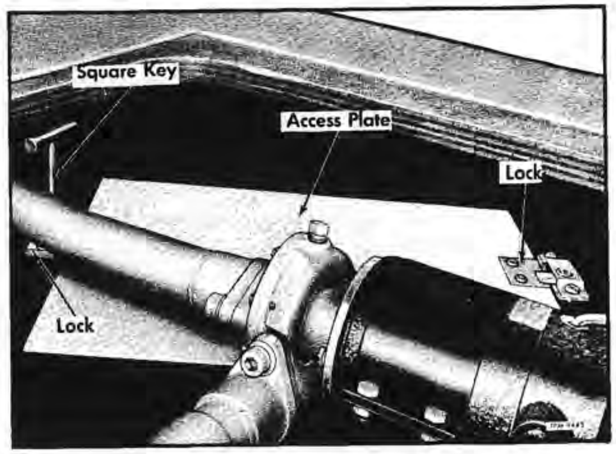


Figure 61—Access Opening To Compressor Valves (All Suburban Model Coaches)

at less than full capacity as shown in lower right view of figure 59, oil line P from the cylinder unloader mechanism is connected to crankcase pressure through orifice J which allows the pressure in the annular chamber R to dissipate; the cylinder unloader springs V expand, lifting the unloader piston S. This raises the take-up ring T, the valve lift pins U, and holds the suction valve W open so that the controlled cylinder is operating in an unloaded condition.

COMPRESSOR MAINTENANCE

Compressor requires practically no maintenance other than making sure that sufficient (but not too much) oil and refrigerant is maintained in the system at all times. The lubrication system of the compressor will fail if the system loses its charge of oil or refrigerant. Both oil and refrigerant must be circulating through the compressor whenever it is running to prevent very serious damage. Check compressor mounting bolts periodically. Check carefully for indication of oil or refrigerant leakage. Leaks should be remedied promptly to prevent excessive refrigerant and oil loss. If necessary, compressor can be overhauled as explained later under "Refrigerant Compressor Overhaul."

COMPRESSOR LUBRICATION

The compressor crankcase serves as a reservoir for the main oil charge. A portion of the lubricating oil circulates with the refrigerant, and this oil is separated from the refrigerant as the refrigerant passes through the suction cavity of the compressor. As the low pressure refrigerant and oil separate in the suction chamber, the oil goes to the bottom of the chamber, and the gas goes to the top of the chamber. The oil passes from the suction chamber to the crankcase through a check valve in the crankcase wall. This check valve allows oil to flow into the crankcase from the suction cavity, but checks against the flow of oil out of the crankcase.

During the "OFF" cycle of the compressor, refrigerant tends to collect and condense in the crankcase. The liquid refrigerant mixes with the oil in the crankcase. When the compressor begins to operate, there is a rapid reduction of pressure in the crankcase above the oil level. This permits the liquid refrigerant to evaporate out of the oil. As the refrigerant boils off and leaves the crankcase, the oil tends to foam and leave with the refrigerant. To prevent serious loss of crankcase oil on start-up, the refrigerant leaving the crankcase passes through a fine bronze screen or foam breaker. The foam breaker separates the oil from the refrigerant and returns the oil through a passage to the crankcase.

Compressor lubrication is accomplished by a force feed, direct drive, positive displacement pump, which is mounted to the end of the crankshaft. The pump is not self-reversing and must be operated in one direction of rotation. Oil from the crankcase is drawn into the pump through a tube which connects the pump to a fine mesh strainer located in the sump of the crankcase. This strainer scavenges oil from the bottom of the crankcase and prevents the entrance of foreign particles into the oil circulating system.

The pump then draws oil past a magnetic plug which attracts steel particles that escaped through strainer. Pump forces oil into suction end main bearing after which it enters end of crankshaft. Crankshaft oil passages are arranged to feed from inside of crankshaft throw. Two magnetic plugs in crankshaft oil passages trap steel particles. Oil escapes between rod bearings and is converted into mist to lubricate wrist pins and cylinder walls.

Small cup and hole in top of each connecting rod allows lubricant to travel down through this hole to lubricate the piston pin.

Oil also flows from drive end of crankshaft into crankshaft seal chamber. Pump also forces oil through two small lines to No. 3 and 4 cylinder unloaders.

It is highly important that only the recommended refrigeration compressor oils which contain a de-foamant be used in this compressor. The approved oils for use in this compressor are listed in "AIR CONDITIONING LUBRICATION AND INSPECTION" later in this group. These oils can be obtained locally through refrigeration equipment suppliers. Oil should be purchased in sealed cans only. Never use bulk oil or oil which has been exposed to air.

IMPORTANT: USE ONLY APPROVED COMPRESSOR OILS.

The initial charge of oil in the compressor is 14 pints. After the compressor has been operated for about 30 minutes, the oil level should be about 1/4 to 1/2 of the way up on the compressor sight glass. If oil is near or below the bottom of the sight glass, oil should be added. The oil level should always be checked with the compressor operating. Before adding oil, first determine and correct cause of loss of oil.

A new compressor or one having been overhauled should be drained and refilled after the first 200 hours of operation. Refer to "SYSTEM SERVICES AND TESTS" for adding and draining of compressor oil.

COMPRESSOR SHUT-OFF VALVES

Double-seating shut-off valves are provided at the compressor discharge and suction ports. Valves are accessible from compressor compartment or through an access opening in floor (figs. 60 and 61). With both valve stems turned all the way in (closed), compressor is isolated from the rest of the system. "Operating Position" of valves, frequently referred to in this section is with the valve stem in the full back-seated position as shown in figure 62. NOTE: On these coaches it should never be necessary to place valves in the off back-seated position.

IMPORTANT: Valve stem caps with gaskets must be in place and tight at all times during system operation.

COMPRESSOR STORAGE

1. If compressor is to remain inoperative in coach for an extended period, a considerable amount of refrigerant could be lost through the shaft seal, because the shaft seal did not remain

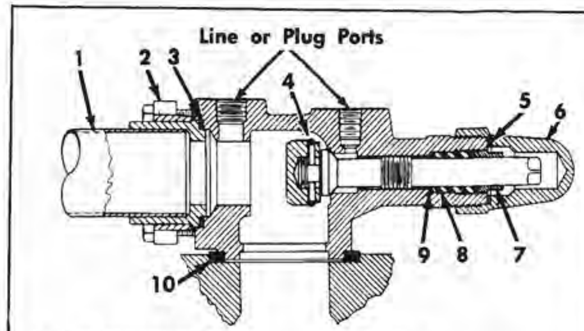


Figure 62—Compressor Refrigerant Valves (Typical)

wetted. To prevent loss of refrigerant through the shaft seal, the compressor, suction, and discharge service valves should be closed (frontseated). This will isolate the compressor from the rest of the system. Another method of preventing loss of refrigerant through the compressor shaft seal when the compressor is idle for a long period of time, is to operate it every four or five days. This will maintain a film of oil on the sealing surfaces of the seal and on the bearings.

2. If compressor is removed from coach and is to remain in storage, stand the compressor on end, drive end down, on blocks in such a way that no weight rests on the compressor shaft.

COMPRESSOR REPLACEMENT

NOTE: Compressor which can be readily removed from compressor compartment is removed with the clutch assembly attached. Before removing compressor, pump down the system as directed later under "Pumping Down the System." It is also necessary to disconnect the hydraulic fluid lines from condenser fan pump if pump is to be removed with compressor.

COMPRESSOR REMOVAL PROCEDURE

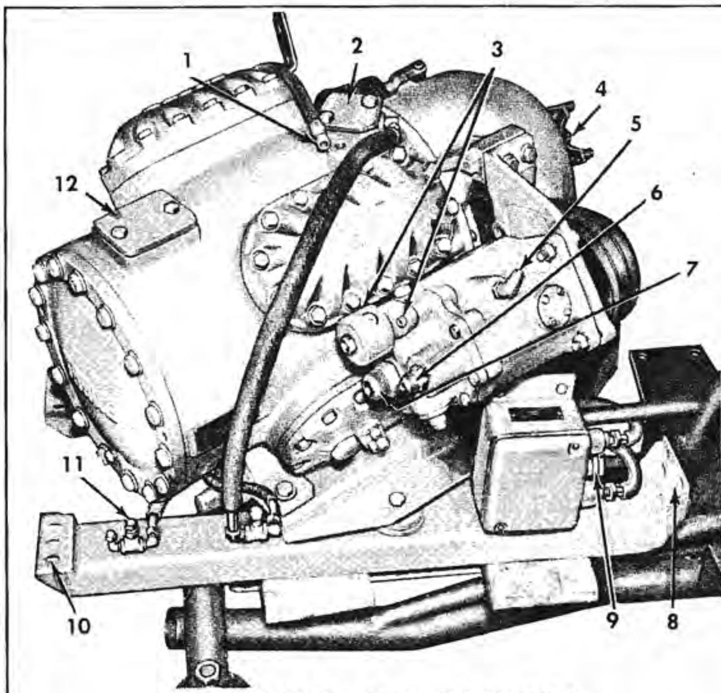
NOTE: Position rear wheels of coach on run-up blocks to provide sufficient clearance for compressor when removing. Key numbers in text refer to figure 63.

1. Remove clutch control air line (1) from air solenoid valve.

2. Disconnect compressor drive shaft (4) from clutch shaft flange.

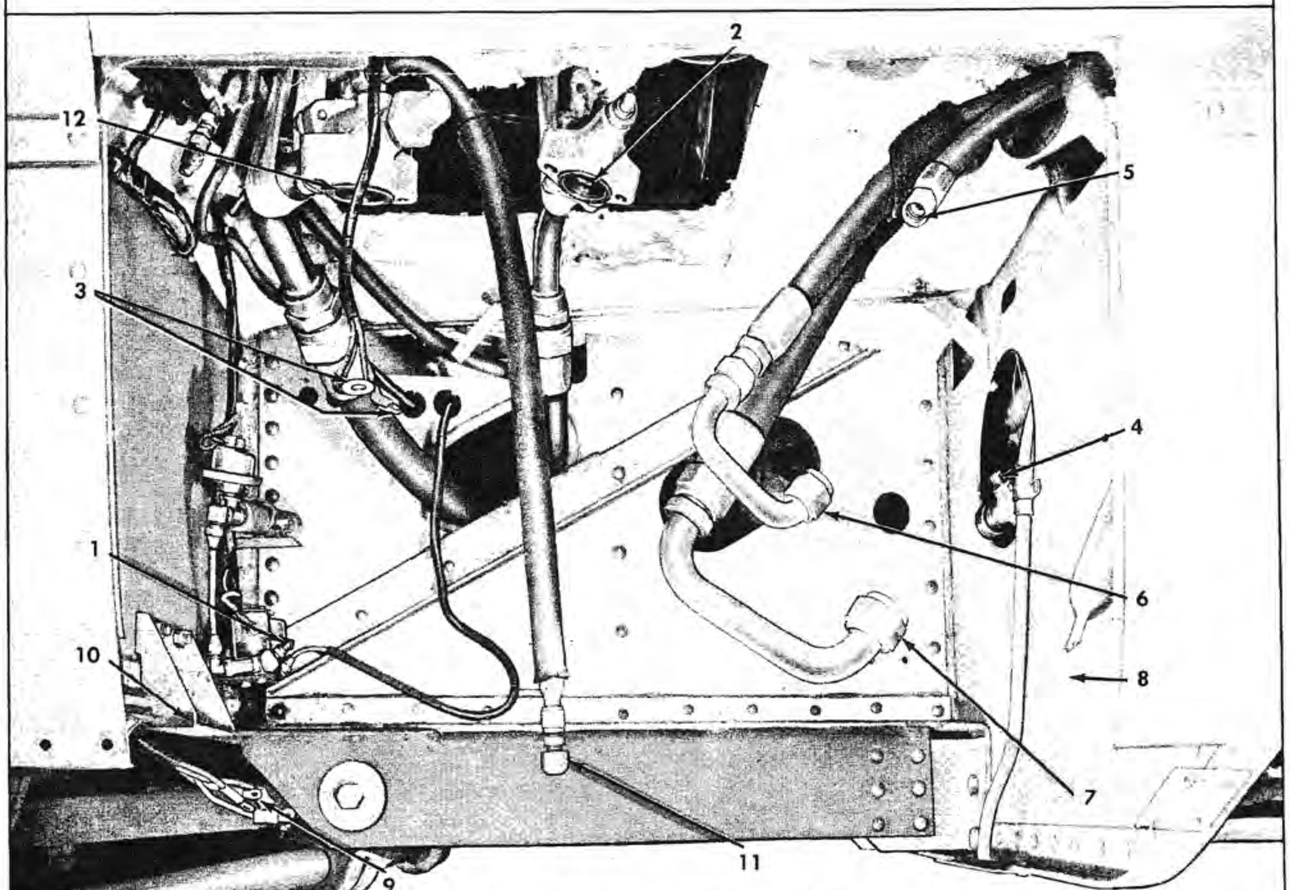
3. Drain condenser fan drive fluid system as instructed earlier under "Condenser Fan Pump Replacement," then disconnect hydraulic fluid lines

SYSTEM MAINTENANCE



DISCONNECT POINTS AT COMPRESSOR

1 Clutch Control Air Supply Line Connection
2 Refrigerant Discharge Valve Connection
3 Condenser Fan Pump Solenoid Wiring Connection
4 Compressor Drive Flange Connection
5 Fan Pump Vent Port to Fluid Reservoir
6 Fan Pump "OUT" Port Line to Fan Motor
7 Fan Pump "IN" Port Line from Fluid Reservoir
8 Platform Rear Mounting Bolt Holes
9 "HI-LOW" Pressure Switch Wiring Connection
10 Platform Front Mounting Bolt Holes
11 Suction Valve Line to Service Fitting Connection
12 Refrigerant Suction Valve Connection



DISCONNECT POINTS IN COMPARTMENT

T-225

Figure 63—Compressor Disconnect Points (Typical)

(5, 6 and 7) from condenser fan pump. Disconnect wiring at pump solenoid.

4. NOTE: The following procedures cover method whereby the refrigerant lines with valves are disconnected from compressor. Close valves by turning stem clockwise, then remove bolts attaching valves to compressor. Raise and tie lines up out of the way. The compressor valve openings should be immediately covered with improvised blank flange plates and gaskets after removing the valves. This will retain some refrigerant in lines and compressor thus minimizing the entry of air and moisture. Figure 64 shows dimensions of closure plates which can be improvised locally.

5. Disconnect "HI-LO" pressure switch suction line (11) at suction valve test fitting. If "HI-LO" pressure switch is mounted on bulkhead, disconnect both lines at test gauge fittings. IMMEDIATELY SEAL ENDS OF ALL LINES AND CAP THE OPEN LINE FITTINGS.

6. Remove dust shield from below compressor; position a lifting dolly to support weight of compressor unit. IMPORTANT: Make sure weight of compressor unit is distributed equally on lifting dolly. If possible, attach compressor platform to dolly.

7. Remove bolts, nuts, and washers which attach ends of compressor platform to coach body. Carefully lower compressor from compartment. Figure 63 shows typical compressor disconnect points.

8. Platform rubber mountings can be readily removed.

9. Compressor clutch unit can be removed from compressor as explained later under "Compressor Drive Clutch." Compressor overhaul procedure is also explained later under "Refrigerant Compressor Overhaul."

COMPRESSOR INSTALLATION PROCEDURE

NOTE: Key numbers in text refer to figure 63.

1. Referring to figure 58, install compressor rubber mounting components to compressor platform if previously removed.

2. Raise compressor assembly with mounting platform to position in compressor compartment. With insulation strip installed at each mounting, install mounting bolts through holes (8 and 10) in compressor platform and secure with flat washer, lock washer, and nut. Tighten nuts of all mounting bolts firmly.

3. Install refrigerant line valves to compressor using new gaskets. Tighten valve attaching bolts.

4. Connect "HI-LO" pressure switch lines to fittings.

5. Connect condenser fan pump lines (5, 6, and 7) to pump, using new O-ring gaskets. Refer to instructions explained previously under "Condenser Fan Drive Pump Replacement."

6. Install compressor drive shaft assembly. Tighten flange bolt nuts firmly.

7. Install clutch control air supply line (1) to air solenoid valve. Tighten connection firmly.

8. Install electrical wiring to terminal of fan pump solenoid and to ground.

9. Accomplish services outlined later under "SYSTEM SERVICES AND TESTS." See "Refrigerant Valves," "Preparing Unit For Operation," "Purging the System," "Testing for Leaks," and "Checking For Air in System."

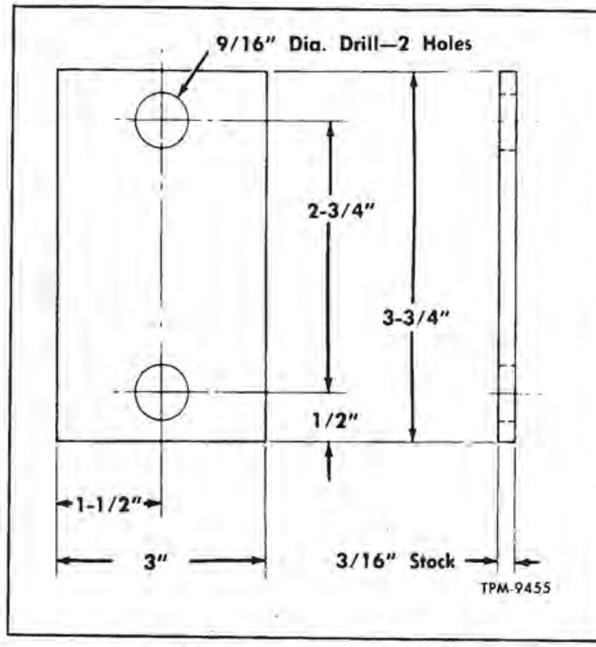


Figure 64—Closure Plates (For Placing Over Compressor Valve Ports)

REFRIGERANT COMPRESSOR OVERHAUL

Before overhauling compressor (fig. 65), the system must be pumped down and the unit removed from coach. Pumping down system instructions are explained later under "SYSTEM SERVICES AND TESTS." See "Pumping Down The System." Instruction procedures for removing compressor are explained previously under "Compressor Replacement."

The immediate area in which the compressor is to be overhauled should be dust-free and if pieces of cloth are to be used for the cleaning of parts, they should be of the lint-free type.

When servicing parts of compressor, handle the parts carefully and protect them against rusting immediately upon removal from compressor housing. Before installing parts, wash with refrig-

SYSTEM MAINTENANCE

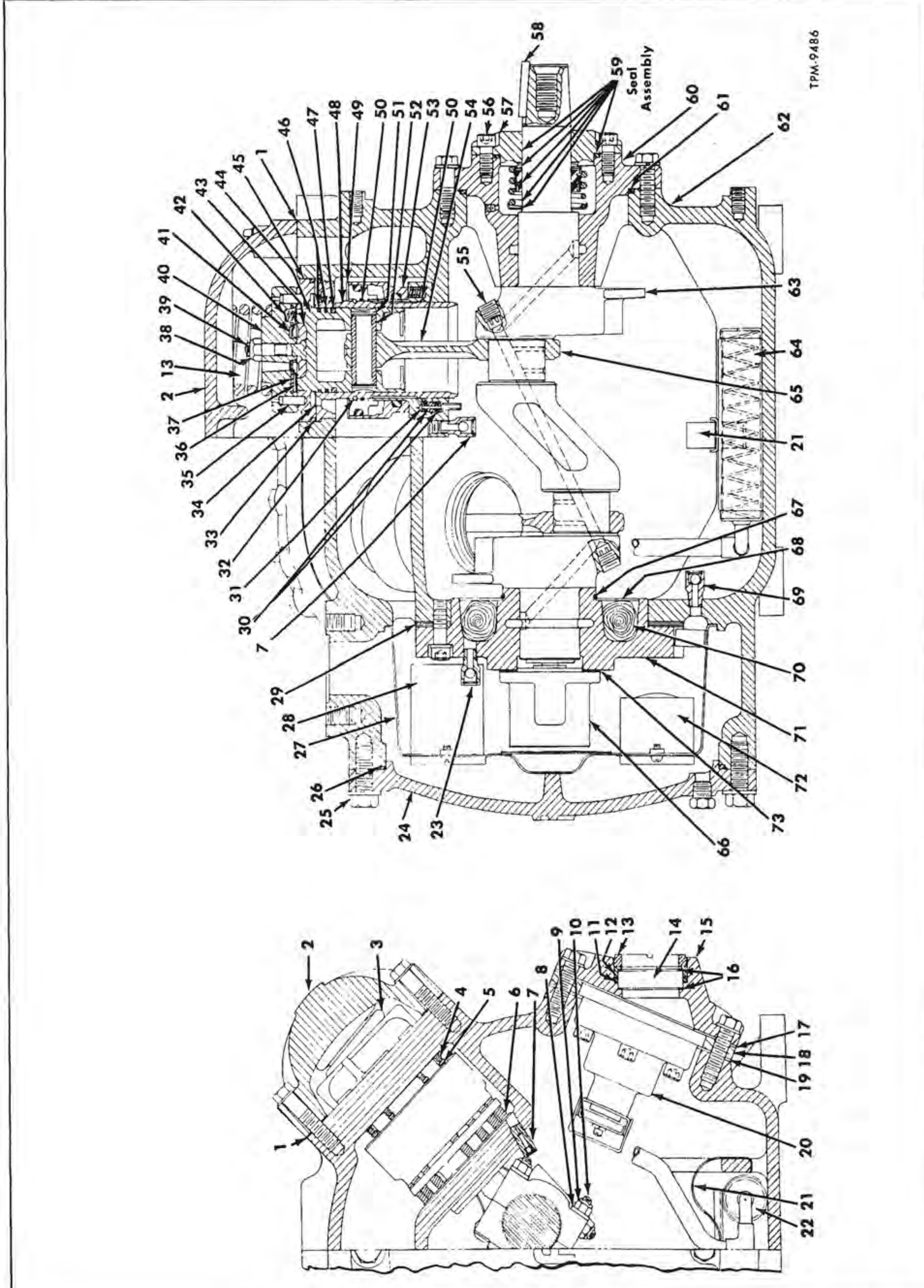


Figure 65—Refrigerant Compressor Assembly

Captions For Figure 65

1 Cylinder Head Gasket
2 Cylinder Head
3 Safety Head Spring
4 Lift Pin Spring
5 Lift Pin
6 Unloader Pin
7 Check Valve Assembly
8 Flat Washer
9 Nut
10 Bolt
11 O-ring Seal
12 Seal Ring
13 Sight Glass Nut
14 Sight Glass
15 Handhole Cover
16 Gasket
17 Plate Gasket
18 Capacity Control Plate
19 Cover Gasket
20 Capacity Control Assembly
21 Hold-down Retainer
22 Crankcase Oil Strainer Assembly
23 Check Valve Assembly
24 Suction Cover
25 Cover Bolt
26 Cover O-ring
27 Suction Strainer Pan Assy.
28 Suction Strainer Screen
29 Shims (.010" and .015")
30 O-ring Seal
31 Oil Connector
32 Retaining Ring
33 O-ring Seal
34 Suction Valve
35 Dowel Pin
36 Discharge Valve Ring
37 Cushion
38 Nut
39 Discharge Valve Bolt
40 Discharge Valve Cage
41 Cushion Retainer
42 Discharge Valve Spring
43 Valve Seat
44 Piston
45 Valve Plate
46 Piston Upper Rings
47 Piston Lower Ring
48 Cylinder Liner
49 Take-up Ring
50 O-ring Seal
51 Snap Ring
52 Piston Pin
53 Unloader Assembly
54 Connecting Rod
55 Magnetic Plugs
56 Cap Screws
57 Seal Cover Plate (Part of Seal Kit - Key 59)
58 Drive Key
59 Crankshaft Seal Kit Assembly
60 Front Bearing Head
61 O-ring Seal
62 Compressor Housing
63 Crankshaft
64 Crankcase Oil Strainer Assembly
65 Connecting Rod Cap
66 Oil Pump Assembly
67 Retaining Ring
68 End Ring
69 Crankcase Oil Check Valve Assembly
70 Foam Breaker Screen
71 Rear Bearing Head
72 Oil Filter Assembly
73 Pump Gasket

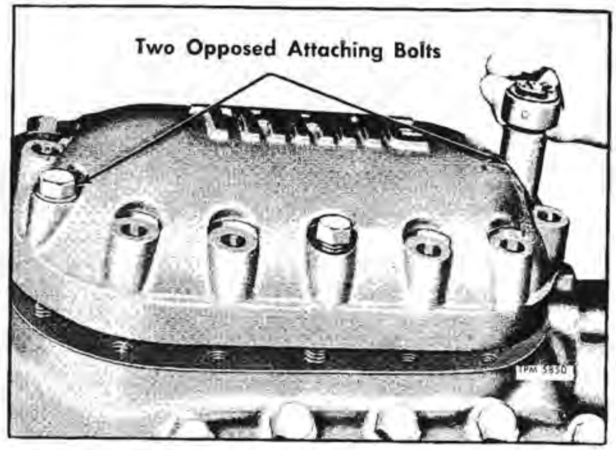


Figure 66—Method of Removing Cylinder Head Cover

eration compressor parts cleaner, then oil with new (clean) compressor oil. This applies especially to seal and bearing surfaces to prevent seizure when unit is first put in operation. Use new O-ring seals and gaskets at build-up of compressor.

The design of compressor permits the replacement of many components and sub-assemblies without having to disassemble balance of compressor. For example the cylinder liner can be replaced without having to remove piston and rod. However, the overhaul procedures described herein covers the complete disassembly of compressor in logical sequence and to the extent recommended by the manufacturer.

NOTE: When overhauling compressor, refer to "Compressor Wear Rate Table" under "Specifications" at end of this section.

NOTE: Cylinders marked 3 and 4 are equipped with unloader mechanism. Cylinders are marked on compressor housing.

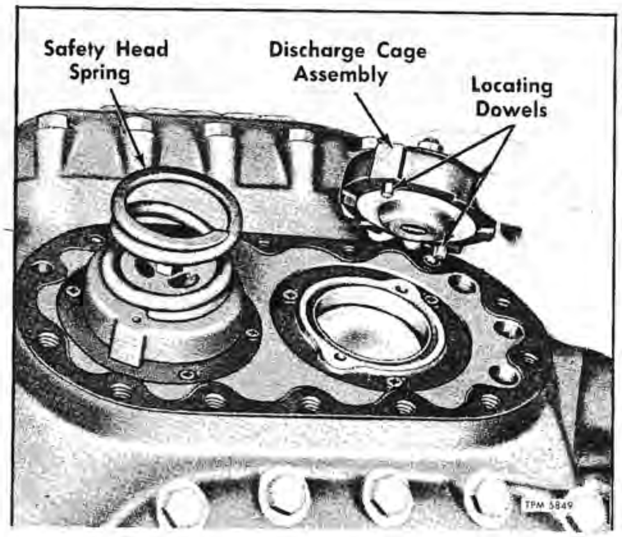


Figure 67—Removing Discharge Cage Assembly

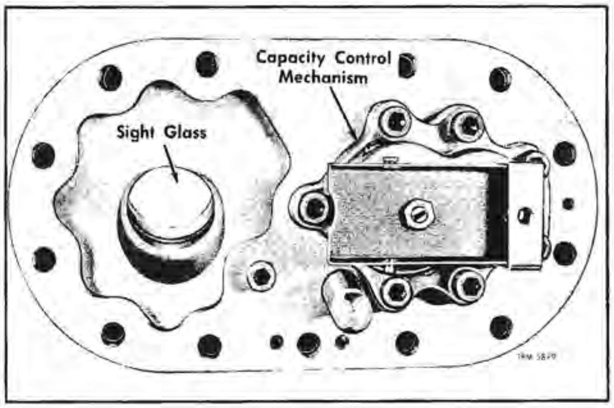


Figure 68—Handhole Cover With Capacity Control Assembly

COMPRESSOR DISASSEMBLY

CYLINDER HEAD AND DISCHARGE VALVE REMOVAL AND DISASSEMBLY

NOTE: Key numbers in text refer to figure 65.

1. Remove all but two opposed cylinder head attaching bolts. Back off remaining bolts two or three full turns (fig. 66).

2. Examine cylinder head (2) to see if head is following heads of attaching bolts as shown. If not, tap the head with a plastic hammer until head gasket (1) breaks loose.

3. As an aid in determining how far the bolts must be turned until they are freed of the tapped holes, a third bolt can be threaded (2 turns) into top center hole. This bolt will serve as an indicator as to how far opposed bolts can be turned out before becoming free of tapped holes.

4. Slowly and alternately remove two cylinder head end bolts, then the top center bolt. Remove head. Lift off safety head springs (3) and remove head gasket (1).

5. Lift discharge valve assembly from compressor (fig. 67).

6. Remove lock nut (38) from discharge valve bolt (39). Remove bolt and valve seat (43). Separate discharge valve ring, five springs, cushion retainer, and cushion from discharge valve cage.

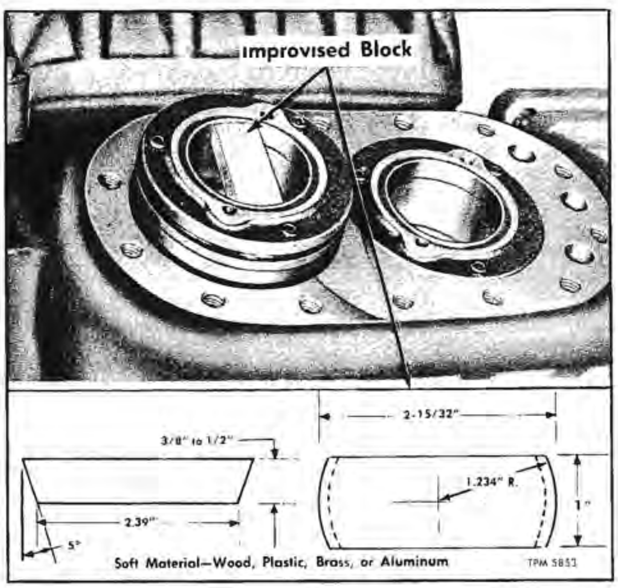


Figure 69—Using Improvised Block To Remove Suction Valve and Liner

HANDHOLE COVER REMOVAL AND DISASSEMBLY

NOTE: Key numbers in text refer to figure 65.

1. Handhole cover is identified by key number 15. Remove all but the top center cover attaching screw. The top center screw should be backed out approximately 8 to 10 turns, but should be left in the compressor housing to support the weight of the cover. If necessary, tap the cover with plastic hammer to free cover from compressor. Remove cover and cover gasket (16).

2. The opposite cover and gasket can be removed from compressor in same manner. There are no connections behind either cover to disconnect.

NOTE: The capacity control unit (20) is a complete assembly and can be removed with the handhole cover (fig. 68). Capacity control unit is not serviced and if it becomes inoperative, the entire cover with control must be replaced as a unit. Do not tamper with small nut and slotted screw on unit sensing lever. Slotted screw adjustment is factory set.

CYLINDER LINER, PISTON AND CONNECTING ROD REMOVAL

NOTE: The cylinder liner with or without unloader mechanism can be removed from compressor without having to remove the piston and connecting rod. See following Steps 1, 2, and 3.

NOTE: Key numbers in text refer to figure 65.

1. The suction valve plate (45) is tapered inward at the top. A block of wood, plastic, or soft metal should be improvised to dimensions shown in figure 69 to fit into this taper.

2. Rotate the crankshaft until piston head is down about 2 inches from top, then place the block into cylinder. Rotate crankshaft to cause piston (44) to press block and cylinder liner (48) from compressor bore (fig. 69). CAUTION: Do not bump piston against block, use an even pressure.

3. To remove liner only, make sure liner is forced out beyond the O-ring seal (33), then withdraw liner by hand. If liner is equipped with unloader, the unloader unit will come out with liner. Support the piston through the liner so that piston

does not bump against the compressor housing when the liner comes off piston.

IMPORTANT: Before removing other cylinder liner units the related piston and connecting rod should be removed from unit. Damage to the piston and piston rings will occur if crankshaft is rotated during removal of remaining liner units. See "Connecting Rod and Piston Removal and Disassembly" later in this section.

4. To remove liner, piston, and connecting rod as a complete assembly, rotate crankshaft (63) until connecting rod cap nuts (9) are accessible through the handhole cover openings. Remove nuts and flat washers (8) from cap bolts. Using soft driver rod and hammer, drive connecting rod bolts upward to free rod cap. Remove cap, then carefully pull liner with piston and rod from cylinder bore.

IMPORTANT: Keep all liner, piston, and rod assemblies separate and mark them in relation to bore from which they were removed.

5. If liner having unloader mechanism was removed, pull small oil connector (31) from hole in compressor cylinder bore or from bottom of unloader.

CYLINDER UNLOADER, CYLINDER LINER, AND SUCTION VALVE DISASSEMBLY

NOTE: Refer to Step 2 below for disassembly of liner assembly less the cylinder unloader mechanism. Key numbers in text refer to figure 65.

1. To remove unloader assembly (53) and unloader actuated parts from cylinder liner, grip the unloader firmly with both hands and strike bottom of liner against a soft wood (flat) surface (fig. 70). Separate unloader from liner. Invert piston on bench, then release retaining ring (32) and slide it off liner. Lift take-up ring (49) from liner and remove lift pins (5) and pin springs (4) from holes in liner.

NOTE: The unloader mechanism (53) is a subassembly which is not to be disassembled in the field. Should the unloader become inoperative, the entire unloader assembly must be replaced.

2. To disassemble liner and suction valve assembly only, remove three screws which attach valve plate (45) to top of liner. Be cautious not to move valve plate around top of liner as valve surfaces could be damaged. Carefully invert liner and valve assembly, keeping valve against liner. Lift liner (48) from valve plate (45). Remove suction valve (34), valve springs, and rubber O-ring seal (33) from valve plate.

NOTE: Until time of assembly keep valve plate with related liner as a matched set.

PISTON AND CONNECTING ROD DISASSEMBLY

NOTE: Key numbers in text refer to figure 65.

1. If rings (46 and 47) are to be reused, they can be removed from piston using thin shim stock inserted between rings and piston. Carefully work rings out of groove and slide them over the shim stock and off piston.

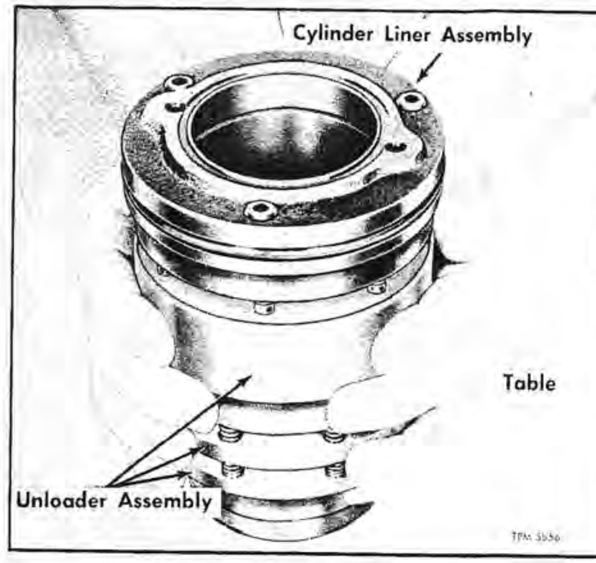


Figure 70—Method of Removing Unloader Assembly

2. Using Tru-Arc pliers, remove snap rings (51) from ends of piston pin (52). Drive pin from piston using a soft driving rod. Use care not to nick piston surface or distort piston pin hole.

COMPRESSOR SHAFT SEAL REMOVAL

NOTE: Key numbers in text refer to figure 65.

1. Loosen and remove all but two opposite head cap screws (56) which attach seal cover plate (57) to front bearing head (60). Slowly and alternately back out the remaining two cap screws (fig. 71). Seal cover plate should be forced away from bearing head by tension of shaft seal spring. However, if plate does not follow the two cap screws,

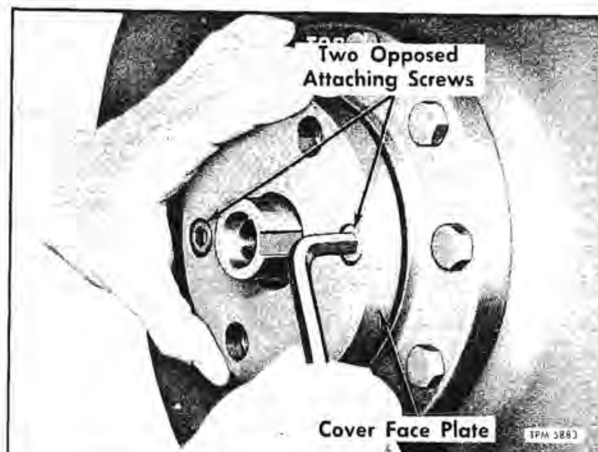


Figure 71—Removing Seal Cover Face Plate

SYSTEM MAINTENANCE

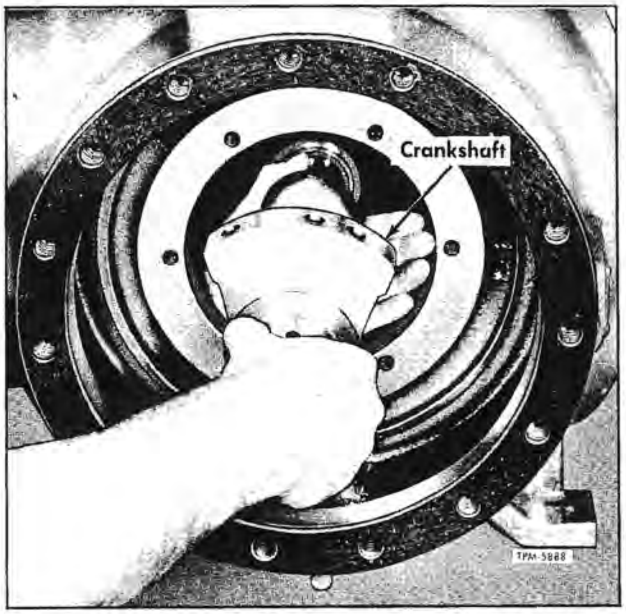


Figure 72—Recommended Method of Supporting Compressor Crankshaft When Making Replacement

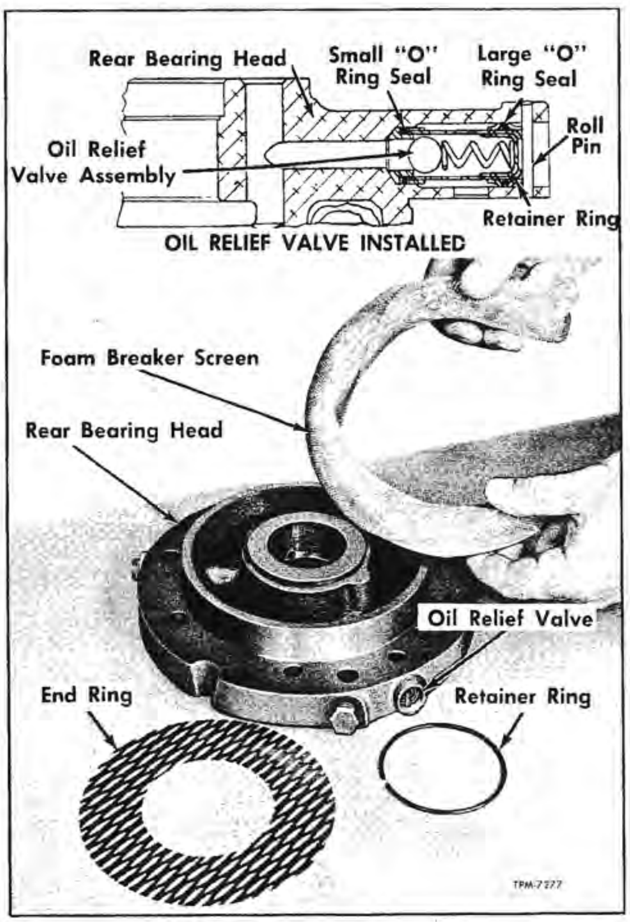


Figure 73—Foam Breaker Screen Removed and Oil Pressure Relief Valve Assembly Installed

tap rim of cover plate lightly with plastic hammer to free plate from housing. Carefully back out the two cap screws.

IMPORTANT: Be sure that plate is removed evenly so as not to distort seal and cause breakage of carbon ring within seal.

2. When the plate has been removed, the seal components (carbon nose ring, neoprene ring, steel retainer, spring, and spring holder) can usually be pulled from crankshaft. In some cases, the neoprene ring will adhere to shaft. It can be loosened by using a seal puller or by hooking short ends of two Allen-type wrenches behind ring and pulling ring from shaft.

IMPORTANT: Use extreme care in the handling and stowing of seal components. The carbon nose ring can be easily broken.

SUCTION COVER AND STRAINER PAN REMOVAL

NOTE: Key numbers in text refer to figure 65.

1. Remove all suction cover attaching screws (25) with the exception of the top screw. Back out top screw 10 or 12 full turns. This screw will support cover when cover seal is broken.

2. The cover is provided with two jack screw holes. Thread two cover attaching screws in these holes, then turn screws alternately to force cover from compressor housing. Remove cover and cover O-ring (26).

3. Remove strainer pan assembly (27) from the compressor suction chamber. Strainer assembly can be serviced as explained later under "Cleaning and Inspection."

OIL PUMP REMOVAL

NOTE: Key numbers in text refer to figure 65.

Remove four socket head screws which attach oil pump assembly (66) to rear bearing head (71). Remove oil pump and pump gasket (73). NOTE: It may be necessary to rock pump assembly up and down to break the gasket seal. CAUTION: Do not strike pump with hammer.

BEARING HEADS AND CRANKSHAFT REMOVAL

NOTE: Crankshaft is removed from rear (suction end) of compressor. Key numbers in text refer to figure 65.

1. Remove screws which attach rear bearing head (71) to compressor housing. Insert two attaching screws into jack screw holes in bearing head. While turning screws inward to pull bearing head, check to see if crankshaft, which might be seized to bearing, is following bearing head. If it is, support front end of shaft through handhole cover opening. If shaft does not follow head, back head out and support at bottom with hand. Remove head or head and crankshaft. Remove shims (29) from head or housing.

2. If crankshaft was not removed with rear bearing head, grip crankshaft at center and at rear end, then slowly and carefully draw shaft out of compressor (fig. 72).

IMPORTANT: Do not damage bearing surface in front bearing head while removing shaft.

3. Remove magnetic plugs (55) from crankshaft and remove metallic particles from magnets.

4. Remove screws attaching front bearing head (60) to compressor housing. Use two screws as jack screws in tapped holes in bearing head. Remove head and head O-ring (61).

REAR BEARING HEAD DISASSEMBLY

NOTE: Key numbers in text refer to figure 65.

1. Remove retaining ring (67) which secures end ring (68) over foam breaker screen (70).

2. Lift foam-breaker screen (70) from recess in head. Screen should be cleaned as directed later under "Cleaning and Inspection." Figure 73 illustrates screen and retaining parts removed from head cavity.

3. If necessary, plugs can be removed from bearing head. Remove metallic particles from the magnetic plug.

4. Referring to sectional view of figure 73, remove relief valve assembly from bearing head by driving the small retaining pin from over valve. then using a pointed tool through hole in side of head, pry valve from head. Clean and inspect valve components.

5. Remove three check valve assemblies (23) from rear bearing head. Inspect valves for plugged condition.

CRANKCASE OIL STRAINER AND CHECK VALVE REMOVAL

NOTE: Key numbers in text refer to figure 65.

1. Loosen, but do not disconnect, flare nut at tube end of strainer assembly (64).

2. Disengage one end of strainer hold-down retainer (21) from housing, then disengage opposite end. Remove retainer.

3. Disconnect strainer tube flare nut, then remove strainer from housing through handhole cover opening.

4. Remove oil check valve (69) from housing and remove check valve (7) protruding down from top of compressor housing.

SUCTION AND DISCHARGE VALVES REMOVAL

Remove two bolts which attach each valve body to compressor housing. Lift valve assembly from housing, then remove valve body gasket. Line flange clamp and flange seal can be removed from valve body after removing four flange clamp bolts. Figure 62 shows cross section of valve assemblies.

Figure 74—Checking Piston Ring Groove Clearance

CLEANING AND INSPECTION

CLEANING

1. Clean all compressor components except the oil filter element (72, fig. 65) at bottom of oil strainer pan with refrigeration compressor parts cleaner. DO NOT USE CARBON TETRACHLORIDE. The oil filter element, if contaminated, should be replaced. Use a stiff bristle brush if necessary to loosen foreign particles. Direct air through all

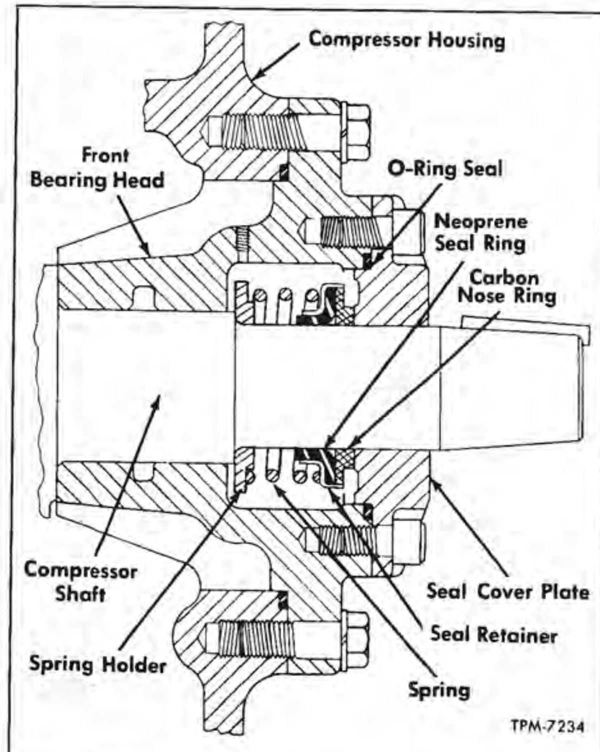


Figure 75—Crankshaft Seal Construction

SYSTEM MAINTENANCE

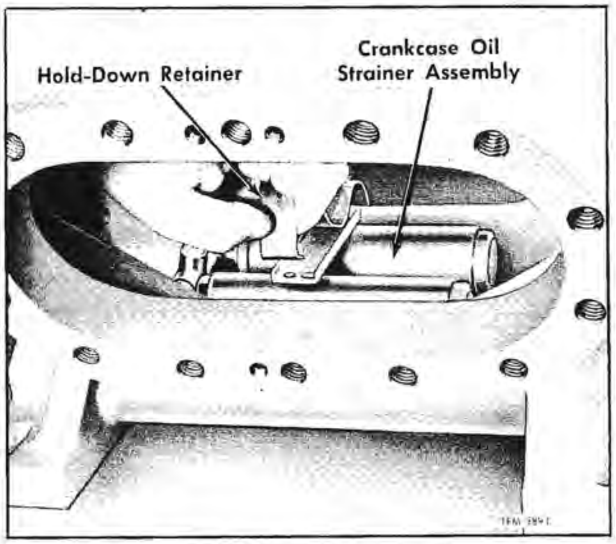


Figure 76—Installing Crankcase Oil Strainer Hold-Down Retainer

passages in castings and into both ends of all check and relief valves. If necessary, valves can be disassembled, cleaned, and inspected. If balls fail to seat properly in valve bodies, replace entire valve assembly.

2. Scrape all gasket flange surfaces to make sure all gasket and sealing material is removed.

CAUTION

DO NOT GOUGE FLANGE SURFACE WHILE SCRAPING.

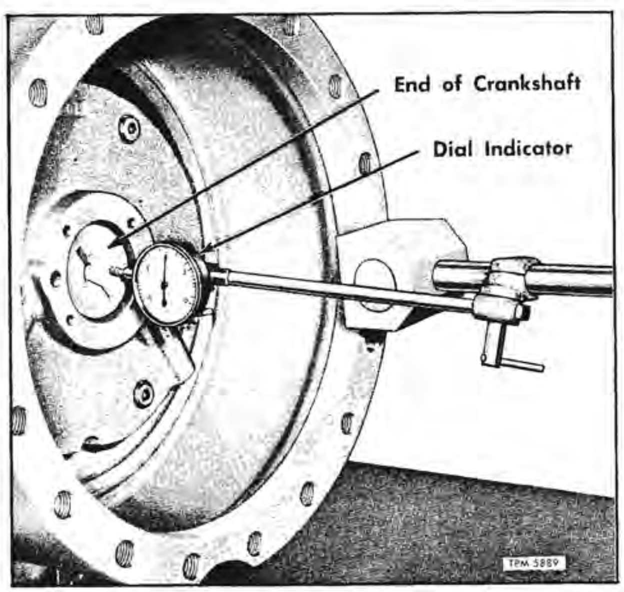


Figure 77—Checking Crankshaft End Play Using Dial Indicator

INSPECTION

NOTE: Key numbers in text refer to figure 65.

1. Inspect compressor housing (62) and other tapped components for cross threads and any other damage.

2. Examine valve surfaces of suction and discharge valve components. Try blowing air through valve ports while in open and closed positions to check for sealing. Replace worn parts.

3. Inspect pistons (44) for scoring, cracks, or damage of any kind.

4. Check fit of rings (46 and 47) in piston ring grooves. Use back edge of ring to check fit (fig. 74). Rings should move freely in piston grooves.

5. Examine crankshaft seal components for excessive wear or damage. If components are found in good condition they can be reused. If damaged, replace with complete new seal assembly. Figure 75 shows seal components installed. Check components of compressor for wear to dimensions shown on "Compressor Wear Rate Table" at rear of this section under "Specifications."

COMPRESSOR BUILD-UP

Before building up compressor, coat all components with clean compressor oil. This will provide initial lubrication and prevent rusting.

Use new O-ring seals and gaskets when assembling compressor.

NOTE: Key numbers in following text refer to figure 65.

SUCTION AND DISCHARGE VALVE INSTALLATION

1. Using new gasket, attach valve body to compressor housing with two bolts. Tighten bolts evenly and firmly.

2. If line flange clamp was removed, place new seal gasket in position, then install line and clamp flange to valve body with four bolts. Tighten bolts evenly to 58 foot-pounds torque.

CRANKCASE OIL STRAINER AND CHECK VALVE INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. Install two check valves (7) into roof of compressor housing.

2. Install oil check valve (69) in housing at lower rear end.

NOTE: Identification of valves can be made by the amount of distance ball travels in valve body. Valve with long ball travel should be installed into roof of crankcase, valve with short travel should be installed at rear of housing (see fig. 65).

3. Place strainer assembly (64) into compressor housing and connect strainer tube flare nut loosely. Secure strainer to bottom of housing with hold-down retainer (21). Make sure ends of retainer

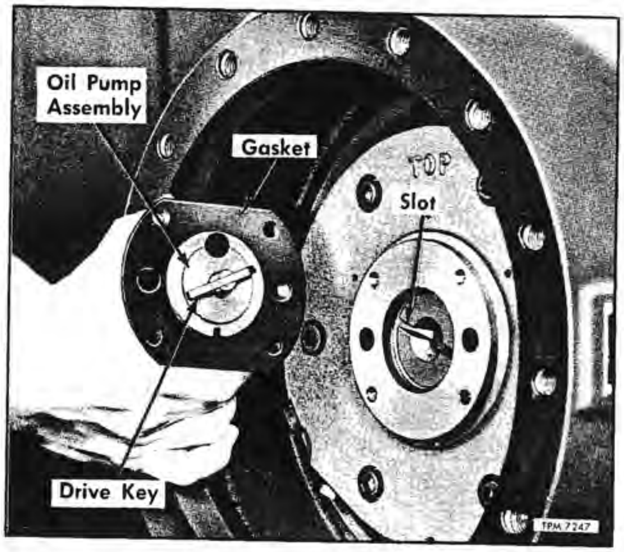


Figure 78—Installing Compressor Oil Pump

engage holes in housing (fig. 76). Final tighten strainer flare nut.

ASSEMBLY OF REAR BEARING HEAD

NOTE: Key numbers in text refer to figure 65.

1. Install check valves (23) into rear bearing head.

2. With O-ring seals in relief valve grooves, install relief valve assembly with retainer ring as shown in sectional view of figure 73, into bearing head. Secure valve in position with pin driven into holes over valve.

3. If hex plugs were removed from bearing head, install plugs, making sure they are tightened firmly.

4. Roll foam-breaker screen (70) into shape and place in bearing head cavity. Place end ring (68) over screen, then install retaining ring (67). Make certain retaining ring is fully seated in ring groove.

BEARING HEADS AND CRANKSHAFT INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. Install two magnetic plugs (55) into crankshaft oil passages.

2. Lubricate all bearing surfaces of crankshaft and bearing surfaces in bearing heads. Install front bearing head. Make sure "Top" marked on front bearing head is properly located, then attach front bearing head to compressor housing with cap screws. Do not final tighten cap screws until after rear bearing head is installed later.

3. Carefully insert crankshaft into compressor housing. Balance crankshaft with one hand through handhole opening (fig. 72), then carefully insert crankshaft through front bearing.

CAUTION: Do not damage bearing surfaces.

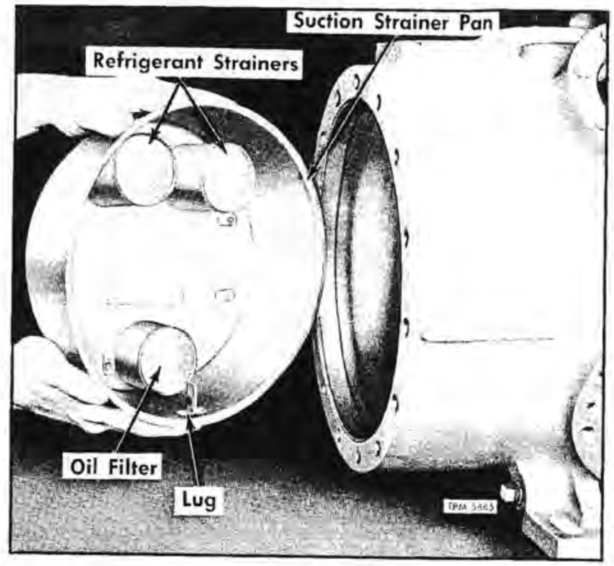


Figure 79—Installing Suction Strainer Pan

Weight of crankshaft now is supported safely by front bearing head.

4. Before installing rear bearing head (71), three (0.015" thick) paper shims (29) should be placed on flange on rear bearing. Shims serve to provide proper crankshaft end play clearance. NOTE: Two thicknesses of shims are available, 0.910" and 0.015", and they should be installed dry.

5. With shims in place, carefully position rear bearing head (71) on rear end of crankshaft. Make sure "TOP" marked on head is properly located. Install head attaching bolts, then tighten both front and rear head attaching bolts evenly to 30 foot-pounds torque.

6. Check crankshaft end play, using a feeler gauge between crankshaft and rear bearing head. Check clearance in several places around the shaft. Push crankshaft forward while checking end play. The proper end play clearance should be 0.010" to 0.017". If clearance is above maximum, decrease thickness of shims (29). If clearance is be-

Figure 80—Installing Seal Carbon Nose Ring

SYSTEM MAINTENANCE

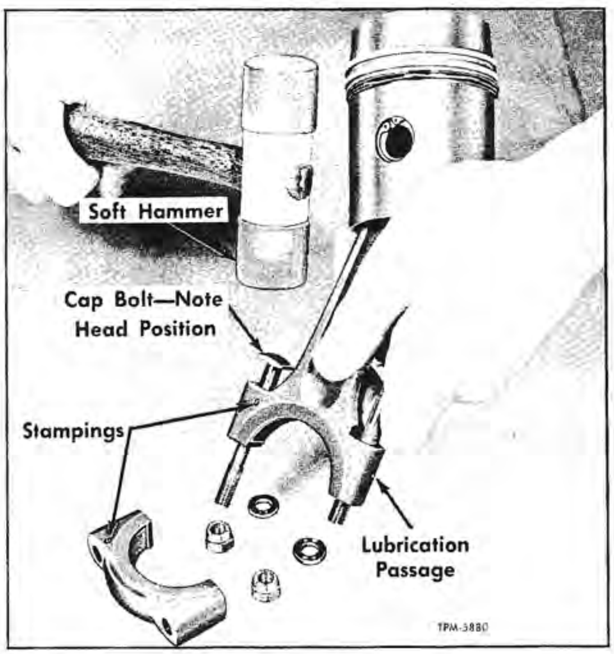


Figure 81—Installing Connecting Rod Cap Bolt

low minimum allowance, increase shim thickness. A combination of shims should be selected to obtain proper end play clearance. An alternate method of checking crankshaft end play is to use a dial indicator as shown in figure 77. Move crankshaft fore and aft while using this method. Make sure dial is mounted firmly.

7. After final adjustment is obtained, torque front bearing head attaching bolts to 30 foot-pounds torque and rear bearing head bolts to 23 foot-pounds torque.

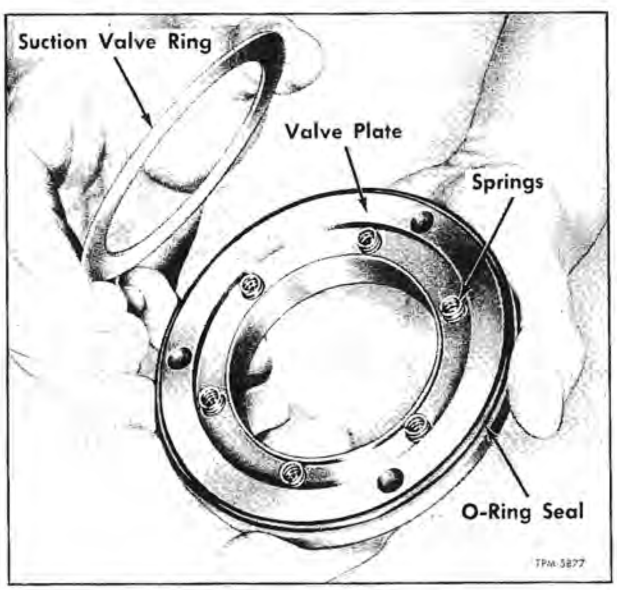


Figure 82—Assembling Suction Valve

OIL PUMP INSTALLATION

1. Before installing oil pump (66), make sure pump flange and bearing head surfaces are clean.

2. Insert attaching bolts with lock washers through pump assembly. Lubricate pump gasket (73) with clean compressor oil, then position gasket over threaded ends of bolts.

3. Align key of pump shaft with slot in end of crankshaft (fig. 78), then install pump to bearing head. Tighten pump attaching bolts to 14 foot-pounds torque.

SUCTION STRAINER AND COVER INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. If suction strainer screens (28) or oil filter assembly (72) were removed from the strainer pan, attach these units to pan firmly with screws and lock washers. Units are located on pan as shown in figure 79.

2. Place strainer pan assembly into suction chamber, making sure slot in bottom of rear bearing head is engaged with guide on pan.

3. Lubricate cover gasket (26) with clean compressor oil, then position gasket to cover.

4. Place two attaching bolts (25) with flat washers into suction cover (one at top and one at bottom), then install cover to compressor. Make sure name on cover is positioned properly. Tighten two bolts finger-tight, then install remaining attaching bolts and washers. Tighten all bolts evenly to 58 foot-pounds torque.

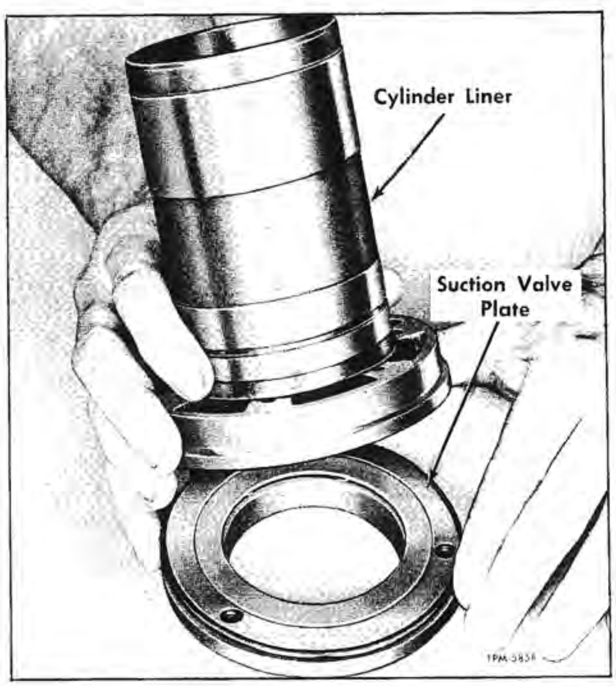


Figure 83—Locating Cylinder Liner on Suction Valve

COMPRESSOR SHAFT SEAL INSTALLATION

NOTE: Refer to figure 75 when assembling seal kit.

1. Seal components must be installed as a kit. Never attempt to replace any of the single components of seal assembly. Seal kit consists of carbon nose ring, neoprene ring, spring retainer, spring, spring holder and seal cover plate as shown.

2. With finger, check shaft seal surface. Surface should be smooth and free of dirt.

3. Apply clean compressor oil or white petroleum jelly to inner surface of Neoprene ring and to shaft.

IMPORTANT: After shaft is lubricated do not touch it again with fingers.

4. Position spring to spring holder, then install both over shaft and into seal chamber.

5. Install steel retainer and Neoprene ring over shaft, using care not to damage ring on sharp edges of shaft keyway slot.

6. Thoroughly clean carbon nose ring with cleaning fluid, then inspect ring for grooved, cracked, or chipped condition. Once ring has been cleaned do not touch again with fingers.

7. Wet face of nose ring with clean compressor oil, then place ring over shaft end and into engagement with notches of Neoprene ring retainer (fig. 80).

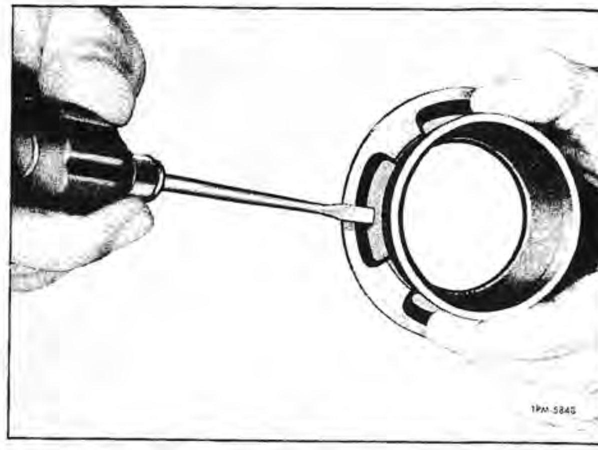


Figure 84—Checking Suction Valve Alignment

8. Clean and lubricate sealing surface of seal cover plate. Lubricate O-ring seal, then position seal around flange of cover plate.

9. Insert two attaching screws into opposite holes of cover plate. Carefully press plate assembly evenly against carbon ring and to compressor. Tighten both attaching screws slowly and alternately one or two threads at a time (fig. 71), otherwise carbon nose ring may crack.

10. When seal cover plate is flush to housing

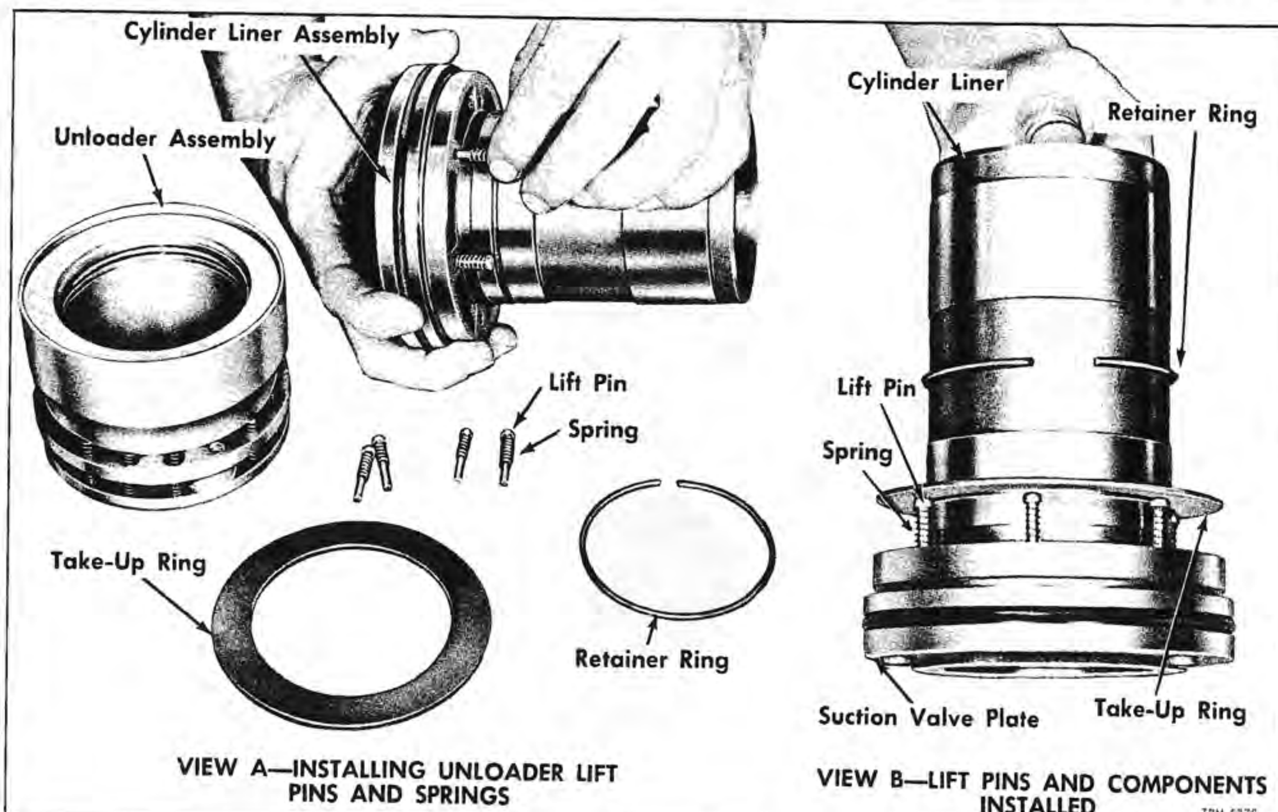


Figure 85—Building Up Unloader Components

SYSTEM MAINTENANCE

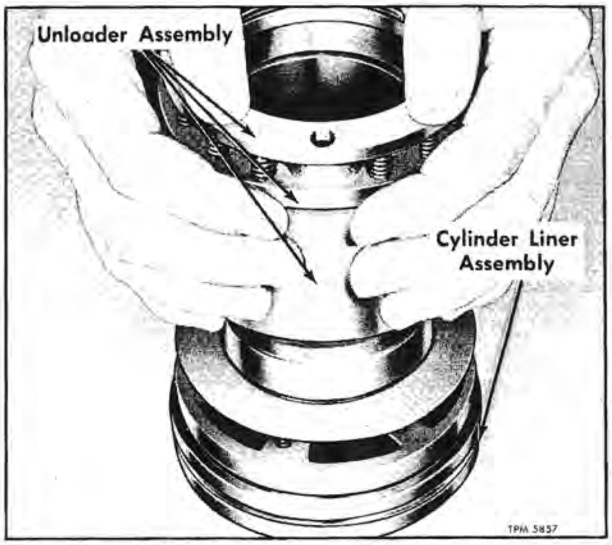


Figure 86—Installing Unloader Assembly

install remaining attaching screws. Tighten all screws to 23 foot-pounds torque.

ASSEMBLY OF PISTON, RINGS, AND CONNECTING ROD

NOTE: Key numbers in text refer to figure 65.

1. Position connecting rod (54) in piston (44). Drive piston pin (52) through piston and rod using a hammer and soft driver. Install pin snap rings (51) using Tru-Arc pliers.

2. Work rings (46 and 47) carefully over top of piston to their respective grooves, using shim stock to aid in moving rings into position. NOTE: Oil ring (47) goes in bottom groove and the two compression rings (46) go in two upper grooves. Check for freeness of rings in grooves after installing.

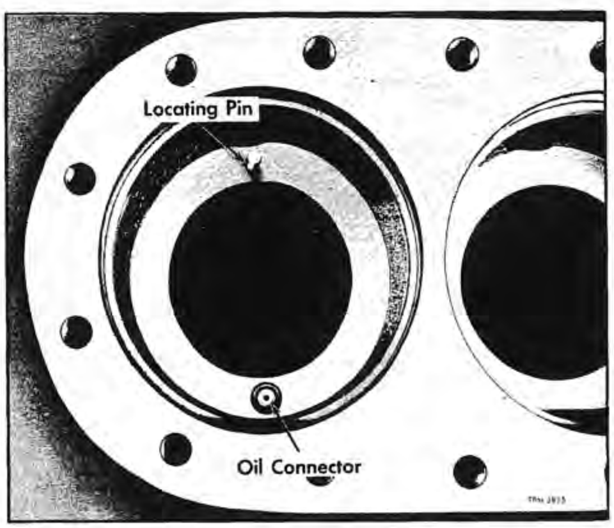


Figure 87—Alignment Pin and Oil Connector Installed

Figure 88—Installing Piston in Liner Assembly

3. Inasmuch as connecting rod bolts (10) are a tight fit in connecting rod, they must be driven into place with a light weight soft hammer (fig. 81). Be sure that flat side of bolt head is positioned to mate with shank on rod.

ASSEMBLY OF SUCTION VALVE, LINER, AND UNLOADER MECHANISM

NOTE: Key numbers in text refer to figure 65.

1. Install O-ring seal (33) around flange of suction valve plate (45).

2. Insert six springs into pockets of suction valve plate (fig. 82), then place suction valve ring (34) over springs.

3. Locate cylinder liner (48) on valve plate (fig. 83), then invert both liner and plate and set in upright position on bench. Install three socket head screws attaching plate to liner. Tighten screws snug only. Again invert liner and plate and with small screwdriver check suction valve ring to see that its movement is not restricted (fig. 84). Tighten plate attaching screws to 7 foot-pounds torque.

4. On liners having unloaders, position springs (4) on lift pins (5), then insert pins into flange of liner (View A, fig. 85). NOTE: Push pins in and out to see that movement is free. Lower the take-up ring (49) down over heads of pins, then install retainer ring (32) over take-up ring (View B, fig. 85) to position in ring groove. Check action of take-up mechanism by pressing up and down on take-up ring.

5. The cylinder unloader, when used, slides down over cylinder liner and is sealed in position

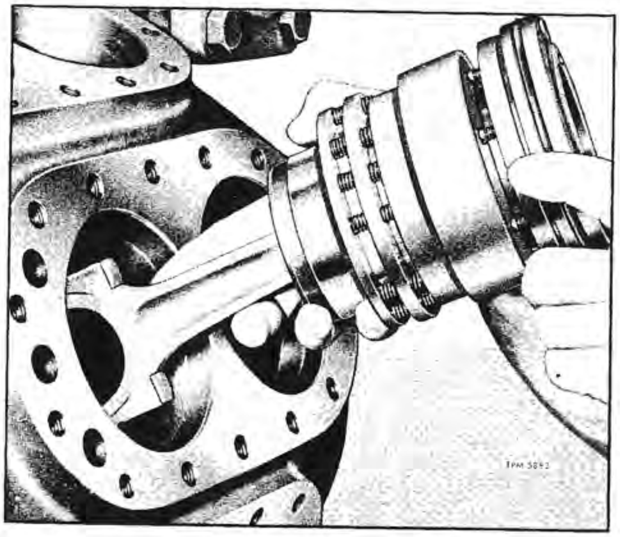


Figure 89—Installing Connecting Rod, Piston Liner, and Unloader Assembly

by two O-ring seals (50). Oil external surfaces of cylinder liner and inside diameter of unloader with clean compressor oil. Referring to figure 86, position liner as shown on a clean flat surface, then press unloader mechanism slowly and evenly down over liner.

CAUTION

Keep fingers free of being pinched between unloader and liner flange.

When the unloader mechanism is in final position, it should be touching the surface of take-up ring (49). Be sure retainer ring (32) is properly in place in groove in cylinder liner so that unloader mechanism and take-up ring will operate correctly.

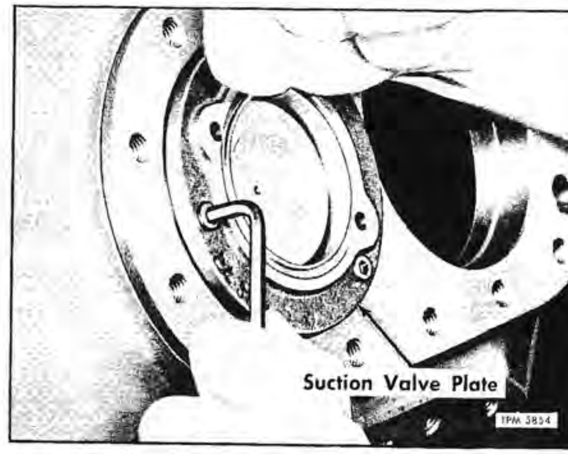


Figure 90—Method of Aligning Suction Plate

INSTALLATION OF CONNECTING ROD, PISTON, AND CYLINDER LINER

NOTE: The installation of cylinder liner with unloader is the same as the installation of the plain liner less unloader as far as entry of piston and rings are concerned. The main difference, however, is in the proper positioning of unloader in the compressor housing. The unloader cylinder housing is fitted with a roll-pin and an oil connector as shown in figure 87. The inside of unloader has two holes which must coincide with roll pin and oil connector.

NOTE: Key numbers in following text refer to figure 65.

1. Invert cylinder liner on clean flat work surface. Rotate piston rings on piston to stagger the ring gaps. Apply clean compressor oil to rings and to inner walls of liner.

2. Carefully insert piston down into liner (fig. 88). NOTE: Both piston and liner are tapered to assist installation. Rotate and rock piston while at

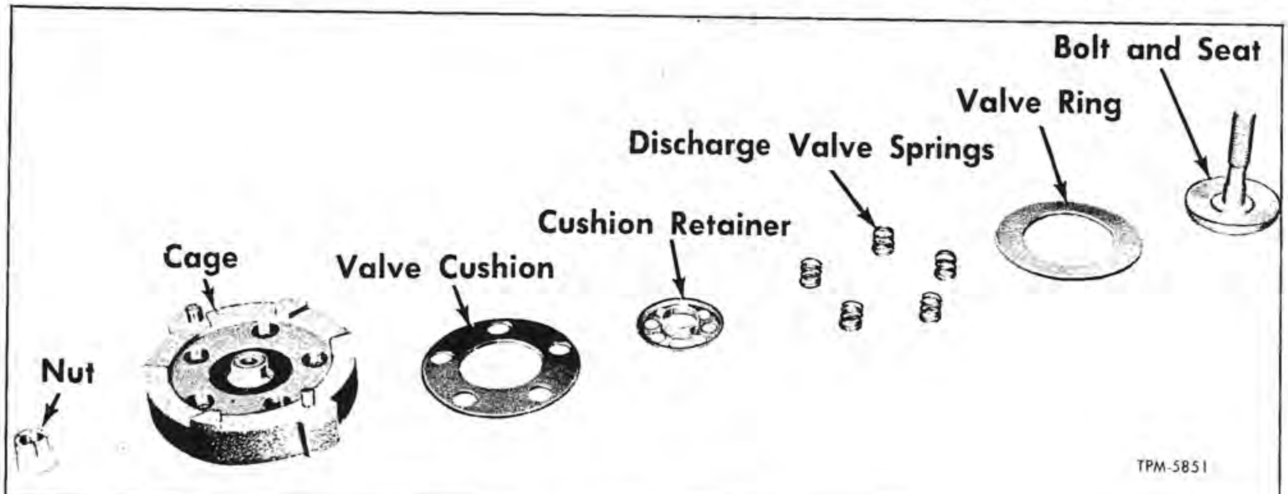


Figure 91—Discharge Valve Components

SYSTEM MAINTENANCE

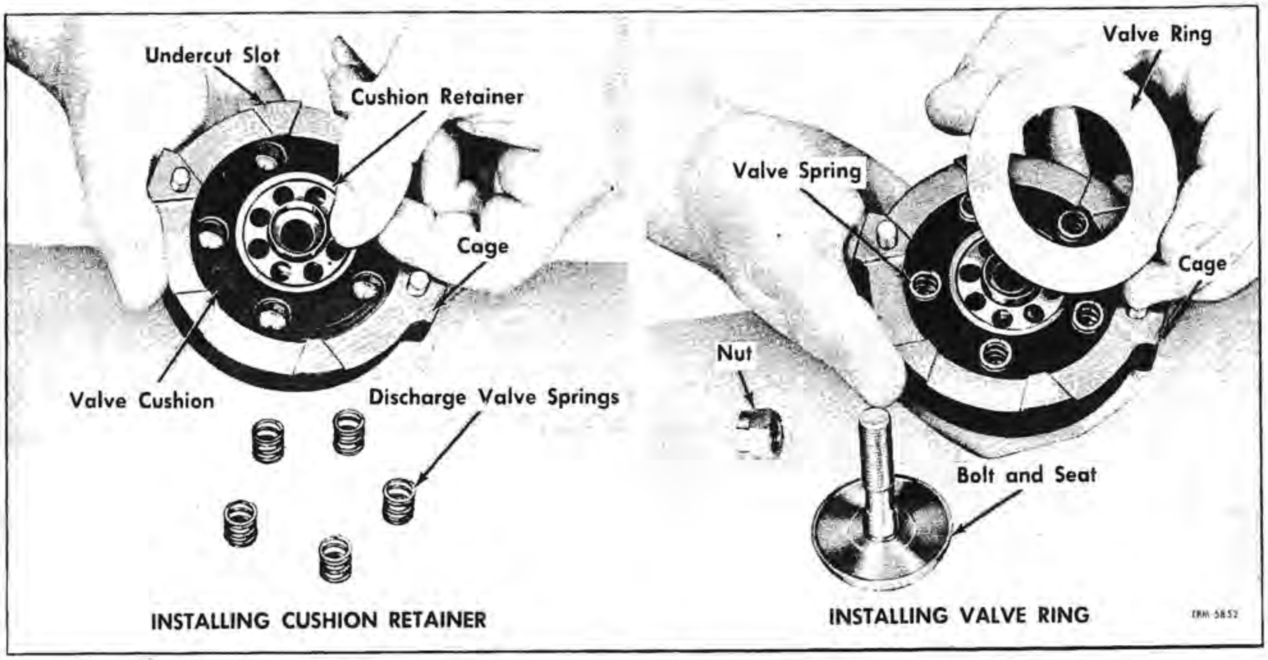


Figure 92—Building Up Discharge Valve Assembly

same time pressing lightly downward causing rings to compress into liner. Press piston into liner until the bottom of piston is flush with bottom of liner.

3. IMPORTANT: Before installing connecting rod with liner assembled, make sure bearing surfaces on crankshaft and connecting rod are clean and free of dirt. Lubricate these surfaces with clean compressor oil.

4. In housing bore where a liner having unloader mechanism is to be installed, insert oil connector (31), with two new O-ring seals (30) in each end of connector, into lower hole (fig. 87). Before installing connector apply clean compressor oil to O-ring seals.

5. Rotate the crankshaft until shaft journal is in position to accept connecting rod.

6. Rotate the liner with reference to connecting rod so that side of rod with match marks (see figure 81 for match mark locations) are facing the seal end of compressor and the alignment pin and oil connector holes (fig. 87) are properly aligned for entry into housing liner bore.

7. All connecting rods have corresponding match marks (fig. 81) which identify the rod and cap as being matched. IMPORTANT: These two matched parts must be assembled so that they are on the same side of rod and when assembling the rod to crankshaft, the marks must always be positioned facing the seal end of compressor.

8. Referring to figure 89, push the entire connecting rod and liner assembly down into housing bore as far as liner will go without being forced.

9. With connecting rod in position at crankshaft journal, install rod cap (65). CAUTION: Make sure match marks on rod and cap correspond and that both are facing seal end (drive end) of compressor.

The rod cap must be drawn evenly into final position by the rod bolt nuts and washers, otherwise cap will become distorted and damaged. Tighten nuts snug only at this time.

10. Using hands, push cylinder liner down into housing bore. CAUTION: NEVER ATTEMPT TO SEAT LINER USING A HAMMER.

If liner will not seat, and alignment pin and oil connector on units having unloaders are in alignment, loosen the three screws which attach suction valve plate to liner. Referring to figure 90 push liner into bore as shown. When liner is in place, tighten socket head cap screws.

NOTE: Rotate unloader mechanism if necessary to align with alignment pin and oil connector in housing bore. If an attempt was made to force unloader mechanism down when improperly positioned, the small O-ring seal (30) on oil connector may have been damaged. A damaged seal may cause erratic functioning of the unloader mechanism when compressor is operated. Replace seals if damaged.

11. After liner is properly seated into compressor housing, final tighten connecting rod nuts to 15 foot-pounds torque.

CAUTION: Use a torque wrench and under no circumstance should nuts be tightened above specified torque, as cap will be distorted. Rotate the crankshaft to make sure that connecting rod is free on shaft. Repeat as each rod is installed.

HANDHOLE COVER INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. Before installing handhole cover (15), make sure cover is clean.

2. Oil both sides of cover gasket (19) with clean compressor oil, then position gasket to cover flange. Insert two cover attaching bolts up through cover and gasket (one at each end of cover).

3. Position cover and gasket to compressor housing and tighten the two bolts hand-tight. Install remaining bolts, then final tighten all bolts evenly to 43 foot-pounds torque.

ASSEMBLY OF DISCHARGE VALVE COMPONENTS

NOTE: Key numbers in text refer to figure 65. Figure 91 illustrates components of valve assembly.

1. Place valve cushion (37) into discharge valve cage (40), making sure that outer edge of cushion is tucked into undercut slot in cage. Align holes in cushion with spring pockets in cage.

2. Press valve cushion retainer (41) into place (left view, fig. 92), then position discharge valve springs through cushion and into cage spring pockets.

3. Lay discharge valve ring (36) over springs as shown in right view, figure 92. Insert seat (43) and bolt (39) into cage, then install bolt nut (38). Before tightening nut, make sure discharge valve ring (36) registers in the valve guide. Tighten nut to 23 foot-pounds torque, then check valve ring movement for any restriction by the valve guide. Ring must be free.

DISCHARGE VALVE AND CYLINDER HEAD INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. Position discharge valve assembly to cylinder liner with valve cage dowels located in liner holes (fig. 67).

2. Place safety head springs (3) over discharge valves, making sure they are centered over valves (fig. 67).

3. Insert two attaching bolts with washers through cylinder head (2), one at each end (fig. 66). Apply clean compressor oil to both sides of head gasket (1), then position gasket and head to compressor housing. Tighten two bolts alternately. Install remaining attaching bolts, then tighten all bolts to 43 foot-pounds torque.

4. If compressor is to be placed in storage, the suction and discharge valves should be closed (stems turned clockwise) and the line ports should be plugged.

COMPRESSOR DRIVE

Compressor, mounted in coach as shown in figure 93 is driven through an air-operated disc clutch which is mounted to drive end of compressor. Clutch is propeller shaft driven from accessory drive unit mounted to front end of coach engine.

The condenser fan drive pump is belt-driven through the compressor drive clutch from the compressor flywheel pulley.

Clutch is engaged by air pressure admitted through an electrically-operated air valve (26, fig. 7). Air pressure from solenoid valve to the clutch air cylinder is supplied through a flexible air line.

When air pressure is applied to clutch cylinder the clutch is engaged. When air pressure is exhausted from cylinder clutch becomes disengaged. Spring within clutch removes the pressure from clutch plate.

Procedures for removing and overhauling the clutch assembly are explained later under "Compressor Drive Clutch." Overhaul procedure of clutch assembly is also explained later under "Compressor Drive Clutch."

COMPRESSOR DRIVE OPERATION

With "VENTILATION" switch on control panel at left of driver placed in "AIR CONDITION" position, and with the engine oil pressure being less than 15 psi and the pressure in coach air system at 65 psi or more, the clutch control solenoid valve becomes energized. With solenoid valve operating coil energized, air pressure is admitted to clutch air cylinder through the flexible line which releases

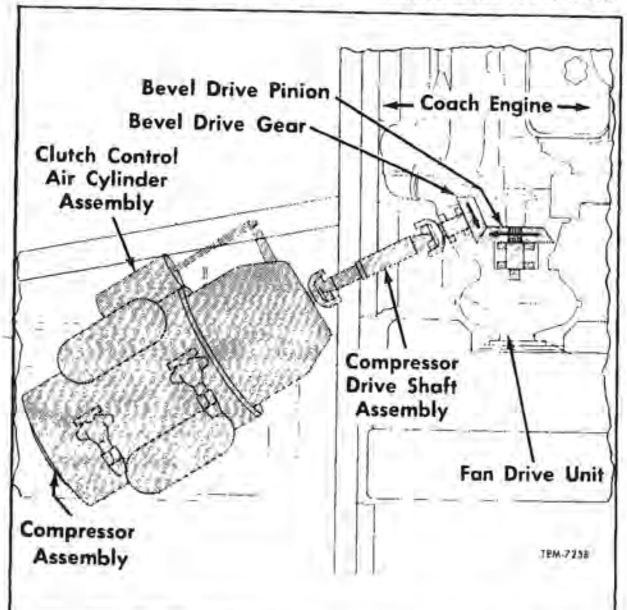


Figure 93—Compressor Drive Shaft and Accessory Drive Layout (Typical)

SYSTEM MAINTENANCE

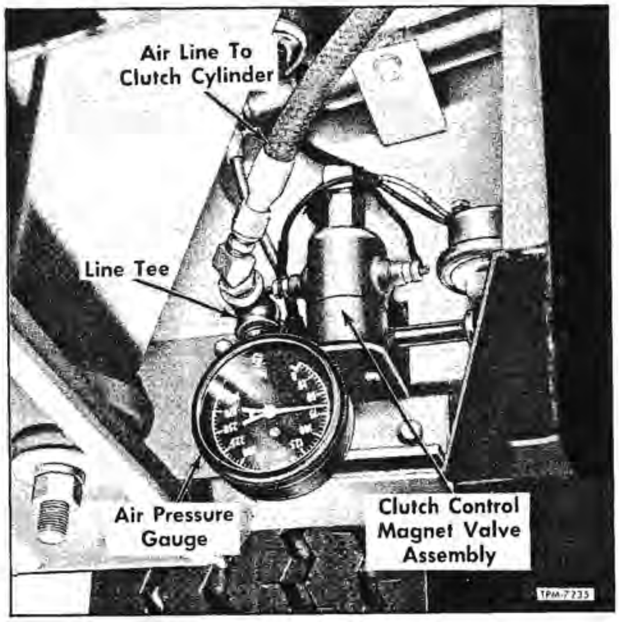


Figure 94—Clutch Control Air Pressure Check (Typical)

pressure from clutch cover spring causing clutch to become engaged. Lower view of figure 95 shows clutch in the engaged position, air pressure applied. The upper view of figure 95 shows disassembled components of clutch.

Refer to Schematic Wiring Diagram (fig. 3) for electric circuits. Detail wiring diagrams are shown in back of this manual.

COMPRESSOR DRIVE MAINTENANCE

The following instructions apply to items which require periodic inspection and adjustment. Maintenance information on compressor drive propeller shaft, accessory drive clutch, and clutch control air cylinder is explained later under respective headings.

Inspect clutch drive components, making sure clutch housing bolts and drive shaft universal joint flange bolts and nuts are tight.

CLUTCH CONTROL AIR PRESSURE CHECK

In manner shown in figure 94, check the air pressure to clutch control cylinder. Disconnect air line between solenoid valve and air cylinder, and install a test air pressure gauge as shown. Deplete pressure in coach air system down to 40 to 50 pounds or even less. While observing test gauge have assistant start engine and place air conditioning control to operating position. Note pressure on gauge at time solenoid valve releases air pressure to test gauge. Solenoid valve should be energized (opened) by the air pressure switch at 65 ± 3 pounds. If this does not occur, replace air pressure switch (fig. 94), then recheck.

LUBRICATION

After each three months of operation, two small square head plugs should be removed from end covers of clutch control air cylinder and 1/2 oz. of SAE 10W engine oil injected into cylinder. Replace plugs firmly after adding lubricant.

At regular chassis lubrication intervals, apply SAE #140 gear lubricant to fitting at each joint of compressor drive shaft assembly and also to fitting on shaft slip yoke.

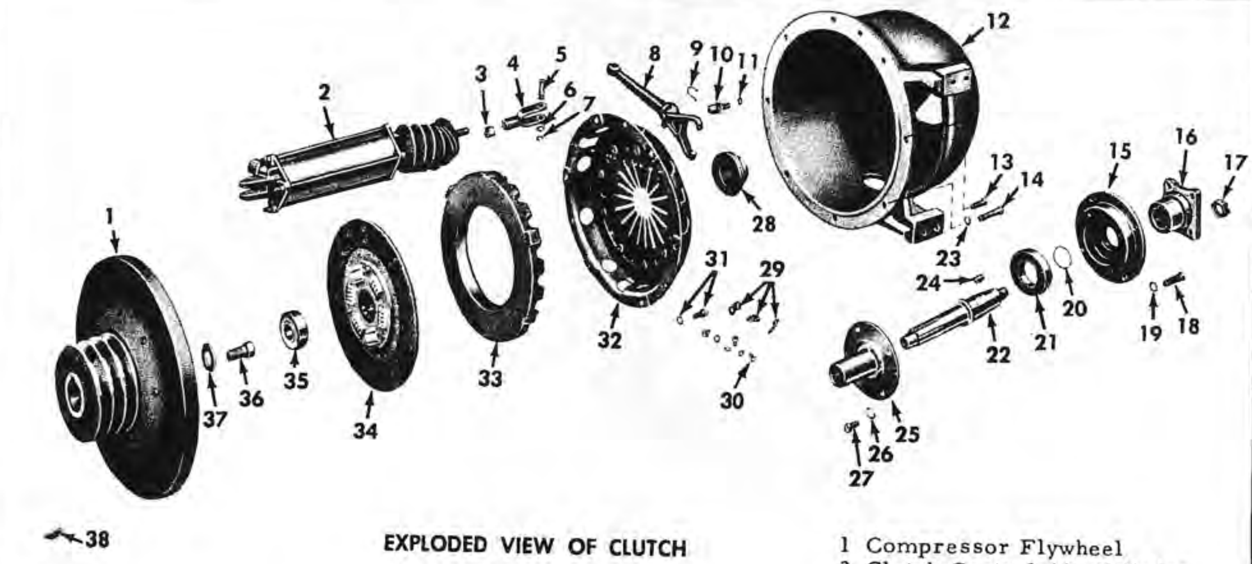
Before placing system in season operation and at periodic chassis lubrication intervals, the clutch release bearing surface of retainer, item 25, figure 95 and the pin at each end of clutch air cylinder should be lubricated. Access to the bearing retainer can be obtained by removing the compressor compartment dust shield and using a small long-handled brush to reach into access hole to underside of clutch housing. Use grease containing zinc oxide.

COMPRESSOR CLUTCH RELEASE FORK ADJUSTMENT

At regular intervals the over-all clearance between the clutch driven plate, the pressure plate, and the compressor flywheel (dimension "C" fig. 95) should be checked. Clearance should measure 0.010" to 0.030". This is accomplished as follows: With clutch disengaged, air cylinder push rod extended, measure plate clearance through hole in bottom of clutch housing and one of the holes in pressure plate cover (fig. 96). Clutch cover must be rotated so that holes will line up to insert feeler. If clearance is not as specified, make adjustment as follows:

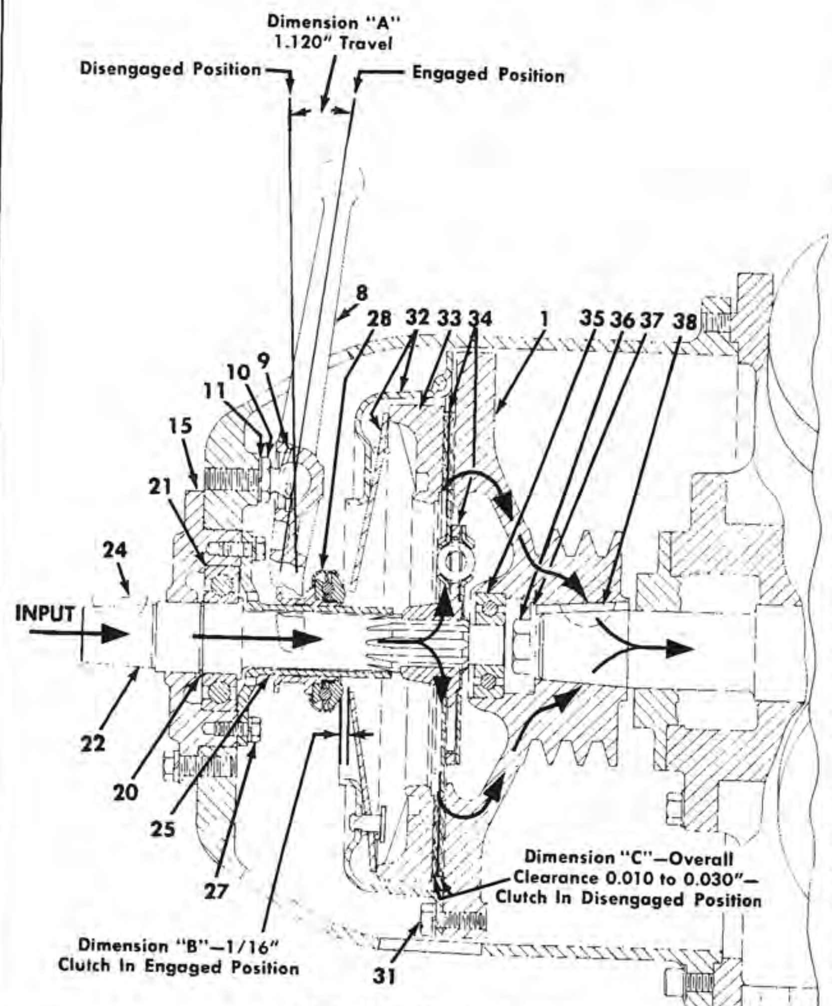
With clutch cylinder push rod in the retracted position, or air pressure applied, and with release bearing resting against the Belleville spring, locate yoke on push rod so that hole in clutch release fork is about two-thirds of a hole out of line with hole in yoke, the hole in fork being further away from the air cylinder. Swing release fork so that its hole will line up with yoke hole and insert pin. Extend push rod by shutting off air supply to air cylinder. Push rod should move out a minimum of 1.120 inches (fig. 97). Measure plate clearance through hole in bottom of clutch housing. If clearance is not enough, thread yoke further out on push rod and vice versa.

With clutch in the engaged position (air pressure applied), release bearing should clear the Belleville spring by at least 1/16 inch (dimension "B," fig. 95). If there is less than 1/16 inch it means that more stroke is being applied to spring than is necessary to get .010-.030 inch plate clearance. Distance of release bearing from Belleville spring can be checked by removing pin through yoke and release fork and swinging bearing against spring by hand. Then gradually move bearing away from spring, observing distance the outer end of release



EXPLODED VIEW OF CLUTCH

1 Compressor Flywheel
2 Clutch Control Air Cylinder Assy.
3 Lock Nut
4 Yoke
5 Yoke Pin
6 Yoke Pin Retainer Washer
7 Yoke Pin O-ring
8 Clutch Release Fork
9 Retainer Spring
10 Ball Stud
11 External Lock Washer
12 Clutch Housing
13 Housing to Compressor Short Bolts (7 Req'd.)
14 Housing to Compressor Long Bolt (1 Req'd.)
15 Main Bearing Carrier
16 Drive Flange
17 Flange Nut
18 Carrier Attaching Bolts (4)
19 Lock Washer
20 Bearing Retainer Ring
21 Main Bearing Assy.
22 Clutch Shaft
23 Special Flat Washer
24 Drive Flange Key
25 Main Bearing Retainer
26 Lock Washer
27 Retainer Attaching Bolts (4)
28 Clutch Release Bearing Assy.
29 Pressure Plate Retracting Springs
30 Spring Attaching Screws and Washers
31 Cover to Flywheel Bolts and Washers
32 Pressure Plate Cover Assy.
33 Pressure Plate
34 Drive Plate Assy.
35 Clutch Shaft Pilot Bearing Assy.
36 Flywheel to Compressor Bolt
37 Flat Washer
38 Flywheel to Compressor Key



SECTIONAL VIEW OF CLUTCH

T-172

Figure 95—Compressor Drive Clutch Components

SYSTEM MAINTENANCE

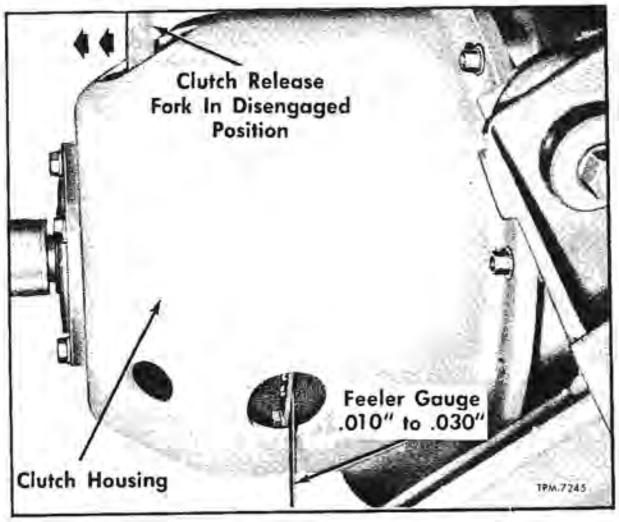


Figure 96—Checking Clutch Drive Plate Clearance

fork travels. A 7/64 inch movement at outer end is equal to 1/16 inch at the inner end. After correct adjustment is obtained, lock jam nut against yoke and place rubber holding washer and O-ring on end of pin (see inset, fig. 97).

COMPRESSOR DRIVE PROPELLER SHAFT

Compressor drive propeller shaft is used to transmit power from engine accessory drive to air conditioning compressor (fig. 93). Fixed-yoke end of shaft is toward engine accessory drive and slip-yoke end of shaft is toward compressor.

Drive shaft is solid type, equipped with needle bearing type universal joints at each end, also a splined slip-yoke to absorb any endwise movement.

DRIVE SHAFT REMOVAL (Refer to Fig. 98)

Remove flange bolts, nuts, and washers from

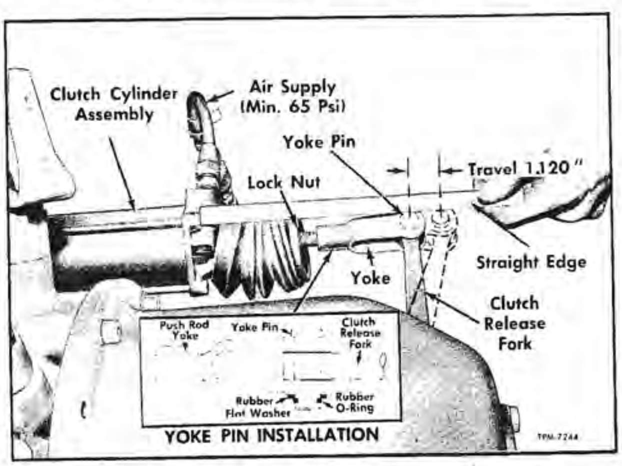


Figure 97—Piston Rod Yoke Adjustment

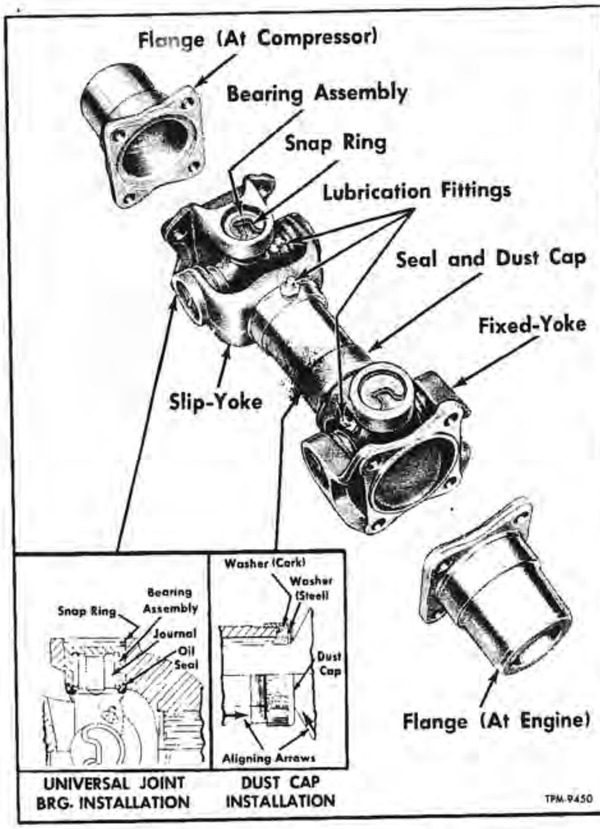


Figure 98—Compressor Drive Shaft Assembly

each end of drive shaft assembly. Remove drive shaft assembly to remove flange at compressor and at engine, remove attaching cotter pin, nut and washer. Remove flange.

DRIVE SHAFT INSTALLATION (Refer to Fig. 98)

If flange at compressor and at engine were removed, install drive key, and flange to shaft. Secure flange with washer and nut. NOTE: At engine flange only, apply oil sealant to surfaces of flange washer and to face of nut. Tighten nut to 100-110 foot-pounds torque. Install nut cotter pin.

Position drive shaft assembly with fixed-yoke end toward engine accessory drive, and slip-yoke end toward compressor. With drive shaft in position, install flange bolts, nuts, and washers. Tighten nuts firmly.

UNIVERSAL JOINT BEARING REPLACEMENT (Refer to Fig. 98)

<u>Removal</u>

1. Remove snap rings which retain bearings in shaft yokes.

2. Strike one side of yoke with soft hammer to force one bearing assembly out of yoke. Strike opposite side of yoke to force opposite bearing out.

CAUTION: DO NOT DROP BEARINGS.

3. Journal can now be tilted to permit removal of yoke from journal.

4. Remove the remaining two bearing assemblies in same manner to permit removing journal from other yoke.

Installation

1. NOTE: Make sure oil seals are in place securing needle rollers in bearing. Apply SAE #140 gear oil to needles to provide initial lubrication.

2. Install journal in yoke, then install bearing assemblies in yoke over journal trunnions. Use a soft hammer to tap bearings into place.

3. Install snap rings into yoke groove to secure bearings in yoke. IMPORTANT: Make sure snap rings are fully seated in yoke grooves.

SLIP YOKE SPLINE SEAL AND DUST CAP REPLACEMENT

1. Separate slip-yoke from fixed-yoke by pulling apart.

2. Unthread dust cap from slip-yoke, then remove dust washer (cork or felt) and flat steel washer from cap.

3. To install, refer to inset on figure 98 for relative position of parts, then place steel washer and dust washer (seal) in cap. Place cap over splines on fixed-yoke.

4. Referring to alignment arrows on sides of slip-yoke and flange of fixed-yoke to see that they are aligned with each other, slide splines of fixed-yoke into slip-yoke. Thread dust cap to end of slip-yoke. Tighten cap until snug.

REFRIGERANT COMPRESSOR DRIVE CLUTCH

The compressor drive clutch (fig. 95) enclosed by an aluminum housing is mounted to drive end of compressor. Clutch is of the conventional automotive type and is actuated by an air powered cylinder assembly mounted to side of compressor.

When air CYLINDER IS PRESSURIZED (push rod retracted), the CLUTCH BECOMES ENGAGED. Likewise when PRESSURE IS EXHAUSTED from cylinder (push rod extended) CLUTCH BECOMES DISENGAGED. NOTE: Air cylinder push rod is extended by pressure of multiple coil springs within cylinder assembly.

The clutch input shaft, which is propeller shaft driven from engine accessory drive is engaged directly to the clutch drive plate assembly. Thus the drive plate is turning whenever the coach engine is running. When clutch is engaged by action of the air cylinder, the Belleville spring of clutch pressure plate is released. This action releases pressure plate to engage both drive plate and compressor flywheel to turn the compressor. Large arrows on figure 95, indicate the power flow from the drive shaft input through the clutch to the compressor.

On all models 4502, 4518, and 4519, the clutch drive plate and cover assemblies only can be replaced without having to break any refrigerant lines or having to remove the compressor from coach. See "Clutch Drive Plate and Cover Assembly Replacement (Compressor in Coach) (All Models 4502, 4518, and 4519).

On all models 5302, 5303, and 5304, all of the clutch components can be replaced without having to remove compressor from coach. See "Clutch Housing, Drive Plate, and Cover Assemblies Replacement (Compressor in Coach) (All Models 5302, 5303, and 5304)."

Overhaul of the clutch components are explained later under "Clutch Overhaul."

CLUTCH DRIVE PLATE AND COVER ASSEMBLY REPLACEMENT (COMPRESSOR IN COACH)

(All Models 4502, 4518, and 4519)

NOTE: The following describes procedure for replacing drive plate and cover assemblies only, and does not cover replacement of the aluminum clutch housing. In order to remove housing, it is first necessary to remove the complete compressor unit from coach.

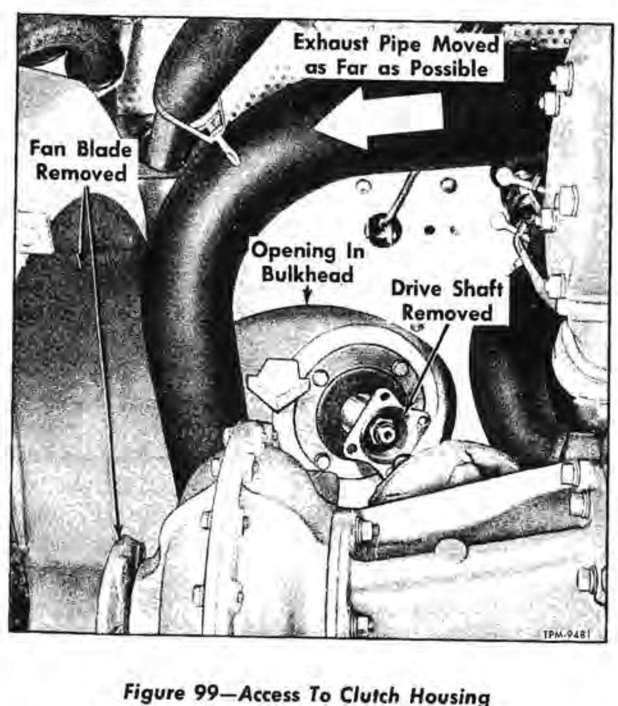


Figure 99—Access To Clutch Housing Through Engine Compartment (Typical)

SYSTEM MAINTENANCE

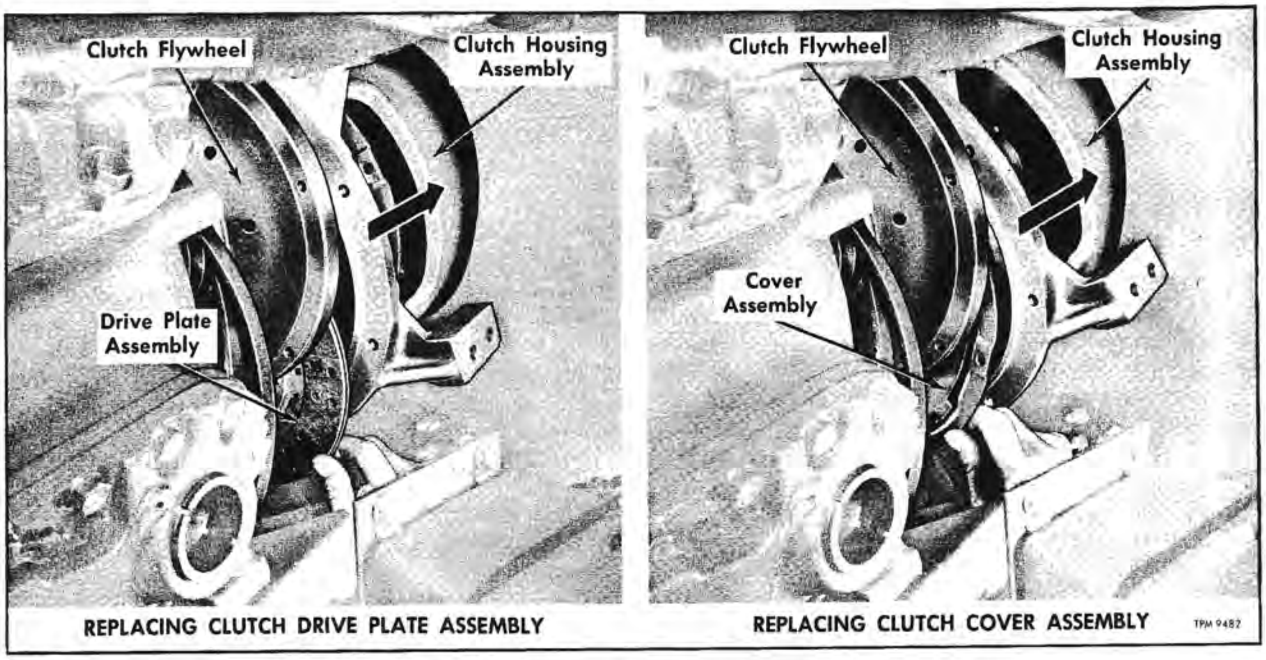


Figure 100—Replacing Clutch Drive Plate and Cover (Compressor in Coach)

IMPORTANT: One special tool, which can be improvised locally is necessary for making these replacements. DO NOT ATTEMPT TO MAKE REPLACEMENTS UNLESS THIS TOOL IS AVAILABLE. Tool is used for holding drive plate in alignment when installing cover assembly to clutch flywheel. Cut off a portion of an old clutch shaft (22, fig. 95) at a point shown in figure 101. Same like part can be made up from an old Chevrolet mechanical transmission main drive (clutch) gear.

DRIVE PLATE AND COVER REMOVAL

1. Using run-up blocks, raise rear of coach to provide access from below compressor compartment. Set hand brake.
2. Place engine control switches in engine compartment to "OFF" position.
3. Remove stone shield from below compressor and from under engine at left side.
4. Remove muffler assembly from engine compartment (models with 8V engine). This will provide access to compressor drive shaft.
5. Remove fan blade from engine. Through access hole in seat-back above engine, disconnect exhaust pipe from exhaust manifold. Also loosen exhaust pipe at muffler base. Move exhaust pipe toward radiator as far as possible. See figure 99.
6. Remove compressor drive shaft assembly. NOTE: If necessary to rotate shaft for access to flange bolts, turn engine crankshaft using a 1-1/2 inch socket wrench on lower camshaft pulley nut.
7. Spring-loaded clutch cylinder (2, fig. 95) must be disconnected from clutch release fork (8, fig. 95). In order to remove fork connecting pin (5, fig. 95), disconnect cylinder air line hose at air control solenoid valve, then apply shop air pressure through hose into air cylinder (min. air pressure required - 65 lbs.). This action will relieve pressure on cylinder yoke pin, allowing pin to be removed.
8. Remove condenser fan drive pump from compressor clutch housing as directed previously under "Fan Drive Pump Replacement."
9. Remove cover from access hole in coach floor above compressor. This will provide access to clutch housing upper attaching bolts.
10. Remove socket head bolts (13 and 14, fig. 95) which attach clutch housing to compressor. Using two of these screws installed into tapped holes, one at top, and bottom of housing, separate housing evenly from compressor.

NOTE: On some early coaches, it may be necessary to remove radiator surge tank overflow line from opening in engine bulkhead before moving clutch housing rearward.

10. Referring to figure 99, move clutch housing rearward into propeller shaft opening in body bulkhead. With the aid of an assistant to retain housing in position, remove cover attaching bolts, then work clutch drive plate and cover assembly from clutch housing in manner shown in figure 100.

INSTALLATION OF DRIVE PLATE AND COVER

NOTE: While clutch housing is separated from compressor, examine and if necessary replace fluid pump drive belts. See figure 120.

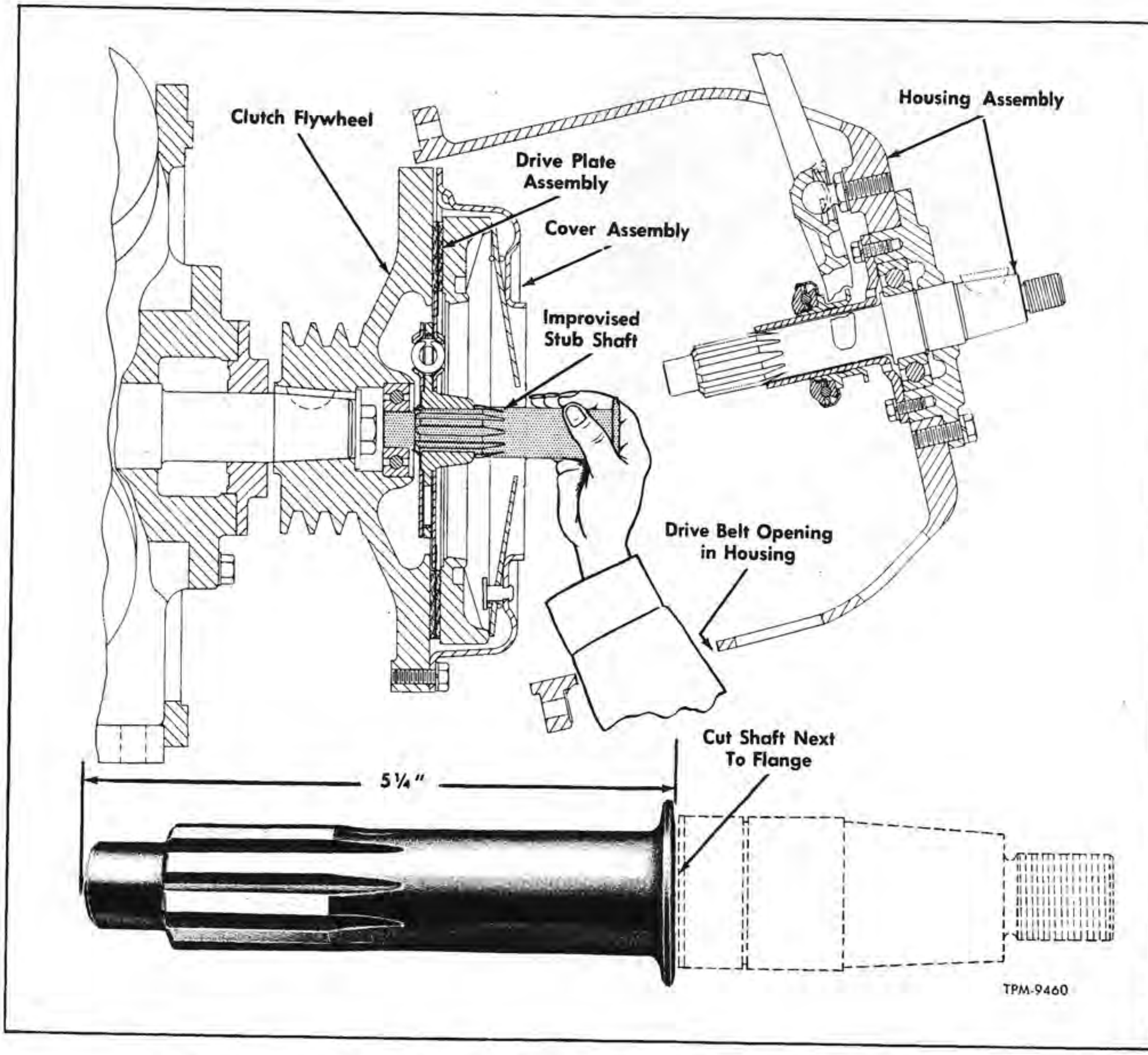


Figure 101—Installing Clutch Drive Plate and Cover Using Alignment Tool (Compressor in Coach)

IMPORTANT: If new belts are to be installed make sure they are all from same service set. DO NOT USE OLD AND NEW BELTS TOGETHER.

NOTE: The aid of an assistant is recommended when installing clutch components.

1. Referring to figure 100, insert clutch cover and drive plate into clutch housing as shown.
2. Using improvised stub shaft as shown in figure 101, insert shaft into splines of drive plate and then into pilot bearing within clutch flywheel.

NOTE: Clutch housing must be located slightly out of alignment with compressor (See upper view) in order to use the alignment stub shaft as existing shaft within housing will interfere.

3. Carefully line up clutch cover with flywheel then install cover attaching bolts and lock washers alternately. This will prevent distorting clutch cover when compressing clutch spring.

IMPORTANT: If a new cover assembly was installed, pry three shipping blocks from around cover. Blocks are located as shown in figure 106.

NOTE: Cover attaching bolts should be tightened to approximately 40 foot-pounds torque. Remove improvised stub shaft from clutch drive plate.

4. While assistant rotates the clutch shaft from the engine compartment, engage splines of clutch shaft into drive plate and into pilot bearing in flywheel.
5. Install clutch housing evenly to compressor using socket head bolts and special flat washers.

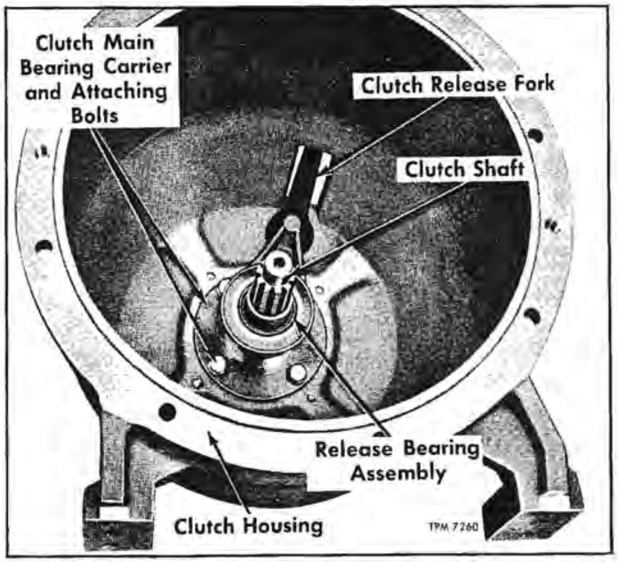


Figure 102—Clutch Fork and Drive Shaft Installed in Clutch Housing

NOTE: Install longer attaching bolt at location shown in figure 95. See item 14.

6. Apply shop air pressure to clutch control air cylinder, then install cylinder to release fork clevis pin, pin (washer) retainer, and rubber O-ring (5, 6, and 7, fig. 95). Attach cylinder air line to air control solenoid valve.

7. Install condenser fan drive pump and bracket assembly to clutch housing as directed previoutly under "Fan Drive Pump Replacement."

8. Install compressor drive shaft assembly. IMPORTANT: Make sure the slip yoke end of shaft assembly is positioned toward the compressor (see fig. 98). NOTE: If necessary to rotate engine flange for alignment see step 6 under "Drive Plate and Cover Removal."

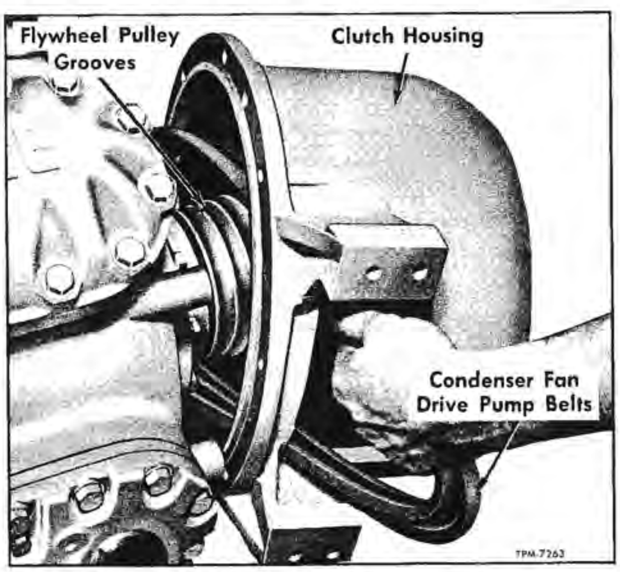


Figure 103—Installing Clutch Housing

9. Install muffler assembly.

10. Fasten stone shields under compressor and engine.

11. Place engine control switches in the engine compartment in operating positions.

12. Remove coach from run-up blocks.

CLUTCH HOUSING, DRIVE PLATE AND COVER ASSEMBLY REPLACEMENT (COMPRESSOR IN COACH)

(All Models 5302, 5303 and 5304)

NOTE: The clutch drive plate and cover assemblies can be replaced in same manner as directed previously for models 4502, 4518, and 4519; however, on models 5302, 5303 and 5304, having more area in the compressor compartment, the compressor and clutch assembly can be moved forward on its mounting platform and then all of the clutch components can be readily replaced. This procedure will not necessitate the breaking of any refrigerant line connections.

REMOVAL

1. Perform Removal Steps 1 through 9, explained previously under "Clutch Drive Plate and Cover Assembly Replacement (Compressor in Coach) (All Models 4502, 4518, and 4519)."

2. Remove four bolts, nuts, and washers which attach legs of compressor to mounting platform. Carefully raise compressor slightly and slide a sheet of plywood under compressor assembly.

3. Move compressor forward in compartment, being careful not to damage refrigerant lines and connections.

4. Remove socket head bolts (13 and 14, fig. 95) which attach clutch housing to compressor. Using two of these screws installed into tapped holes, one at top, and bottom of housing, separate housing evenly from compressor. Remove housing assembly from compartment.

5. Remove and repair clutch components as directed later under "Clutch Overhaul."

INSTALLATION

1. Install clutch components to compressor as directed later under "Clutch Overhaul."

2. Carefully slide compressor with assembled clutch unit rearward to regular mounting location. Remove plywood sheet from below compressor. Install four bolts, washers, and nuts which attach compressor legs to mounting platform. Tighten bolts firmly.

3. Perform Installation Steps 6 through 12, explained previously under "Clutch Drive Plate and Cover Assembly Replacement (Compressor in Coach (All Models 4502, 4518, and 4519)."

CLUTCH OVERHAUL

CLUTCH HOUSING AND SHAFT ASSEMBLY REPLACEMENT (COMPRESSOR REMOVED FROM COACH)

NOTE: Key numbers in following text refer to figure 95.

Removal

1. Apply shop air pressure to clutch control air cylinder (min. air pressure required - 65 psi). This action will relieve pressure on yoke pin at end of release fork. Remove yoke pin.

2. Remove socket head screws (13 and 14), which attach clutch housing (12) to compressor. Using two puller screws installed into tapped holes near top and bottom of clutch housing, remove housing evenly from compressor. Figure 102 shows housing with shaft removed. Remove pump drive belts from compressor flywheel pulley.

Installation

1. With three condenser fan drive belts located in clutch housing as shown in figure 103, position clutch housing assembly to compressor. Install eight attaching bolts (13 and 14) with special flat washers (23).

NOTE: A single long bolt (14) is installed into hole shown on figure 95. Tighten bolts to 20 foot-pounds torque.

CLUTCH HOUSING AND SHAFT DISASSEMBLY (Refer to Fig. 102)

1. Using a flange holding tool (fig. 104), remove nut (17) from drive flange (16). Remove flange and flange key (24).

2. Using a suitable wrench, turn ball stud (10) and lock washer (11) from clutch housing. Remove stud with clutch release fork (8). Slide release bearing (28) from retainer (25). Remove retainer spring (9) holding ball stud in fork.

3. Remove four bolts (18) and lock washers (19) which attach main bearing carrier with shaft as a unit from housing.

4. Remove four bolts (27) and lock washer (26) attaching main bearing retainer (25) to main bearing carrier. Remove retainer and carrier from clutch shaft (22).

5. Using snap ring pliers, remove bearing retainer ring (20) from clutch shaft. Using arbor press, force main bearing assembly (21) from shaft.

CLUTCH HOUSING AND SHAFT ASSEMBLY

1. Press main bearing assembly (21) onto clutch shaft (22) making sure unshielded side of bearing is toward flange on shaft.

2. Install bearing retainer ring (20) into ring groove on shaft.

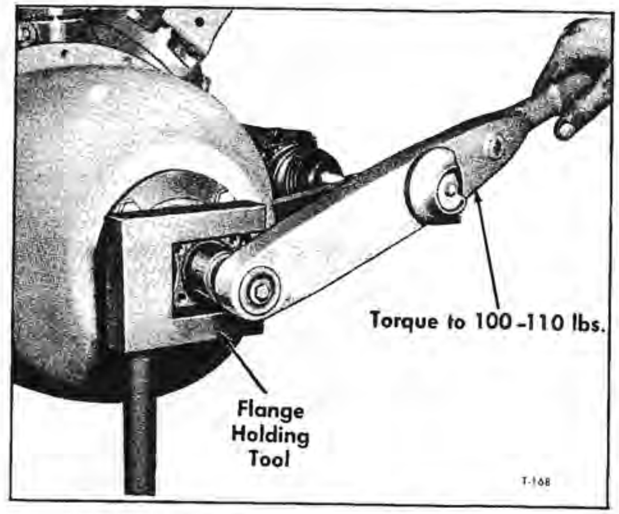


Figure 104—Replacing Drive Shaft Flange Nut

3. Pack cavity of main bearing carrier (15) with #2 - 3% Moly grease. Referring to figure 95 for position of parts, place carrier on shaft, then position main bearing retainer over bearing. Install retainer to carrier with four bolts (27) and lock washers (26). Tighten bolts firmly.

4. Install carrier (15) with shaft (22) into clutch housing with four bolts (18) and lock washers (19). Tighten bolts evenly and firmly.

5. Pack ball stud socket of clutch release fork (8) with wheel bearing grease, then insert ball stud (10) into socket. Secure stud with retainer spring (9). Make sure both ends of spring are located in fork.

6. Slide clutch release bearing (28) over main bearing retainer to position shown in sectional view of figure 95.

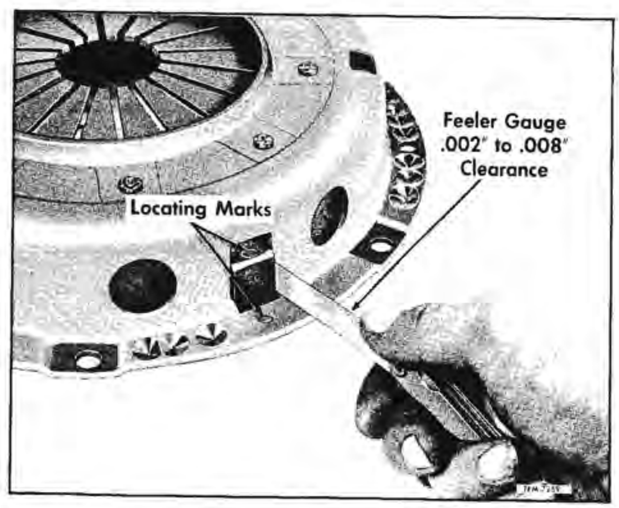


Figure 105—Clutch Cover To Plate Alignment Marks and Driving Lug Clearance Check

SYSTEM MAINTENANCE

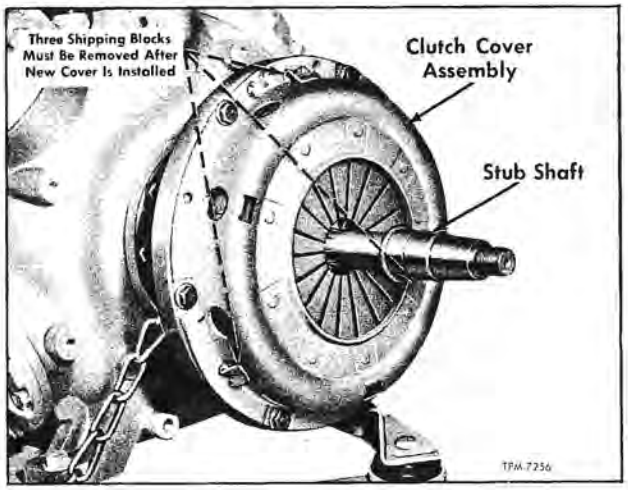


Figure 106—Using Stub Shaft To Align Clutch Components

7. Install clutch release fork (8) to clutch housing, using new external lock washer on ball stud. Tighten stud firmly. Figure 102 shows assembly built up.

8. Install compressor drive shaft flange (16) with key (24) to clutch and secure with flange nut (17). Using flange holding tool shown in figure 104, torque flange nut to 100-110 foot-pounds.

CLUTCH DRIVE PLATE, PRESSURE PLATE AND COVER REMOVAL AND DISASSEMBLY

1. Loosen cover to compressor flywheel bolts (31) one turn at a time until clutch spring pressure is released, then carefully remove clutch cover assembly (32) and drive plate (34).

NOTE: Check clearance between driving lugs of pressure plate (23) and mating slots in clutch cover (32) in manner shown in figure 105. If clearance is greater than .008", examine cover and lugs of pressure plate for wear and if necessary, replace worn parts.

If locating marks "O" on cover and pressure plate (fig. 105) are not visible, mark parts as shown. Remove pressure plate retracting spring bolts (30), remove springs (29), then separate pressure plate from cover.

NOTE: Pressure plate can be resurfaced as directed later under "Inspection and Repair."

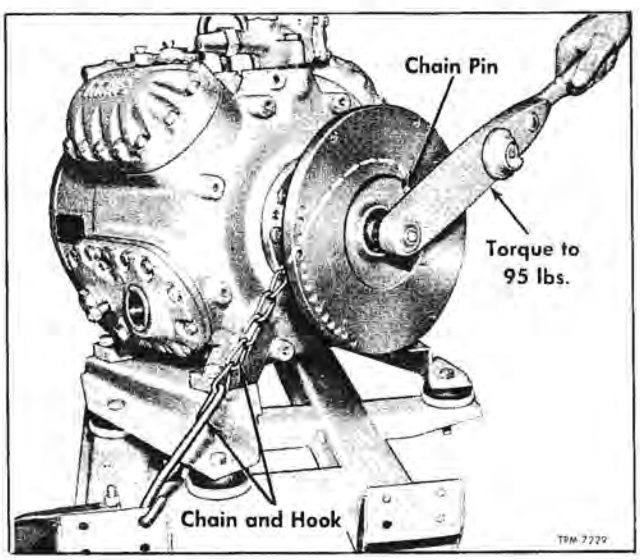


Figure 107—Tightening Compressor Flywheel Bolt

CLUTCH DRIVE PLATE, PRESSURE PLATE AND COVER ASSEMBLY AND INSTALLATION

1. Apply light coat of graphite grease on sides of pressure plate driving lugs; then install plate in cover, making sure balance mark "O" on cover (32) is matched with corresponding mark on pressure plate (33). Refer to figure 105.

2. Install three retracting springs (29) on pressure plate (33). There must not be any clearance between clutch spring and retracting spring when spring attaching screws are tight.

3. Making sure clutch wear friction surfaces are free of grease and dirt, set drive plate (34) in place against flywheel with extended portion of hub away from flywheel. While holding plate in place, move cover assembly (32) with pressure plate (33) into place against flywheel. Using a stub shaft as shown in figure 106 to align clutch drive plate, install cover attaching bolts (31) with lock washers alternately to compress clutch spring evenly and prevent possible distortion of cover flange. Remove stub shaft when all bolts are tightened to 40 lbs. torque. IMPORTANT: If a new cover assembly was installed, pry three shipping blocks from around cover. Blocks are located as shown in figure 106.

CLUTCH FLYWHEEL AND PILOT BEARING REPLACEMENT

Removal

1. Remove pilot bearing (35) from compressor flywheel using convention bearing puller tool.

2. Using proper size wrench socket, remove bolt (36) and flat washer (37) which attach flywheel (1) to compressor shaft (fig. 107). Remove flywheel and flywheel key (38).

Installation

1. Insert drive key (38) into slot of compressor crankshaft, then with flywheel aligned, position flywheel to compressor. Install flywheel flat washer (37) and special bolt (36). Tighten bolt to 95 lbs. torque in manner shown in figure 107.

NOTE: Flywheel can be retained when tightening bolt, using a large size cotter pin on a link of chain. Engage pin into hole at back side of flywheel and hook the other end of chain to compressor platform as shown.

2. Pack cavity around head of flywheel attaching bolt with #2 - 3% Moly grease; then press pilot bearing (35) evenly into clywheel.

IMPORTANT

Shielded side of bearing must face cavity.

INSPECTION AND REPAIR

NOTE: Key numbers in text refer to figure 95.

1. Wash all parts in cleaning solvent, except bearings and clutch drive plate assembly (34).

2. Carefully examine clutch cover and spring assembly (32). Check spring for wear at inner end of levers at point contacted by release bearing (28). Also look for wear and fractures at outer rim of clutch spring. Replace complete cover and spring assembly if any of the component parts are damaged or worn.

3. Inspect pressure plate (33) for scoring on contact surface. Regrind pressure plate if plate is grooved, rough, heat checked, or cracked. Replace with new plate if distorted or if driving lugs are worn.

4. Inspect contact surface of compressor flywheel (1) for grooved, or worn condition. Flywheel can also be ground down as explained later.

5. Replace pilot bearing (35) clutch release bearing (28) and clutch shaft main bearing (21) if bearings are rough or damaged.

RESURFACING PRESSURE PLATE

Before resurfacing pressure plate a check should be made to determine whether plate has been resurfaced previously. This may be determined by measuring from the front surface of plate to the surface at rear side which is contacted by the Belleville spring. Dimension of new pressure plate is 1.0945" to 1.0970". Not more than .045 inch of stock may be removed from contact surface by grinding. If pressure plate is to be resurfaced, proceed as follows:

1. Grind off friction surface of pressure plate as necessary to produce a flat surface. If necessary to reduce plate thickness more than .045 inch to restore smooth flat surface, plate should be discarded and replaced with a new part.

2. After plate has been resurfaced, measure thickness as directed above. Subtract thickness of resurfaced plate from thickness of new plate to determine how much stock has been removed during resurfacing operation.

RESURFACING COMPRESSOR FLYWHEEL

Remove flywheel from compressor and grind from wear surface of flywheel rim, the same amount of stock as was removed from pressure plate. The last operation is necessary in order to maintain torque capacity of clutch and assure proper operation of clutch spring. When refacing is done properly, the clutch spring will be flat when clutch parts are assembled to flywheel, that is; the inner end of fingers will be in same plane as the outer rim of spring, or fingers may slant slightly rearward.

CLUTCH CONTROL AIR CYLINDER

Clutch control air cylinder (fig. 108), pivot-mounted to side of compressor is employed to engage and disengage the compressor clutch. When cylinder push rod is retracted by air pressure supplied by the control air solenoid valve, clutch becomes engaged. When solenoid valve closes, exhausting air supply to cylinder, springs within cylinder extend the push rod to cause clutch to become disengaged.

Air, which is drawn into vented end of air cylinder when clutch is disengaged, enters through an air strainer assembly, mounted to pivot end of cylinder. Air strainer should be removed and cleaned after every three months of operation or more often if subject to operation under extreme dusty conditions.

AIR CYLINDER REMOVAL

1. Disconnect coach air supply line at air cylinder and apply shop air pressure to cylinder to free clevis pin at clutch release fork.

2. Remove rubber O-ring, and flat rubber washer at lower end of cylinder push rod yoke pin. Remove pin from yoke and clutch release fork, then disconnect shop air pressure from cylinder.

3. Remove pin which attaches pivot-end of cylinder to compressor bracket. Carefully lower cylinder from compartment.

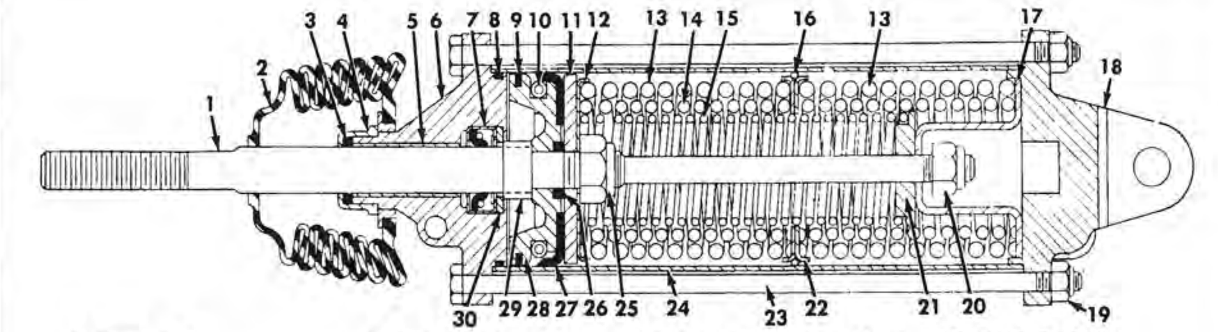
4. If necessary, remove air strainer assembly from rear cover of cylinder. Instructions for cleaning air strainer are explained later under "Cylinder Air Strainer."

AIR CYLINDER INSTALLATION

NOTE: Alignment of air cylinder pivot bracket with clutch release fork should be checked, to prevent push rod binding, before cylinder is installed as shown in figure 109. This check is necessary especially if the bolts attaching pivot bracket to compressor have been loosened, allowing bracket to tilt out of alignment.

1. Align clutch control air cylinder pivot

SYSTEM MAINTENANCE



1 Push Rod
2 Push Rod Boot
3 Seal
4 Seal Cap
5 Push Rod Bushing
6 Front Cover Assy.
7 Push Rod Seal Assy.
8 Tube O-ring
9 Piston Felt
10 Expander Spring
11 Piston Plate
12 Spring Retainer
13 Spring (Large Dia.)
14 Spring (Med. Dia.)
15 Spring (Small Dia.)
16 Anti-friction Ring
17 Spring Retainer Cup
18 Rear Cover
19 Nut
20 Push Rod Nut
21 Spring Seat
22 Spring Retainer Assy.
23 Bolt
24 Cylinder Tube
25 Push Rod Nut
26 O-ring
27 Piston Cup
28 Piston Follower
29 Spacer
30 Seal Washer

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Figure 108—Clutch Control Air Cylinder Assembly

bracket with clutch release fork using a piece of straight bar stock positioned on bracket and fork as shown. If entire top surface of pivot bracket is not contacting bar, loosen bracket attaching bolts and allow bracket to align. Tighten bolts firmly after bracket is properly aligned.

2. Apply small quantity of Lubriplate to pivot end of cylinder and to yoke at push rod end of cylinder.

3. Raise cylinder assembly into position. Attach pivot end to mounting bracket with pin.

4. Connect shop air supply line to air cylinder

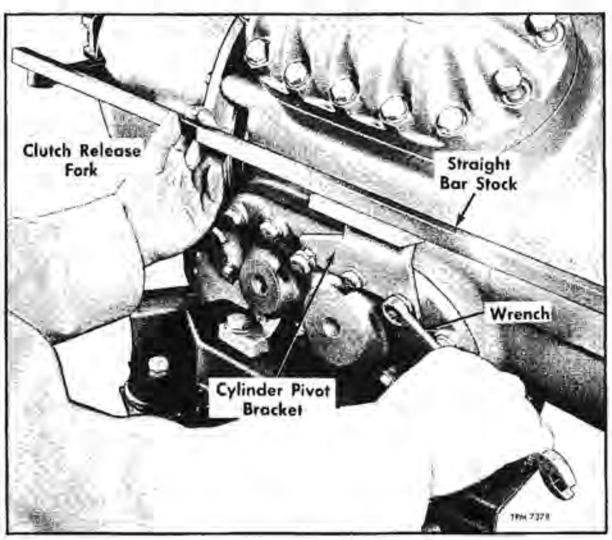


Figure 109—Checking Air Cylinder Mounting Bracket Alignment

to retract cylinder push rod.

5. Check and adjust clutch control as explained previously under "Clutch Release Adjustment."

6. After proper adjustment is obtained make certain that flat rubber washer and rubber O-ring (6 and 7, fig. 95) are installed to lower end of push rod yoke pin. See inset on figure 97.

CYLINDER OVERHAUL

DISASSEMBLY

NOTE: Key numbers in text refer to figure 108.

1. Mark cylinder front cover (6), cylinder tube (24), and rear cover (18) so as to assure proper alignment when assembled later.

2. Remove boot (2) from push rod and cover.

3. Remove nut (19) from ends of four bolts (23) retaining cylinder assembly together. Remove bolts.

4. Separate front cover (6) with push rod and springs from cylinder tube and rear cover. Slide front cover (6) from push rod being careful not to damage push rod seal (7).

5. Remove O-ring (8) from groove of cover.

NOTE: At this point of disassembly, anti-friction ring (16) can be removed and condition of piston components can be checked. To disassemble piston components, an arbor press having sufficient travel is necessary for compressing springs to allow removal of inner push rod nut (20).

CAUTION: DO NOT ATTEMPT TO DISASSEMBLE OR ASSEMBLE SPRINGS WITHOUT PROPER EQUIPMENT AS SERIOUS INJURY COULD RESULT.

6. Using arbor press with a suitable fixture that will prevent the springs from "snaking" out of position, remove push rod nut (20). Carefully back off arbor press to remove tension on springs. Remove spring retainer cup (17), spring seat (21) and all springs with spring retainer assembly (22).

7. Remove push rod nut (25), then remove spring retainer (12), piston plate (11), piston cup (27), expander spring (10) and piston felt (9).

8. O-ring (26) can be removed from piston follower (28).

9. Slide spacer (29) from push rod.

10. If necessary, seal washer (30) and seal assembly (7) can be removed from front cover (6).

CLEANING AND INSPECTION

Clean all parts thoroughly, then inspect cylinder tube (24) and piston cup (27).

ASSEMBLY

NOTE: Key numbers in text refer to figure 108. Refer to this view for positioning of parts when assembling unit.

1. Install new seal assembly (7) into front cover (6). Install seal washer (30). Stake washer in four places.

2. Slide small diameter end of push rod (1) into boot end of front cover (6) and through seal.

3. Place spacer (29) into position on push rod.

4. Place piston follower (28) on push rod, then install small O-ring (26) into recess of follower.

5. Referring to figure 108 for proper positioning of parts, install piston felt (9) and expander spring (10) into grooves of follower (28). Install piston cup (27), piston plate (11), spring retainer (12) and new push rod nut (25). Tighten nut firmly.

6. Place push rod and front cover in arbor press fixture, then position springs (14 and 15), and two larger diameter springs (13) with spring retainer (22) located between springs. Locate

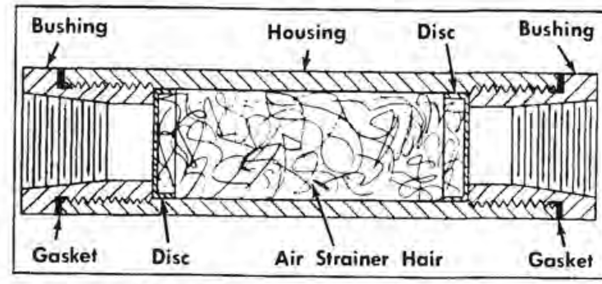


Figure 110—Air Strainer Assembly

spring seat (21) with flange positioned as shown, then carefully press seat and spring retainer cup (17) over end of push rod to allow installation of new push rod nut (20). Tighten nut firmly.

7. Locate tube O-ring (8) into groove of front cover and place anti-friction ring (16) into groove of spring retainer (22).

8. Coat inside of cylinder tube (24) with Lubriplate, then place tube over springs to front cover. Locate rear cover (18) to tube. Align marks on tube and covers which were made prior to disassembly. Install four bolts (23) and nuts (19). Tighten nuts evenly.

9. If previously removed, install seal (3) and seal cap (4).

10. Apply small quantity of clean grease to push rod, then install push rod boot (2) to front cover.

CYLINDER AIR STRAINER

Air strainer (fig. 110), installed at pivot end of air cylinder, should be removed and cleaned after every three months of operation or more often if subject to extreme dusty conditions.

Soak strainer material in cleaning solution, then flush strainer. Allow material to dry, then assemble strainer. Replace gaskets if necessary. Tighten end bushings firmly. Install strainer to air cylinder.

COMPRESSOR ACCESSORY DRIVE

The accessory drive, as used to transfer power of coach engine to operate the air conditioning refrigerant compressor, consists of a bevel drive gear and pinion enclosed within engine fan drive housing, as shown in figure 93. Sectional view of gears installed in housing is shown in figure 111.

Referring to figure 111, engine torque is transferred from fan drive pinion (14) to the bevel gear (13) at a ratio of 1.388 to 1 on all models except model SDM5301 with 8-cylinder engine which has a ratio of 1.588 to 1.

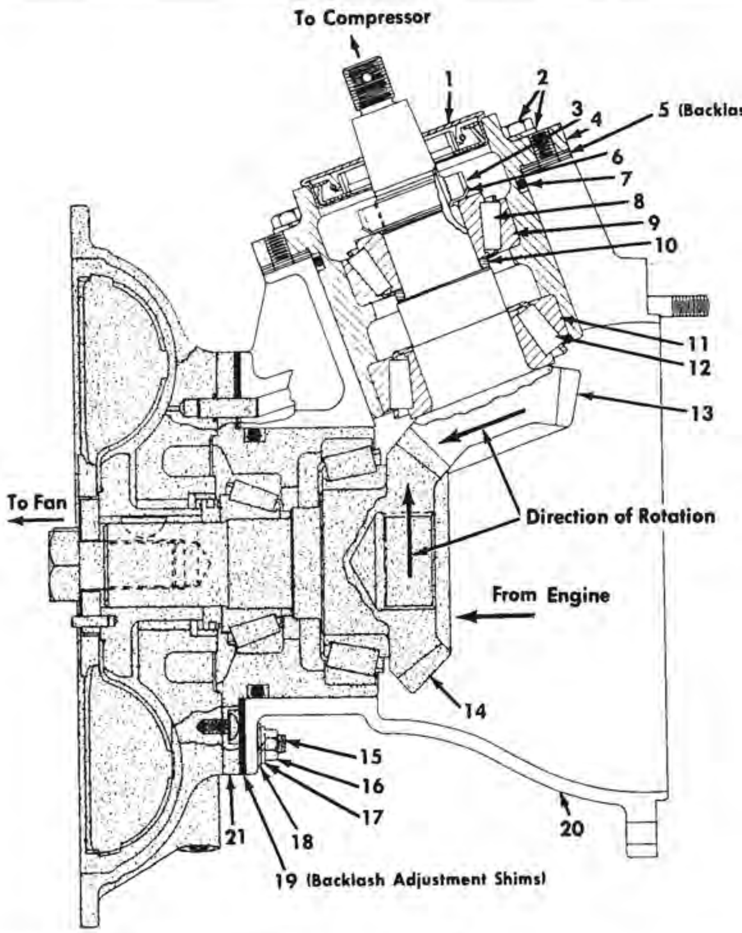
Bevel gear (13, fig. 111) is supported in bearing retainer (4, fig. 111) on two taper roller bearings which are lubricated by engine oil pressure through internal drilled passages. Bearing retainers (4 and 21, fig. 111) of both gears can be .001" press fit or .001" loose fit in opening of accessory drive housing (20, fig. 111).

BEVEL GEAR AND PINION ARE USED IN MATCHED SETS ONLY.

Adjustment of gear backlash and tooth contact is accomplished by removing or adding shims (5 and 19, fig. 111) which relocate position of one gear in relation to the other. Instructions for making adjustments are explained later under "Bevel Gear and Pinion Adjustments."

The following information applies to removal, disassembly, cleaning and inspection, assembly

SYSTEM MAINTENANCE



1 Oil Seal Assy.
2 Bearing Retainer Attaching Bolts and Lock Washers
3 Bearing Adjustment Nut
4 Bearing Retainer
5 Backlash Adjustment Shims
6 Adjustment Nut Lock
7 Bearing Retainer O-ring Seal
8 Outer Bearing Cone Assy.
9 Outer Bearing Cup
10 Bearing Adjustment Spacer (Variable Thickness)
11 Inner Bearing Cup
12 Inner Bearing Cone Assy.
13 Bevel Gear
14 Bevel Pinion with Bearing Retainer and Fan Drive Unit
15 Stud
16 Nut
17 Lock Washer
18 Flat Washer
19 Backlash Adjustment Shims
20 Accessory Drive Housing
21 Fan Drive Bearing Retainer

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Figure 111—Compressor Accessory Drive

and installation of the bevel gear and bearing retainer unit only. For information on fan drive bevel pinion and bearing retainer unit, refer to current Diesel Engine Maintenance Manual.

BEVEL GEAR AND BEARING RETAINER REMOVAL

NOTE: Key numbers in text refer to figure 111.

1. Remove nut which attaches propeller shaft flange to drive gear (13). Remove flange and flange key.

2. Mark position of bearing retainer (4) in relation to accessory drive housing to assure original position when assembled later.

3. Install two puller screws into tapped holes in bearing retainer (4) and force bearing retainer evenly from housing. Remove puller screws. Retain shim pack (5) to assure original gear backlash if it was found satisfactory.

4. Disassemble bevel gear and retainer unit as explained later under "Bevel Gear and Bearing Retainer Disassembly."

BEVEL GEAR AND BEARING RETAINER DISASSEMBLY

NOTE: Key numbers in text refer to figure 111.

1. Remove O-ring seal (7) from groove in bearing retainer.

2. Using sharp bladed tool pry oil seal assembly (1) from bearing retainer.

3. Bend down tab of adjustment nut lock (6).

4. Position bevel gear assembly in a vise having soft jaws, then using a spanner wrench, remove adjustment nut (3). Remove nut lock (6).

5. Support bevel gear retainer (4) in an arbor press and force bevel gear (13) with inner bearing cone (12) and bearing adjustment spacer (10) from retainer. Remove spacer (10) from shaft. If inner bearing needs replacement, remove bearing using arbor press and remover plates.

6. Remove outer bearing cone assembly (8) from retainer.

7. If necessary, bearing cups (9 and 11) can be removed from retainer, using suitable equipment.

CLEANING AND INSPECTION

1. Clean all parts in cleaning solvent. Wipe or blow parts dry.

2. Inspect rollers of bearing cones for nicks and worn spots. Inspect bearing cups also for indication of wear. Replace cones and cups if not in good condition. After cleaning and inspection of bearing parts, lubricate parts generously with clean engine oil, then wrap in clean lint-free cloth or paper until ready to install.

3. Check teeth of bevel gear for poor tooth contact pattern, nicks, or worn condition. NOTE: Bevel gear and pinion are serviced in matched set only.

ASSEMBLY OF BEVEL GEAR AND BEARING RETAINER

NOTE: Key numbers in text refer to figure 111. Coat all parts in clean SAE 30 engine lubricant when assembling unit.

1. If bevel gear inner bearing cone (12) was removed from bevel gear at disassembly, install inner bearing cone using a suitable sleeve and arbor press. Support bevel gear on soft metal or hardwood block and seat bearing race firmly at shoulder (fig. 112).

2. Install bearing adjustment spacer (10) on shaft of bevel gear.

3. Inspect counterbores in bearing retainer (4) which must be clean.

4. Use a suitable driver and arbor press and install bearing cups (9 and 11) in retainer.

5. Apply engine lubricant on bearing assemblies; then set the retainer in place on bevel gear.

6. Install outer bearing cone (8), adjustment nut lock (6) and adjustment nut (3). NOTE: Care should be taken to prevent nut lock from turning with adjustment nut.

7. Support teeth of bevel gear in a soft jaw vice; then adjust gear bearing preload as follows:

a. Wrap a heavy cord around bearing retainer and attach a spring scale as shown in figure 113.

b. Use a deep spanner wrench to tighten bearing adjustment nut (3) to 175 to 200 foot-pounds torque. Rotate bearing retainer by pulling on spring scale. correct bearing preload will require a 4-1/2 to 9-1/2 lbs. pull to rotate retainer. If necessary, replace bearing adjustment spacer (10) with another size.

Spacers of various sizes are available in thicknesses shown in chart at right.

c. When correct adjustment is obtained, lock adjustment nut by bending up tab of adjustment nut lock (6).

8. Apply seal cement to outer diameter of seal (1), then press seal evenly into retainer.

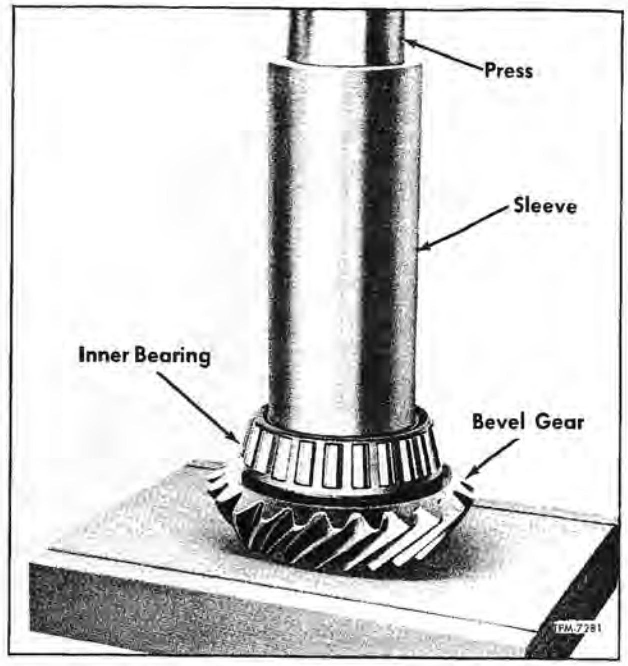


Figure 112—Installing Bevel Gear Inner Bearing

BEARING SPACER CHART

GM Part No.	Thickness	Stamped
2389880	.224"-.223"	P-24
2397019	.2225"-.2215"	P-225
2389879	.221"-.220"	P-21
2397018	.2195"-.2185"	P-195
2389878	.218"-.217"	P-18
2397017	.2165"-.2155"	P-165
2389877	.215"-.214"	P-15
2397016	.2135"-.2125"	P-135
2389876	.212"-.211"	P-12
2397015	.2105"-.2095"	P-105
2389875	.209"-.208"	P-09
2397014	.2075"-.2065"	P-075
2389874	.206"-.205"	P-06
2397013	.2045"-.2035"	P-045
2389873	.203"-.202"	P-03
2397012	.2015"-.2005"	P-015
2386043	.200"-.199"	P-00
2397011	.1985"-.1975"	P-985
2389872	.197"-.196"	P-97

9. Locate new O-ring seal (7) into groove of retainer (4). Assembly is now ready to install in housing.

BEVEL GEAR AND BEARING RETAINER INSTALLATION

NOTE: Key numbers in text refer to figure 111. To facilitate installation, the gear and retainer unit can be cooled and the accessory drive housing can be heated.

SYSTEM MAINTENANCE

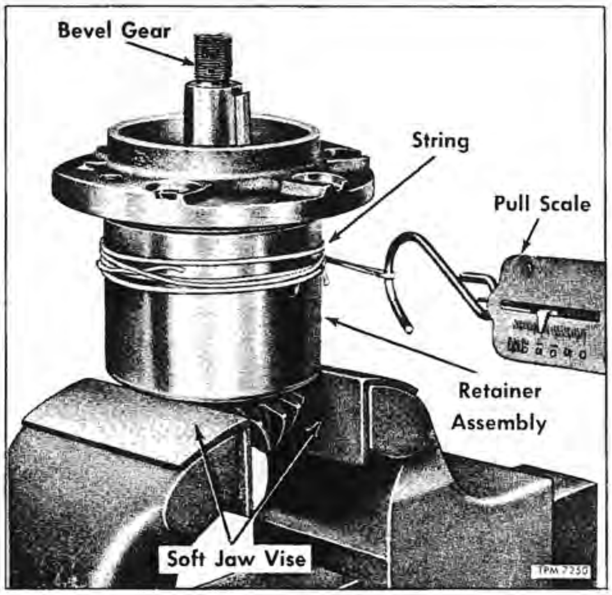


Figure 113—Checking Bevel Gear Adjustment

> **CAUTION**
> IF IT IS FOUND NECESSARY TO HEAT THE ACCESSORY DRIVE HOUSING, APPLY HEAT UNIFORMLY TO HOUSING, OTHERWISE THE CASTING MIGHT FRACTURE. HEAT LAMPS HAVE BEEN FOUND SATISFACTORY FOR THIS PURPOSE.

1. Apply clean (SAE #30) engine lubricant to outer surface of bearing retainer (4) and over O-ring (7) installed in groove of retainer.

2. Locate same pack of adjustment shims (5) removed originally over retainer (4), then with marks made on retainer and housing prior to disassembly aligned, insert bearing retainer into accessory drive housing (20).

3. Use two long bolts, opposing each other to pull retainer into housing, then install bolts and lock washers (2) attaching bearing retainer to accessory drive housing. Tighten bolts evenly and firmly.

4. Install propeller shaft flange with drive key to bevel gear. Coat flats of flange washer and face of flange nut with oil sealant, then install washer and nut. Tighten nut to 100 to 110 foot-pounds torque.

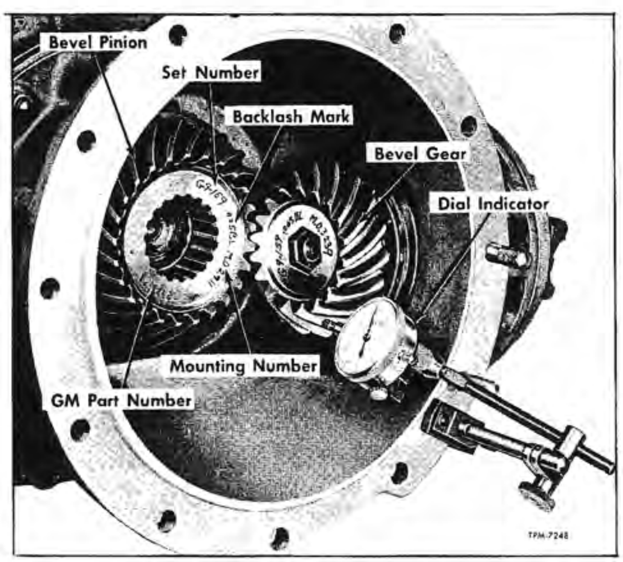


Figure 114—Checking Bevel Gear Backlash

BEVEL GEAR AND PINION ADJUSTMENTS

NOTE: Key numbers in text refer to figure 111.

Shims (5 and 19) are available in three thicknesses (0.003", 0.010", and 0.031") for adjustment of backlash and tooth contact of bevel pinion and bevel gear. Figure 115 shows shims installed between accessory drive housing and pinion gear retainer. Whenever assembling accessory drive unit or installing new pinion and bevel gear, or in event it should become necessary to readjust gear backlash because of normal wear, the following operations must be accomplished to properly adjust the pinion and bevel gear backlash.

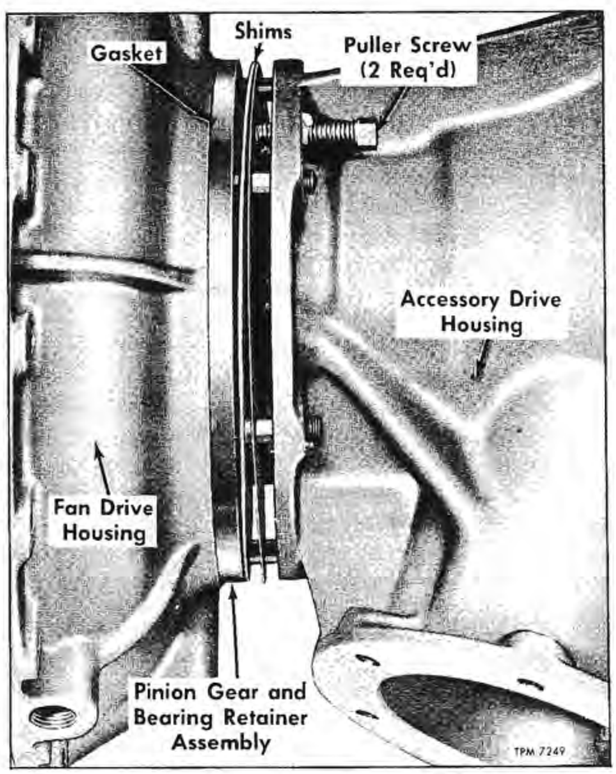


Figure 115—Shims Installed Between Accessory Drive Housing and Pinion Gear Retainer

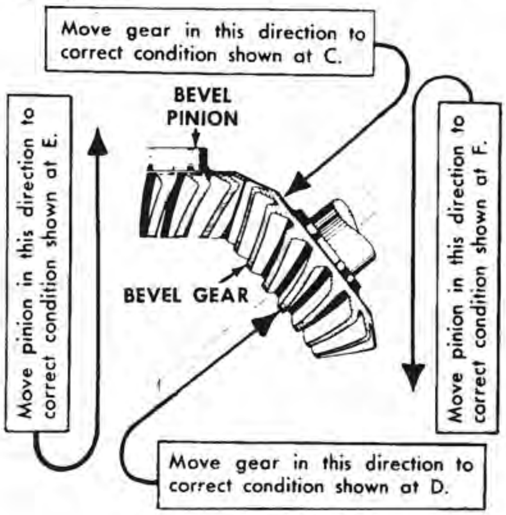
INSTRUCTIONS

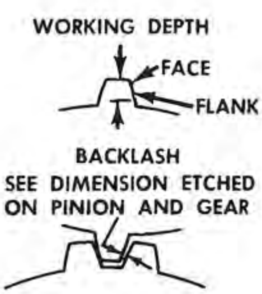
1—Install bevel pinion and bevel gear assemblies; then adjust pinion and bevel gear for proper backlash as directed in "Bevel Gear and Pinion Adjustments" paragraph of this section.

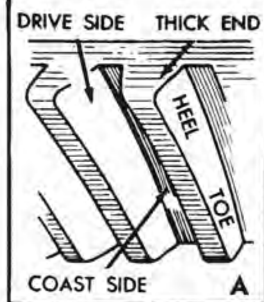
2—Paint three or four teeth of bevel gear with red lead or mechanics blue and rotate bevel gear in direction of rotation until pinion makes complete revolution.

3—Note area of tooth contact which should start at toe and extend about 80 percent of tooth length toward heel, as at B.

4—Vary position of pinion and gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that gear can be completely revolved without any highspots being felt.





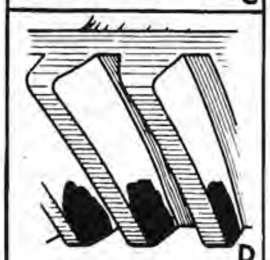


A—Check adjustments at drive side of BEVEL GEAR tooth

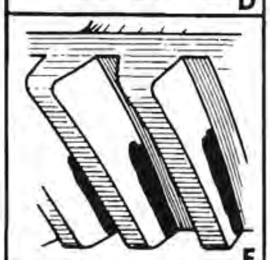
B—Shows correct tooth contact

NOTE: Key Numbers Below Refer to Figure 111.

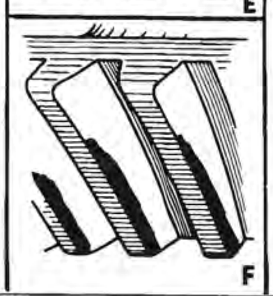
C—Shows short contact at heel. To correct, decrease shim thickness (5) to move gear toward pinion. Then increase shim thickness (19) to move pinion away from gear to again secure correct backlash.



D—Shows short contact at toe. To correct, increase shim thickness (5) to move gear away from pinion. Then decrease shim thickness (19) to secure correct backlash.



E—Shows heavy contact on flank or lower portion of tooth. To correct, increase shim thickness (19) to move pinion away from gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then decrease shim thickness (5) to move gear toward pinion to secure correct backlash.



F—Shows heavy contact on face or upper portion of tooth. To correct, decrease shim thickness (19) to move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then increase shim thickness (5) to move gear away from pinion to secure correct backlash.

TPM 9488

Figure 116—Accessory Drive Bevel Gear and Pinion Tooth Contact Chart

SYSTEM MAINTENANCE

Backlash dimension is etched on pinion and bevel gear as shown in figure 114.

1. If accessory drive is installed to coach engine it must be removed as directed under "Cooling System" in current Diesel Engine Maintenance Manual.

2. Check gear backlash using dial indicator positioned as shown in figure 114. Dimension should be same as etched on gears. Adjustment can be accomplished through shims (5 and 19) provided between bevel gear bearing retainer (4) and accessory drive housing (20), and between bevel pinion bearing retainer (21) and accessory drive housing (20). Shims are of 0.003", 0.010" and 0.031" thickness.

3. To check for proper tooth contact, paint several teeth on pinion gear with a mixture of ground red lead and engine oil or a similar marking compound to provide a method of determining tooth contact.

4. Turn bevel pinion in direction of rotation (fig. 111) and observe tooth contact impression on drive side of gear teeth. Contact should start at toe of tooth (view B, fig. 116) and extend back about 80% of tooth length toward heel. Contact should be distributed evenly over flank and face of tooth, indicating center of contact on pitch line. Refer to views "A" and "B," figure 116.

a. If tooth contact is too far out on tooth toward heel (view C, fig. 116), decrease thickness of shim pack (5) between bevel gear bearing retainer (4) and accessory drive housing (20), moving bevel gear toward pinion. Restore backlash by increasing shim thickness (19) between pinion bearing retainer (21) and accessory drive housing (20). Figure 115 shows shims (19) installed between pinion gear bearing retainer and accessory drive housing. This view also shows puller screws used for removing bearing retainer from accessory drive housing.

b. If tooth contact extends from toe appreciably less than 80% of tooth contact (view D, fig. 116) move bevel gear away from pinion by increasing shim thickness (5) between bevel gear bearing retainer and accessory drive housing. Restore backlash by decreasing shim thickness (19) between pinion bearing retainer and accessory drive housing

c. If tooth contact is low on flank of tooth (view E, fig. 116), move pinion away from bevel gear by increasing shim thickness (19) between pinion bearing retainer and accessory drive housing. Restore backlash by decreasing shim thickness between bevel gear bearing retainer and accessory drive housing.

d. If contact is high on face of tooth (view F, fig. 116), move pinion toward bevel gear by decreasing shim thickness (19) between pinion bearing retainer and accessory drive housing. Restore backlash by increasing shim thickness (5) between bevel gear bearing retainer and accessory drive housing.

5. When pinion and bevel gear adjustments have been completed, make certain that all retainer attaching bolts (2) and nuts (16) are securely tightened. Recheck adjustment. Remove all red lead from gears.

6. Install accessory drive unit in coach.

For information on fan drive unit attached to end of accessory drive housing, refer to current Diesel Engine Maintenance Manual.

System Services and Tests

CONTENTS OF THIS SECTION

NOTE: General instructions for servicing air conditioning system are located on the back side of compressor compartment door as shown in figure 117. Detail service instructions are explained in this section under applicable headings.

CAUTION: ALWAYS WEAR SAFETY GLASSES WHEN HANDLING REFRIGERANT.

PREPARING SYSTEM FOR OPERATION

When air conditioning units have been inoperative during the off-season, certain inspection and service operations must be accomplished before system is placed back in operation.

1. If compressor has been overhauled, make sure proper amount of oil has been replaced in compressor.

2. Charge compressor with refrigerant to provide internal pressure. Refer to "Charging System" later in this section. Check for evidence of oil or refrigerant leakage past the compressor crankshaft seal using a leak detector. If seal leaks, remove compressor from coach and replace seal.

3. Replace filter element in condenser fan fluid reservoir, then refill reservoir to "OIL LEVEL" mark. Refer to "Condenser Fan Fluid Reservoir" previously for element replacement.

4. Remove air intake grille winter cover and shield from condenser compartment hood and cover (figs. 118 and 119).

5. Clean condenser coil as instructed later under "Cleaning Coils of Condenser."

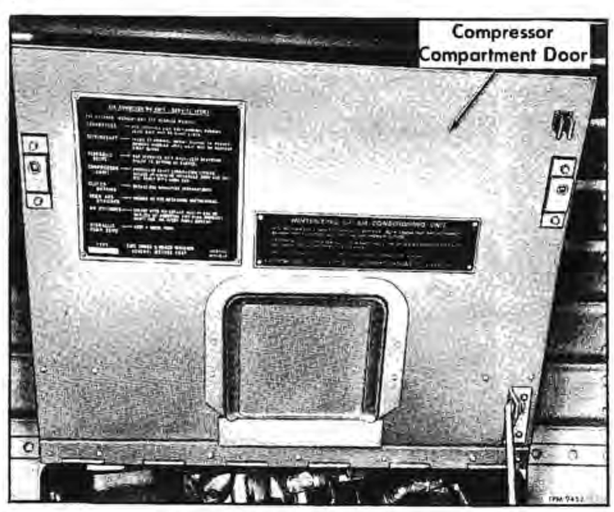


Figure 117—Air Conditioning Service Instruction Plates

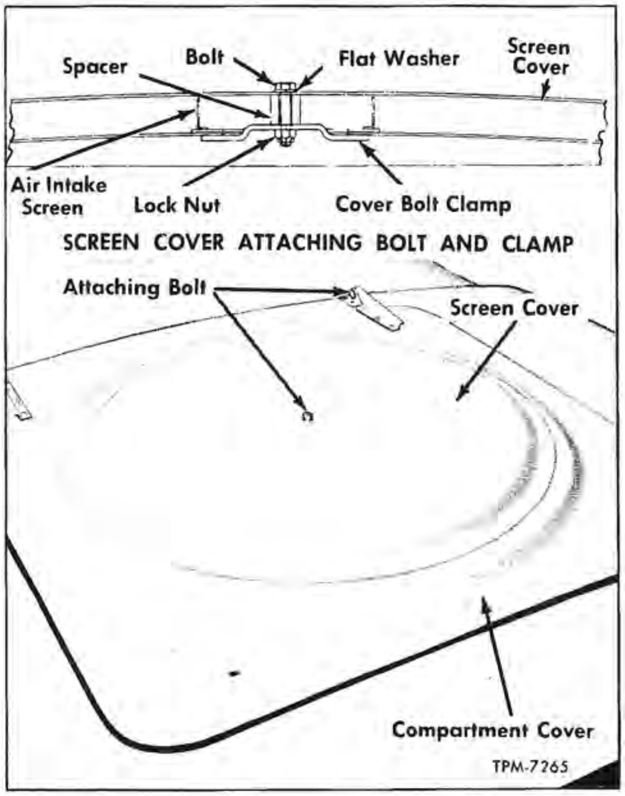


Figure 118—Winterization Top Cover Installed

6. Check tension of condenser fan fluid pump drive belts. Refer to "Condenser Fan and Drive" previously.

7. Clean air filter screens in heating and cooling compartment underneath coach. Also clean the evaporator coil in same compartment. Use high pressure water and air mixed being careful not to damage coil fins.

8. Connect feed wire to clutch control air solenoid valve (26, fig. 7).

9. Install new dehydrator-strainer unit in refrigerant system. Refer to "Replacing Dehydrator-Strainer" later.

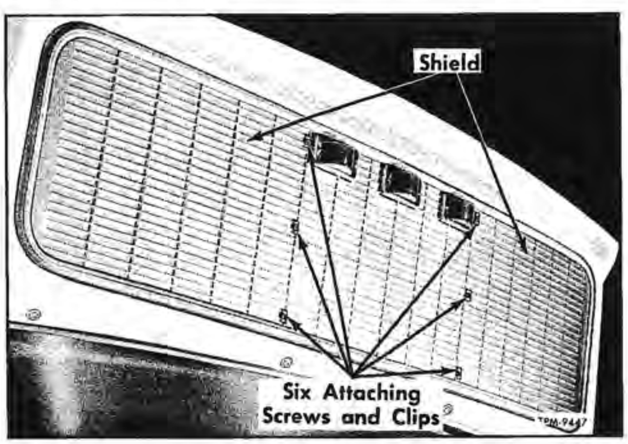


Figure 119—Winterization Rear Shield Installed

10. Place discharge and suction valves atop compressor in operating position as explained later under "Refrigerant Valves." Open receiver valves.

11. Lubricate compressor clutch mechanism as explained previously under "Compressor Drive."

12. Install compressor drive shaft assembly if previously removed or disconnected.

REPLACING CONDENSER FAN DRIVE PUMP BELTS

IMPORTANT: Do not attempt to replace only one or two belts. Replace the entire set. Belts are serviced in set of three.

NOTE: Pump drive belts can be replaced without having to remove compressor from coach.

BELT REMOVAL

1. Using run-up blocks or hoist, raise rear of coach to provide access from below compressor compartment.

2. Place engine control switches in engine compartment to "OFF" position.

3. Remove stone shield from below compressor and from under engine at left side.

4. If 8V engine model, remove muffler assembly from engine compartment. This will provide access to compressor drive shaft.

5. Remove compressor drive shaft assembly. NOTE: If necessary to rotate shaft for access to flange bolts, turn engine crankshaft using a 1-1/2 inch socket wrench on lower camshaft pulley nut.

6. Spring-loaded clutch cylinder (2, fig. 95) must be disconnected from clutch release fork (8, fig. 95). In order to remove fork connecting pin (5, fig. 95), disconnect cylinder air line hose at air control solenoid valve, then apply shop air pressure through hose into air cylinder (min. air pressure required - 65 lbs.). This action will relieve pressure on cylinder yoke pin, allowing pin to be removed. Remove pin.

7. Remove condenser fan drive pump from compressor clutch housing as directed previously under "Fan Drive Pump Replacement."

8. Remove cover from access hole in coach floor above compressor. This will provide access to clutch housing upper attaching bolts.

9. Remove socket head bolts (13 and 14, fig. 95) which attach clutch housing to compressor. Using two of these screws installed into tapped holes, one at top, and bottom of housing, separate housing evenly from compressor.

NOTE: On some coaches, it may be necessary to remove radiator surge tank overflow line from opening in engine bulkhead before moving clutch housing rearward.

10. Referring to figure 120, move clutch housing rearward into propeller shaft opening in body bulkhead. With the aid of an assistant to retain housing in position, work one belt at a time over clutch flywheel and out of opening in housing as shown.

INSTALLATION OF BELTS

NOTE: Belts are serviced in set of three only and all three new belts should be installed. NEVER use new belts with old belts.

1. Referring to figure 120, insert one belt at a time into clutch housing opening and over clutch flywheel to pulley grooves.
2. Install clutch housing evenly to compressor using socket head bolts and special flat washers. NOTE: Install longer attaching bolt at location shown in figure 95. See item 14.
3. Apply shop air pressure to clutch control air cylinder, then install cylinder to release fork clevis pin, pin (washer) retainer, and rubber O-ring (5, 6, and 7, fig. 95). Attach cylinder air line to air control solenoid valve.
4. Install condenser fan drive pump and bracket assembly to clutch housing as directed previously under "Fan Drive Pump Replacement."
5. Install compressor drive shaft assembly.

IMPORTANT: Make sure the slip yoke end of shaft assembly is positioned toward the compressor. See figure 98.

6. Install muffler assembly (8V engine).
7. Fasten stone shields under compressor and engine.
8. Place engine control switches in the engine compartment in operating positions.
9. Remove coach from run-up blocks or hoist.

PREPARATION OF SYSTEM FOR INACTIVE SEASON

1. The system should be pumped down and all refrigerant valves closed (two at receiver tank and two at top of compressor). Install protector cover and shield over condenser compartment openings. Figure 118 shows cover installed. Cover is retained with a bolt, spacer, clamp, and bolt nut. Hood rear shield is attached with six screws and clips (fig. 119).
2. In compressor compartment, disconnect #14 black with brown tracer wire from terminal of clutch control air solenoid valve (26, fig. 7). Tape terminal at end of wire.
3. The compressor drive shaft should also be removed from coach, or disconnected, to prevent wear to shaft universal joint bearings and to clutch shaft bearings.

Tag unit: CAUTION AGAINST STARTING.

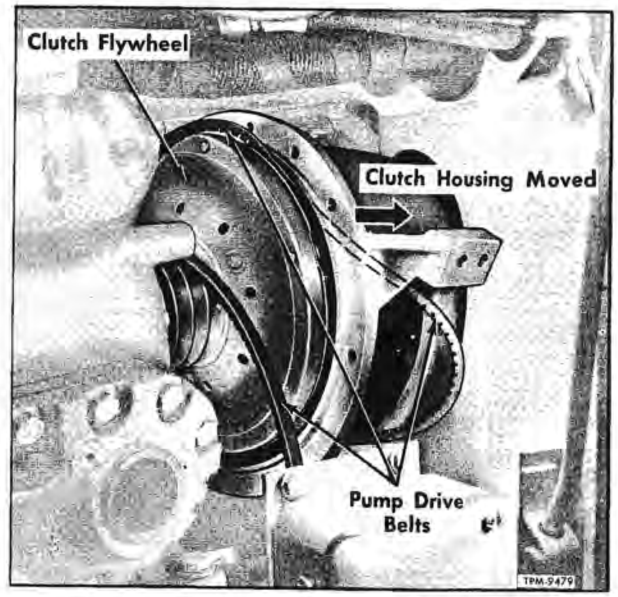


Figure 120—Replacing Condenser Fan Drive Pump Belts

SERVICING CONDENSER FAN DRIVE FLUID SYSTEM

DRAINING SYSTEM

1. Remove cover from fluid reservoir in condenser compartment at rear of coach.
2. With a catch basin positioned under line connections at fluid pump in compressor compartment, slowly break connections one at a time. Allow fluid to drain into basin.
3. After draining system, reconnect lines to pump. Tighten fittings to provide leakproof connections.

FLUSHING SYSTEM LINES

NOTE: Use a mixture of kerosene and air pressure to flush out lines.

1. Remove cover and filter element from fluid reservoir.
2. Disconnect all three lines at fluid pump and permit lines to drain into container.
3. Disconnect lines at fan motor and at fluid reservoir. Be careful to catch draining fluid.
4. Using a container at opposite end of lines, inject kerosene-air pressure mixture into all lines from condenser compartment. Final flush out lines using air pressure only. Clean out fluid reservoir also.

IMPORTANT: If residue from lines appear to be composed of deteriorated inner lining of flexible line, replace line.

5. After flushing out lines, connect lines to units, then fill system to "OIL LEVEL" mark in reservoir.

SYSTEM SERVICES AND TESTS

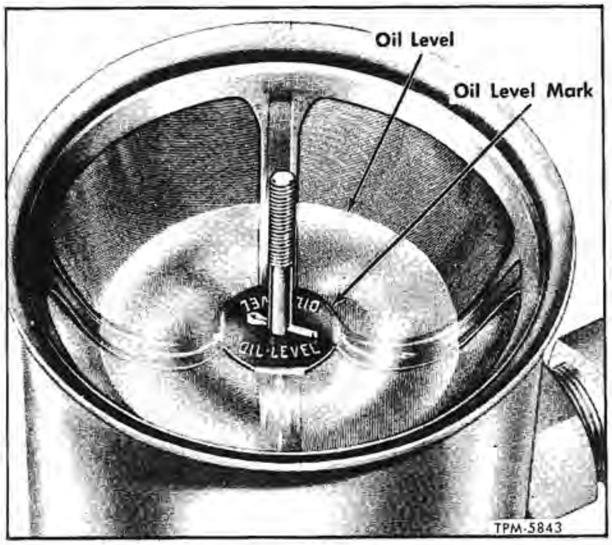


Figure 121—Oil Level in Condenser Fan Drive Fluid Reservoir

FILLING SYSTEM

1. Remove cover from system fluid reservoir in condenser compartment.
2. Fill reservoir with recommended fluid. System requires approximately five quarts.
3. Loosen return (IN) line connection at fluid pump so that this line will fill with fluid. Retighten connection when all air is expelled.
4. While having assistant maintain fluid level in reservoir, start engine and operate fluid pump. Run engine at fast idle speed while filling.

CAUTION: Do not operate engine without fluid in pump.

5. Make sure all air is expelled from system and reservoir is full to "OIL LEVEL" mark (fig. 121). Check for leaks at all line connections.
6. Install reservoir cover making sure large rubber seal at cover and the small rubber seal at cover nut are properly located. Tighten cover nut finger tight only.

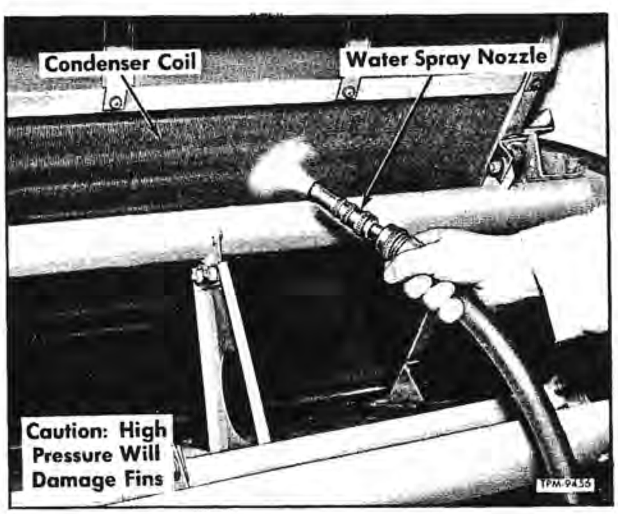


Figure 122—Cleaning Coils of Condenser

REPLACING FILTER ELEMENT

Procedure for replacing reservoir filter element is explained previously under "Condenser Fan and Drive."

CLEANING COILS OF CONDENSER

IMPORTANT: During operating season, clean coils of condenser at weekly intervals or more often if operating under extreme dusty conditions. The importance of keeping the condenser clean cannot be over-emphasized as a clogged up condenser will cause high head pressure and will use up extra operating power.

A combination of water and air pressure blown through coils from the rear side (fig. 122) is satisfactory for loosening and removing dirt.

IMPORTANT: DIRECT PRESSURE STRAIGHT THROUGH COIL TO PREVENT BENDING OF FINS. ALSO, DO NOT USE EXTREME HIGH PRESSURE.

USING REFRIGERANT PRESSURE GAUGE SET

The gauge set shown in figure 123 is one tool that is definitely essential for servicing the air conditioning system. It is used when charging, evacuating and for diagnosing trouble in the system.

Gauge set can usually be obtained through a local refrigeration sales and service dealer.

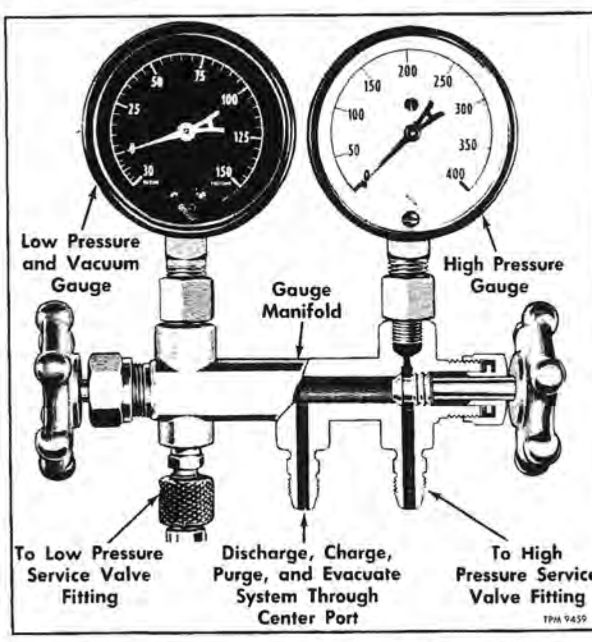


Figure 123—Refrigerant Pressure Gauge Set

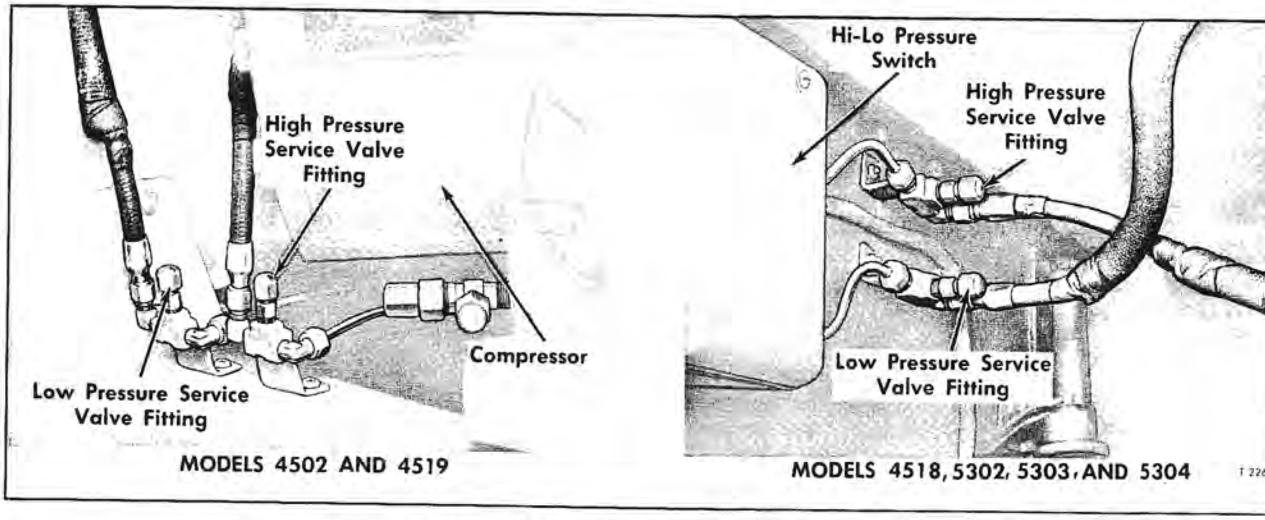


Figure 124—Refrigerant Service Fittings

The pressure gauge unit at the left side of set is the low pressure gauge with face graduated in pounds of pressure from 0 to 150 in 5 pound graduations; and, in the opposite direction, in inches of vacuum from 0 to 30 inches.

THIS GAUGE UNIT MUST ALWAYS BE USED IN CHECKING PRESSURE ON THE LOW PRESSURE SIDE OF SYSTEM.

NOTE: Figure 124 identifies high and low pressure service fittings in compressor compartment for the different coach models.

The pressure gauge unit at right side of set is the high pressure gauge with face graduated in pounds of pressure from 0 to 400 in 5 pound graduations.

THIS GAUGE UNIT SHOULD ALWAYS BE USED IN CHECKING PRESSURE ON THE HIGH PRESSURE SIDE OF SYSTEM.

Three line fittings at bottom of gauge manifold are for purposes explained in figure 123. NOTE: When centerline is not being used, the connected line itself or the line fitting should be capped.

The hand shut-off valves do not have anything to do with opening or closing off pressure to the gauges. They merely close each opening to the center connector and to each other. During most diagnosing and service operations, the valves must be closed. The only occasion for opening both at the same time would be when evacuating the system.

IMPORTANT: When gauge set is being connected to system which is charged, the gauge lines MUST always be purged. Purging is done by "cracking" each valve on the gauge set to allow the pressure of system refrigerant to force air to escape through center manifold fitting. Failure to purge lines will result in air or other contaminants entering the system.

NOTE: To prevent gauges from getting out of calibration, handle carefully, and when not in use store gauge set in a safe place.

CHARGING THE SYSTEM

NOTE: Refrigerant in receiver tank should be to center of tank sight glass after system has been

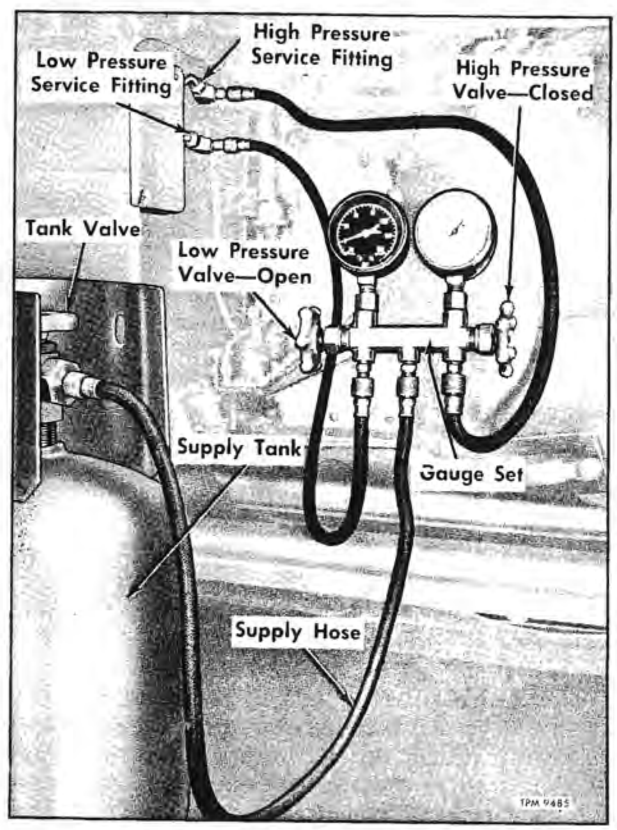


Figure 125—Charging System

in operation for 10 to 20 minutes at approximately 1500 engine rpm.

NOTE: Generally, refrigerant is admitted to the low pressure (suction) side of system in a gas state - refrigerant supply tank retained upright (fig. 125). Refrigerant which is admitted too fast into system may cause slugging in the compressor or it may cause the oil to leave the compressor.

ADDING REFRIGERANT TO SYSTEM

1. Connect refrigerant gauge set loosely to service fittings in the compressor compartment.

IMPORTANT: Make sure gauge lines are connected to respective high and low pressure service fittings. Fittings are identified for the different models on figure 124.

2. Connect the refrigerant supply tank line LOOSELY to center fitting of gauge set.

3. Purge air from tank supply line, then retighten line fitting. Leave supply tank valve open.

4. "Crack" open the shut-off valves of gauge set. This will purge air out of lines to service valves. Tighten line connections at service valves, then close shut-off valve at high pressure side of gauge set. NOTE: The high pressure line is hooked up and is purged of air but will not be used until system is charged and final check is made.

5. Have assistant start and operate system at approximately 1500 engine rpm. Open gauge low pressure valve. Refrigerant will be drawn into system through the low pressure side of system. DO NOT FEED REFRIGERANT TOO FAST AS THIS WILL CAUSE OIL TO LEAVE COMPRESSOR.

NOTE: If desired, charging can be speeded up by immersing supply tank in warm water - or by inverting the container. Again, caution should be taken about charging too fast.

6. Operate system until refrigerant level in receiver sight glass is at middle of glass. Coach temperature should be 85° to 90° F. during leveling off, so that all oil will return to compressor. Steam may be used for additional load on evaporator to hasten return of oil.

7. Close supply tank valve, then disconnect lines and remove gauge set. Install protector seals and caps to service fittings.

CHARGING AN EMPTY SYSTEM

IMPORTANT: The complete system should be thoroughly evacuated before adding refrigerant charge.

System can be charged in same manner as described above for "Adding Refrigerant to System." However, if compressor cannot be operated, refrigerant can be transferred from refrigerant supply tank to system by heating the supply tank, or by connecting tank to system immediately after evacuating, until refrigerant "HI-LO" pressure switch cuts in and compressor starts to operate.

REMOVING EXCESS REFRIGERANT

(Returning to Supply Tank)

NOTE: To avoid the possibility of removing compressor oil along with the refrigerant by exhausting the refrigerant at service fittings, it is recommended that the refrigerant be exhausted from the top of compressor suction valve. Do not operate system when removing refrigerant.

1. Back-seat suction valve by turning valve stem completely counterclockwise.

2. Remove small plug at stem end of suction valve, then connect refrigerant supply tank into plug opening. Hose should be connected loosely to empty or partially full supply tank.

3. Turn compressor suction valve stem clockwise five or more turns and purge air and moisture from hose connection at supply tank. After purging, tighten hose connection.

4. Pack refrigerant supply tank in ice or run cold water over tank until temperature of tank is reduced and pressure in tank is maintained well below the pressure in system.

5. Slowly open tank valve and permit refrigerant to enter tank. NOTE: The rate of refrigerant removal will be determined by the ambient temperature and by the coolness of refrigerant supply tank.

6. After short period of time, close tank shut-off valve, then start and operate system until it levels out. Observe refrigerant level on receiver tank sight glass which should be one-half way up on glass.

7. If necessary, repeat refrigerant removal procedure. NOTE: If too much refrigerant was removed, start up system, slowly open supply tank shut-off valve, then warm the supply tank. When refrigerant raises to center of receiver tank sight glass, close shut-off valve at top of supply tank, then back-seat the compressor valve.

8. Shut down the system. Disconnect supply hose from compressor and install small plug in top of valve. Leave valve stem in back-seated position. Install protector cap over valve stem.

NOTE: If desired, the system can be discharged completely by continuing step 5.

DISCHARGING THE SYSTEM

(To Atmosphere)

1. Back-seat the compressor discharge valve by turning valve stem completely counterclockwise.

2. Remove small plug at stem end of discharge valve, then connect a long hose into plug opening in valve. NOTE: If possible, place opposite end of hose at opening of an exhaust ventilating system. NEVER discharge refrigerant into closed area as possible suffocation could occur.

3. Crack open the discharge valve slightly

(turn stem clockwise) to allow refrigerant to discharge slowly. NOTE: If allowed to discharge rapidly, compressor oil may foam and be discharged also.

4. After discharging to proper level on receiver tank sight glass or discharging system completely, back-seat discharge valve, remove hose, install small plug in top of discharge valve, then install protector cap over valve stem.

5. If system was discharged completely, it can now be opened for parts replacement or any other reason.

EVACUATING THE SYSTEM

Whenever the refrigerant system has been opened to a point where air and moisture has been admitted, it is necessary to thoroughly evacuate the system before recharging. Air in system causes high head pressure and reduces cooling capacity. In case of emergency where a vacuum pump is not available, system may be blown out with refrigerant to eliminate air in system. This should only be done in case of emergency, since considerable refrigerant is used; also, a vacuum pump does a more satisfactory job.

NOTE: In case only a small portion of the system has been opened to atmosphere, that portion of the system may be blown out with refrigerant gas or evacuated as desired.

Any reliable refrigerant vacuum pump may be used. Evacuate the entire system as follows:

IMPORTANT: The system must be completely discharged before attempting to evacuate. See "Discharging the System" procedure.

1. Connect vacuum pump line to center fitting of refrigerant pressure gauge set, then connect the LOW PRESSURE - VACUUM side of gauge set to the high pressure service fitting in the compressor compartment.

IMPORTANT: Never attempt to evacuate through the high pressure side of gauge set, as the vacuum will seriously damage the high pressure gauge. Also make sure shut-off valve at this side of gauge set is closed completely.

NOTE: Figure 126 shows vacuum line (from gauge set) connected to the high pressure service fitting. Figure 124 will identify high and low pressure fittings for various models.

2. Tee a branch line with a wet bulb indicator into vacuum pump line as shown in upper view of figure 126.

NOTE: Wet bulb indicator can be improvised from a test tube, a short line, a rubber stopper, a narrow piece of felt (2 in. long) and an ordinary house thermometer.

3. Place all valves (two at receiver tank and two at the compressor) in operating position.

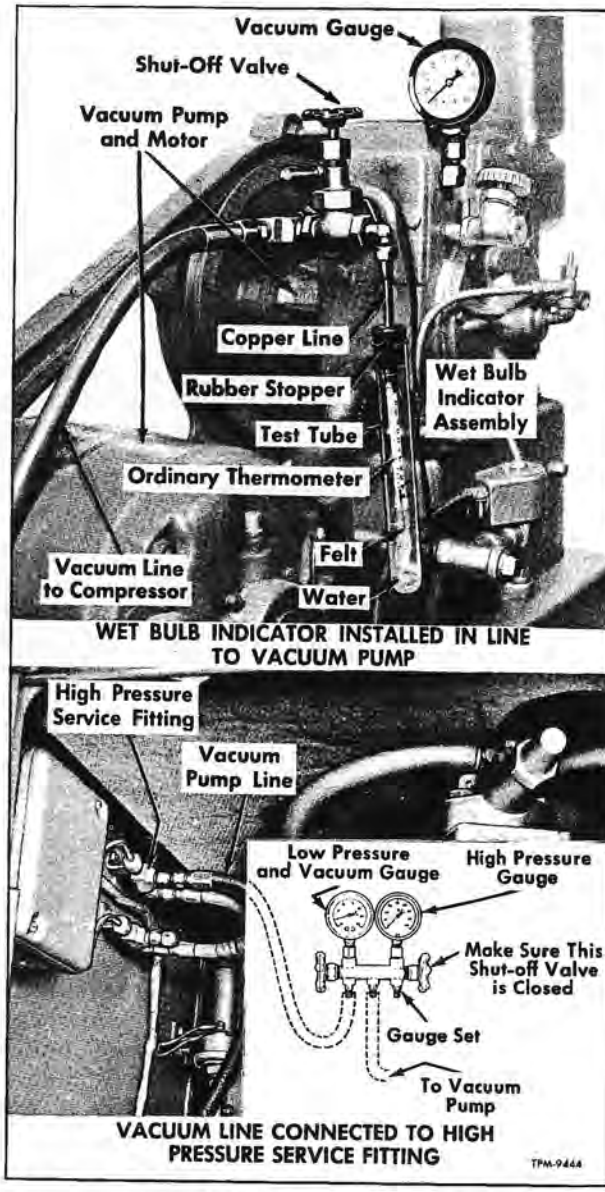


Figure 126—Evacuating the System

IMPORTANT: Before starting up vacuum pump make sure that seal and cap is tightened firmly over valve service fittings in compressor compartment that are not being used, otherwise outside air and moisture will be drawn into system. Figure 124 illustrates service fittings.

4. Operate vacuum pump to give maximum vacuum (28 in. min.) for at least two hours or until temperature reading on thermometer within pump indicator registers $35^{\circ}F$.

IMPORTANT: Open branch line-to-indicator valve only to read indicator. Otherwise keep valve closed during evacuating period.

5. Close the valve at the low pressure side of gauge set. Disconnect vacuum pump from center fitting of gauge set.

SYSTEM SERVICES AND TESTS

NOTE: Refrigerant supply tank (tipped upside down) can be immediately connected to center fitting of gauge set and several pounds of liquid refrigerant will be drawn into system when tank and low pressure gauge shut-off valve are opened.

IMPORTANT: Supply tank connecting hose must be purged before gauge valve is opened.

6. Complete the charging of system as directed previously under "Charging The System."

PUMPING DOWN THE SYSTEM

In order to accomplish any operations on the system which necessitate disconnecting refrigerant lines, it is necessary to first pump down the system to prevent appreciable loss of refrigerant. To pump down the system means to pump most of the refrigerant into the liquid receiver tank.

1. Install a test manifold with compound and high pressure test gauges in the compressor gauge ports.
2. Close the outlet valve on the receiver tank.
3. Connect a jumper wire across the low pressure switch points.
4. Operate the compressor until the compound pressure gauge registers zero.
5. After about thirty (30) seconds, if pressure on compound gauge rises above 10 psi, repeat step No. 4, as required, until pressure does not exceed 2 or 3 psi.
6. Close receiver tank and compressor inlet valves by turning clockwise to full "OFF" position.
7. Do not close or back seat compressor outlet valve. High pressure test gauge connected to this valve is reading actual pressure of refrigerant in compressor, condenser and lines leading to and from condenser. This refrigerant cannot be pumped down but must be released before opening the system.
8. Remove center hose from the test manifold and open valve on high pressure side of manifold. This will allow remaining refrigerant in the condenser and lines to escape to atmosphere. NOTE: This refrigerant can be saved by returning it to a cooled empty supply tank.
9. When indicator on high pressure gauge drops to zero, refrigerant lines on either low or high side may be safely removed. The only unit now containing refrigerant is the liquid receiver tank.

IMPORTANT: Immediately plug line opening or connection after opening.

CHECKING FOR AIR IN SYSTEM

Air in refrigerating system causes excessive head pressures and reduction in cooling capacity. Check for air in system as follows:

1. Connect an accurate pressure gauge to high pressure test gauge fitting.
2. Hang an accurate thermometer near condenser coil and one near receiver tank.
3. Allow compressor to stand idle for several hours to allow temperatures of all parts to equalize, then note readings on both thermometers and reading on gauge.
4. Take an average of the two thermometers and compare this figure with figures shown in pressure-temperature chart on page 423 in this manual. If pressure gauge shows a reading of more than 3 pounds higher than pressure shown on chart for the existing temperature, air must be purged from system.

PURGING AIR FROM SYSTEM

Whenever system has been pumped down or evacuated and system has been opened, or if operating difficulties indicate air in the system, purge air from system after all parts of system reach the same temperatures as follows:

1. Place refrigerant valves in "Operating Position" to admit refrigerant to entire system.
2. To purge air from liquid receiver tank, loosen fusible safety plug in top of receiver tank. Tighten plug after a small amount of refrigerant gas has escaped.
3. To purge evaporator, loosen external equalizer tube fitting at expansion valve, permit a small amount of gas to escape, then tighten fitting.
4. If a large amount of air is indicated, it may be necessary to pump the refrigerant into a refrigerant tank and purge the air from the tank. To accomplish this, connect line from refrigerant tank to high pressure test gauge (upper) fitting which connects to "HI-LO" pressure switch. While cooling refrigerant tank with cold water or ice, run compressor to pump the refrigerant into the tank. Continue to run compressor until low pressure switch stops it. As soon as compressor stops, close valve at refrigerant tank. Let tank stand for several hours, bleed air off top of tank, then transfer the refrigerant back into the system as directed previously under "Charging The System."

SUPERHEAT CHECK

Instructions for checking superheat are explained previously under "Expansion Valve" in "SYSTEM MAINTENANCE" section of this group.

TESTING FOR REFRIGERANT LEAKS

Whenever repairs or adjustments have been made to any part of the refrigerating system which necessitate disconnecting refrigerant lines, connections should be tested for leakage before the system is restored to service. First admit only enough gas into the system to produce 5 or 10 pounds pressure, then test for leaks (fig. 127 using leak detector explained below. If no leak are found at this pressure, increase pressure 5 or 10 pounds, and test for leaks again. In this way, only a slight amount of refrigerant gas will be lost in the event there is a leak. Final test should be made with system under operating pressure. Large leaks will be indicated by oil seepage and must be repaired immediately.

REFRIGERANT LEAK DETECTOR

Refrigerant leak detector, commonly called a Halide Lamp, is a small torch which burns methyl alcohol. Air used in burner is drawn through a flexible sampling tube. Operation of leak detector is as follows:

Pressure is produced in the lamp fuel tank by heat of generation at time alcohol is burned in small cup under burner. Observe color of flame when clear air is being drawn through the sampling tube. Color of flame may vary depending on type and grade of alcohol used in burner.

By holding open end of sampling tube UNDER connections, joints, valves, etc. (fig. 127), any traces of refrigerant would be drawn through the tube to the burner and would be immediately evident by the change in color of the flame. Refrigerant breaks down when coming in contact with the heated copper ring in burner and changes the color of the flame. Do not confuse change in color with change caused by shutting off air supply in holding end of sampling tube too close to some object.

NOTE: Compressor crankshaft seal can be checked for leakage by inserting end of detector tube into hole at bottom of clutch housing when compressor is not operating.

> Instructions are supplied with leak detector and should be carefully studied before using.

Leak detectors which burn acetylene gas are also available and may be used.

When refrigerant has been lost, adding refrigerant without knowing cause or location of leak merely postpones corrective measures and increases maintenance costs. At two or three week intervals, go over entire system with leak detector. Check for leaks at all joints and connections throughout the system.

REPLACING DEHYDRATOR—STRAINER

1. Pump down the system as explained previously.

2. Referring to figure 128, remove old unit in manner shown. CAUTION: Do not twist refrigerant lines; use two wrenches as shown.

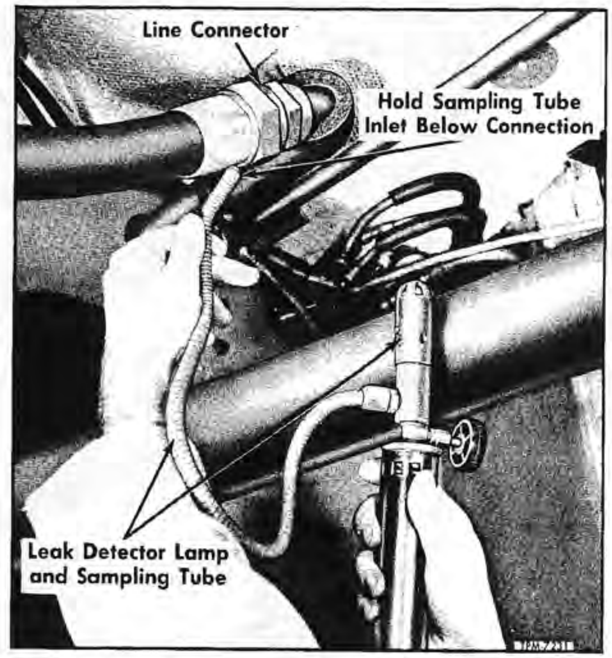


Figure 127—Testing for Refrigerant Leaks

3. Remove old unit from refrigerant line, then remove sealing caps from new unit and IMMEDIATELY thread unit into liquid line. Tighten connections firmly.

4. Open liquid receiver valves and compressor valves before placing the unit in operation. With system operating, test for leaks at connections, using a Halide Torch. Refer to "Testing For Leaks" explained previously.

REFRIGERANT VALVES

Before operating air conditioning system after storage or inactive period and during operation of

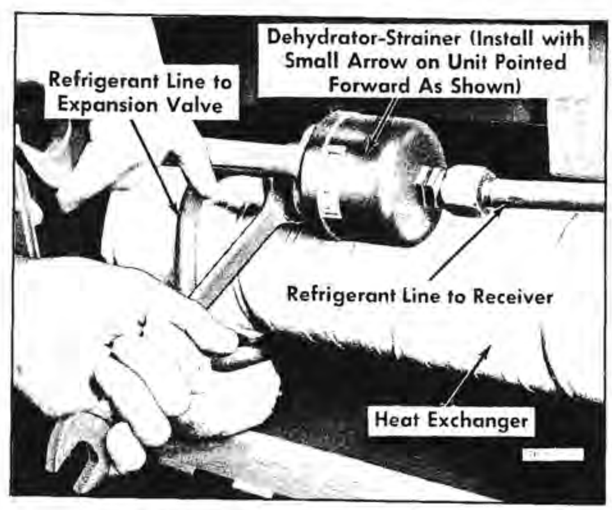


Figure 128—Replacing Dehydrator-Strainer

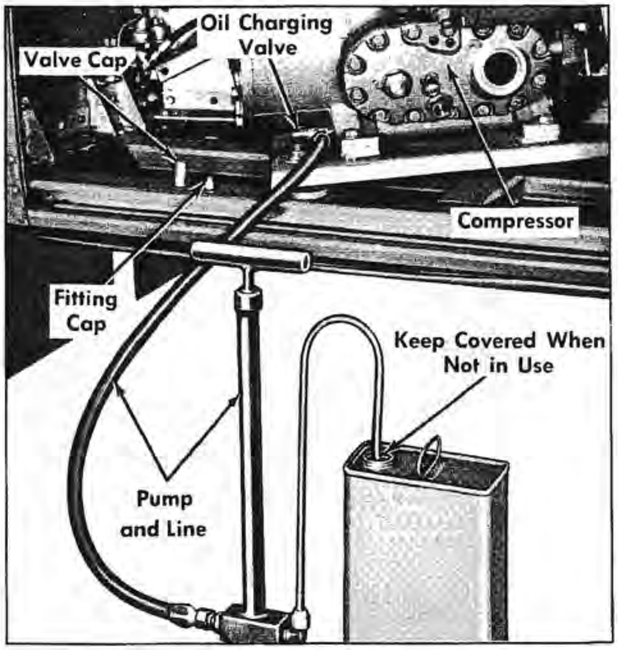


Figure 129—Adding Oil to Compressor (Typical)

system, refrigerant valves must be in "Operating Position." When system has been pumped down and is being prepared for operation, open valves in the following sequence:

1. Receiver Tank Liquid Out Valve - Fully Open. Stem turned counterclockwise.
2. Compressor Suction Valve - Fully Open (Back Seated).
3. Compressor Discharge Valve - Fully Open (Back Seated).
4. Receiver Tank Inlet Valve - Fully Open.

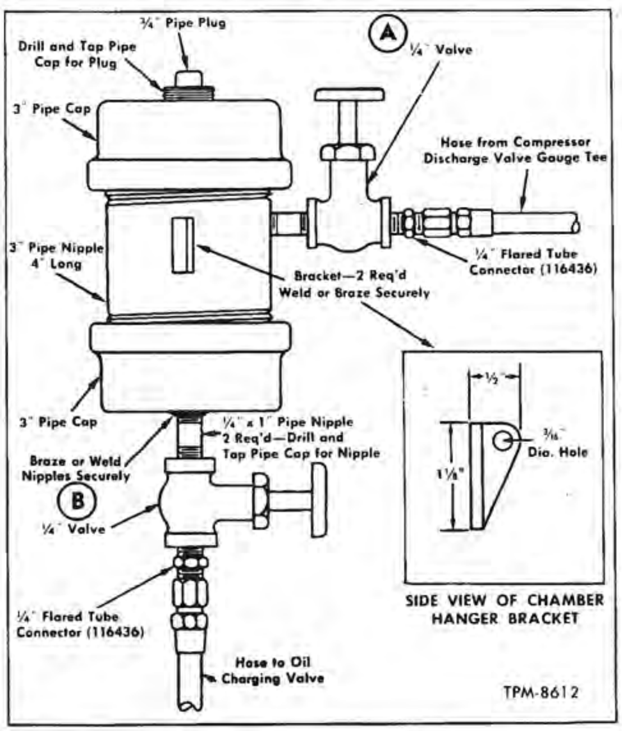


Figure 130—Fabricated Chamber for Adding Oil to Compressor

SERVICING COMPRESSOR OIL CHARGE

The initial charge of oil in the compressor is 14 pints. Oil level in compressor is observed through sight glass at side of compressor. Oil level should be checked immediately after system has been in operation at approximately 1500 engine rpm for 45 to 60 minutes. Level should be 1/3 to 1/2 way up on sight glass.

If oil is to be added, use special wax-free dehydrated refrigerant type oil having a viscosity equivalent to SAE 10. This oil is readily available through major oil companies. Oil should be obtained in sealed cans. Never use oil which has been exposed to air for any length of time.

ADDING OIL TO A CHARGED SYSTEM

Method Using Portable Hand Pump

NOTE: Compressor oil is added to compressor by means of a pump connected to valve at bottom of compressor as shown in figure 129. Pump can usually be obtained from local refrigerant sales and service dealer. Another known source is York-Detroit Contractors, 14385 Wyoming, Detroit, Michigan. Order by Part No. 70-10654.

With system leveled out (system operated for 45 to 60 minutes at approximately 1500 engine rpm) add oil as follows:

1. Stop compressor, then remove protector caps from valve stem and line fitting at bottom of compressor.
2. Connect pump supply line loosely to valve fitting. Fill reservoir of pump with recommended oil, then after all air bubbles have vanished, operate pump to purge air from line to compressor valve. Tighten connection at compressor valve.
3. Open compressor valve by turning stem counterclockwise.
4. Operate pump SLOWLY while checking oil level on compressor sight glass.

IMPORTANT: Keep pump reservoir near full at all times to prevent air from being pumped into system.

Add oil until level is 1/3 to 1/2 way up on sight glass. Close valve at base of compressor, then remove charging equipment.

5. Install protector caps over stem and line fitting of compressor valve.

Method Using Fabricated Oil Pressure Chamber

If a portable hand oil pump is not available, oil can be added with a pressure chamber as described below:

Figure 130 illustrates a chamber which can be fabricated locally using readily available parts. It is easy to visualize many other methods of constructing such a chamber, however, the general principles of the one shown in figure 130 should be followed.

Use chamber as follows:

1. Close both valves ("A" and "B," fig. 130) on oil chamber.

2. Fill the chamber with recommended oil. Hold chamber upright while filling. BE SURE CHAMBER IS COMPLETELY FILLED WITH OIL AND THAT NO AIR IS ENTRAPPED. Install filler plug and tighten firmly.

3. Connect a hose of sufficient length from upper valve (A," fig. 130) of oil chamber loosely to high pressure service fitting. Connect another hose from lower valve ("B," fig. 130) of oil chamber to oil charging valve at bottom of compressor.

NOTE: Before removing the cap from oil charging valve, make sure the valve is closed. Leave both hose connections loose at the oil chamber valves until air is purged from the hoses.

4. Tighten hose connection at high pressure service fitting and then at side of chamber after a slight amount of gas has escaped. Repeat this operation at the oil charging valve and hose. Leave the compressor oil charging valve in open position.

5. Start A/C system and operate until system has leveled out.

6. Open both shut-off valves ("A" and "B," fig. 130) on pressure chamber, then watch oil level in compressor sight glass. When oil level is 1/3 to 1/2 way up on compressor sight glass, quickly close chamber valves. Close the oil charging valve at compressor and disconnect line quickly from the high pressure service fitting.

7. Disconnect hose from compressor oil charging valve. Install caps over fittings.

DRAINING EXCESS OIL FROM COMPRESSOR

NOTE: Compressor should be operated for at least 1/2 hour before draining to allow separation of oil and refrigerant.

1. Remove protector caps from stem and line fitting of valve located at bottom of compressor.

2. Connect flexible hose to valve fitting, then open valve slowly by turning stem counterclockwise. Allow oil to flow into suitable container.

NOTE: Special care should be taken when removing oil because of oil foaming. The foaming makes it difficult to determine the amount of oil being removed. Recheck compressor oil level. Close the valve and install protector caps after draining.

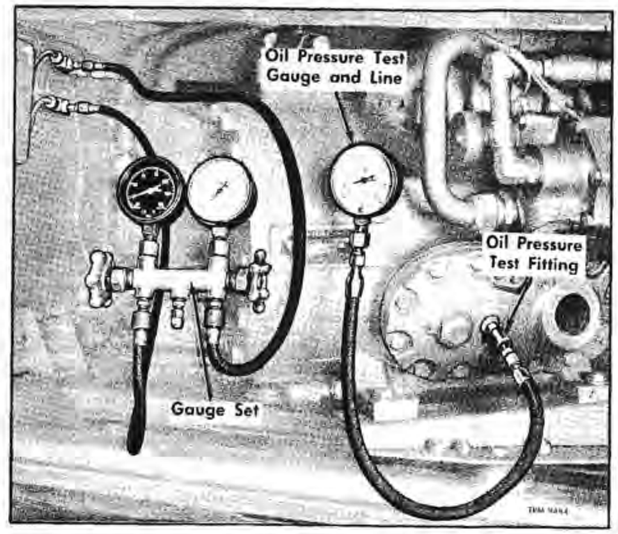


Figure 131—Checking Compressor Oil Pump Pressure

CHECKING COMPRESSOR OIL PRESSURE

To assure proper operation of the compressor unloading mechanism the compressor oil pump must supply the proper oil pressure. The compressor oil pump pressure check is made by subtracting the refrigerant suction pressure reading from the pump pressure reading. The minimum oil pressure reading allowable on pump gauge is 30 psi at 700 rpm engine speed.

Make Check as Follows:

1. Connect refrigerant pressure gauge set to low pressure service fitting (fig. 131). See figure 124 which identifies fittings on the different models.

2. Pump down system, then at side of compressor remove plug and install oil pressure gauge and hose to compressor oil pressure gauge fitting as shown. Install test fitting part No. 2376095 in plug hole.

3. Start engine and operate system for 5 to 20 minutes, then check refrigerant suction pressure reading and the pump pressure reading while system is still operating. If refrigerant suction reading is 55 and the oil pump pressure reading is 85, subtract 55 from 85 which leaves 30 psi, the actual pump pressure. If oil pump pressure is below minimum specified, replace compressor pump. The unloading mechanism will fail to function properly unless sufficient oil pressure is available.

CHECKING COMPRESSOR UNLOADING PRESSURES

Two cylinders of compressor are permanently loaded and two unload individually in two-pound steps when refrigerant suction pressure lowers to

SYSTEM SERVICES AND TESTS

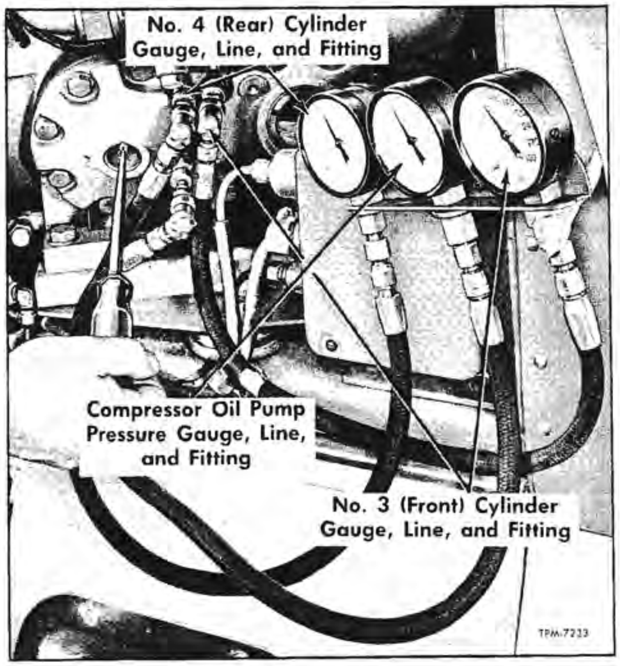


Figure 132—Checking Compressor Unloading Pressures

53 pounds. This function can be checked by observing suction pressure as follows:

1. Install test gauge low pressure line to low pressure test gauge service fitting (fig. 124).

2. Operate coach air conditioning system until reheat system is operating normally (approx. 75°F.)

3. With four cylinders loaded as engine speed is gradually increased, suction pressure should drop down to approximately 55 pounds, then fluctuate and raise to 58 pounds, indicating that No. 3 or front cylinder has unloaded.

4. As engine speed is increased further, suction pressure will lower to approximately 53 pounds and suction pressure will again raise rapidly as

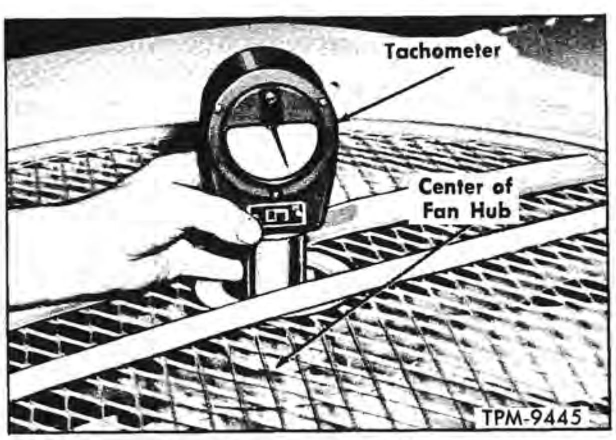


Figure 133—Checking Condenser Fan Speed

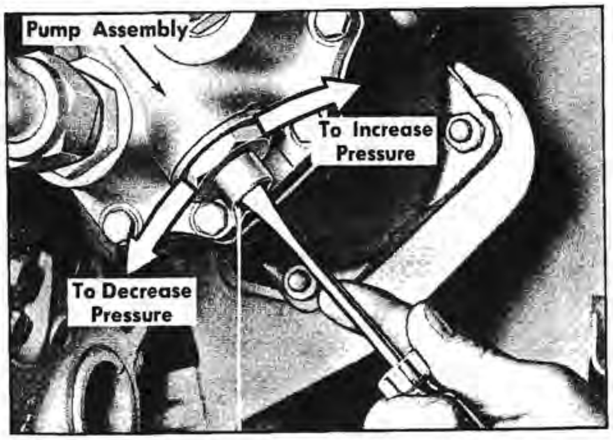


Figure 134—Adjusting Pump Pressure to Change Fan Speed

No. 4 or rear cylinder has unloaded. Further increase in engine speed will pull suction down. If unloading pressures are off, correction can be made by adjustment at valve located on compressor handhole cover. Make adjustment as follows:

a. Remove hex plug from over unloader adjustment screw as shown in figure 132.

b. Using screwdriver, turn screw out or counterclockwise to load up cylinders when they are running unloaded and lower suction pressure point at which cylinders unload. Thus, if all cylinders are loaded below 53 pounds suction, screw should be turned in to unload. If cylinders are unloading above 53 pounds suction, screw should be turned out to load. After making adjustment install hex plug over valve adjustment screw. Tighten plug firmly.

5. If difficulty is encountered in definitely observing unloading on suction gauge, individual gauges can be used to determine performance of each unloader without question. Figure 132 shows individual gauges installed. NOTE: If compressor is not already equipped with check valve connectors at compressor line ports, pump down system and install No. 2376095 check valve connectors. Connect gauge lines to connectors.

a. Right gauge is connected to No. 3 cylinder unloader which unloads first. Left gauge is connected to No. 4 cylinder unloader which unloads last. The center gauge registers the compressor oil pump pressure. Gauges will indicate suction pressure plus oil pressure when cylinders are loaded and suction pressure only when unloaded.

b. Remove two adjacent 1/8 inch pipe plugs at top center of crankcase cover to install gauge lines.

CONDENSER FAN SPEED CHECK AND ADJUSTMENT

1. Using a tachometer (fig. 133) check speed

of fan blade which should be 1800 - 25 rpm when oil in system is hot and engine is at fast idle.

2. If not within speed tolerance, remove hex-head plug at pump relief valve, then quickly turn adjustment screw in 3/4 turn for 100 rpm increase of fan speed, or turn screw out to decrease fan speed (fig. 134). NOTE: A small amount of oil will be lost.

3. After specified speed is obtained, install hex-head plug firmly. Check, and if necessary, add oil to system.

CONDENSER FAN DRIVE PUMP PRESSURE CHECK

If necessary, pressure output of pump can be checked as follows:

1. Refer to figure 135 which shows test gauge installed in the high pressure hose to the condenser fan motor.

2. Disconnect high pressure hose at pump and quickly install improvised tee arrangement into circuit as shown. Connect test gauge and line to tee fitting.

3. Fill fluid reservoir to "OIL LEVEL" mark, then start system and observe pump pressure with engine operating at fast idle. Gauge should register approximately 980 psi after system has been in operation for a minute or two. Check fan speed which should be 1800 plus or minus 25 rpm.

Pressure can be changed by regulating the pump flow control valve as mentioned previously under "Condenser Fan Speed Check and Adjustment" (fig. 234).

PROCEDURE FOR LOWERING COOLING CAPACITY

The following is the recommended procedure for adjusting the system to lower capacity requirements to reduce the air conditioning load on the engine.

1. Raising the compressor unloader settings will increase the evaporator coil temperature and decrease the head pressure, thus reducing the cooling capacity. Raise the operating pressures of the two compressor unloaders from standard settings of 55 pounds and 53 pounds to no higher than 70 pounds. Refer to "Checking Compressor Unloading Pressures" explained previously for method of changing settings.

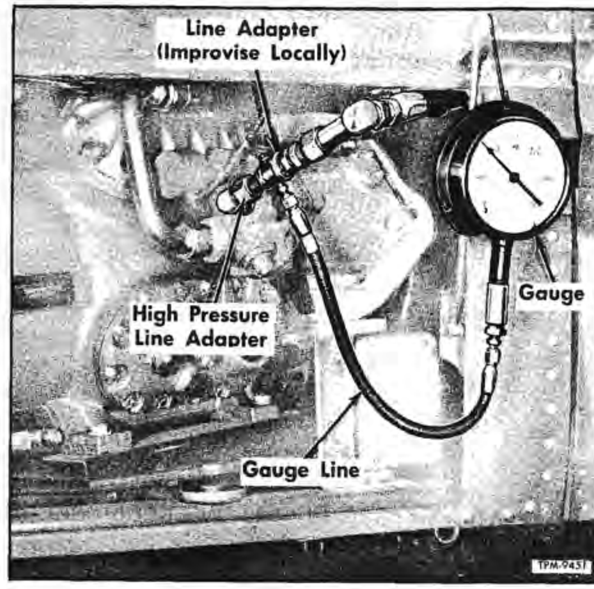


Figure 135—Checking Fan Drive Pump Pressure

CAUTION: Exercise extreme caution in setting up unloaders in high humidity areas as raising unloader settings will increase the evaporator coil temperature thereby reducing capacity.

2. The condenser fan speed may be reduced to less than the standard 1800 rpm setting, but no lower than 1300 rpm. Refer to "Condenser Fan Speed Check and Adjustment" explained previously for changing fan speed.

NOTE: For every 5 pounds increase in unloader setting, fan speed can be dropped 100 rpm to maintain operation at the original head pressure. To avoid stoppage on high head pressure, a margin of at least 30 pounds should be maintained between top operating pressure and the 375 pounds Hi-Lo switch cut-out settings.

Trouble Shooting

Most any trouble in the air conditioning system will produce the same symptoms - insufficient cooling.

The following, which is more of a quick reference chart, deals with locating and correcting the common causes of insufficient cooling.

NOTE: Detail trouble shooting information of a specific condition, the possible causes of a condition, its symptoms and the recommended action to be taken is shown later on "Trouble Analysis Chart" page 501.

IMPORTANT

THE MOST COMMON CAUSE OF INSUFFICIENT COOLING IS A DIRTY, CLOGGED CONDENSER COIL. THIS CONDITION SHOULD BE CHECKED FREQUENTLY AND CORRECTED AS EXPLAINED ON PAGE 490.

CONDITION	REMARK
1. Underfloor Blower Not Running	
(a) Loose Electrical Connections	Tighten
(b) Defective Relay	Replace - Page 412
(c) Defective Blower Motor	Repair
2. Dehydrator - Strainer Clogged	Replace - Page 495
3. Underfloor Air Filter Screen Clogged	Page 424
4. Compressor Valves Not in Operating Position	Page 495
5. Improper Engine Idle Speed	Page 409
6. Low Refrigerant	
(a) Leaks in System	Page 494
(b) Recharge System	Page 491
7. Expansion Valve Inoperative	
(a) Capillary Tube Broken	Page 420
(b) Equalizer Tube Restricted	Page 420
(c) Gummed Cage	Page 420
(d) Check for Proper Superheat	Page 420
(e) System Short of Capacity	See "Trouble Analysis Chart"
8. Compressor Clutch Disengages or Fails to Engage	
(a) Dirty Condenser	Page 490
(b) Loose or Broken Condenser Fan Pump Belts	Page 431
(c) Insufficient Fluid in Condenser Fan Drive System	Page 432
(d) Too Much Refrigerant	Page 493
(e) Air in Refrigerant System	Page 494
(f) Insufficient Air Pressure for Clutch Operation	Page 470
(g) Air Leaks in Clutch Operating System	Page 470
(h) Worn Clutch Plates	Replace - Page 473
(j) Refrigerant Valves Not in Operating Position	Page 495
(k) Dehydrator-Strainer Plugged	Replace - Page 420
(l) Defective Clutch Control Air Cylinder	Page 479
(m) Defective Clutch Control Air Solenoid Valve	Page 418
(n) Faulty Clutch Adjustment	Page 470
9. Compressor Clutch Disengages or Fails to Engage at High Outside Temperatures (Items a, b, c, and e above will cause this condition.)	

TROUBLE ANALYSIS CHART

This Trouble Analysis Chart is to supply information for trouble-shooting a specific condition, affected mostly by the operation of the refrigerant compressor. It also contains information on conditions affecting pressures within the refrigerant system.

CONDITIONS OR COMPLAINTS

NOTE: Reference note numbers listed under each specific condition or complaint refer to information on the possible causes, the symptoms, and also recommendations for making correction. See designated notes below:

Compressor Fails to Start
(See NOTES: 1, 2, 3, 4, 5, 6 and 7)

Compressor "Short Cycles"
(See NOTES: 8, 9, 10, 11, 12, 13, 14 and 15)

Compressor Loses Oil
(See NOTES: 14, 16, 17, 18, 19, 20 and 21)

Compressor is Noisy
(See NOTES: 16, 19, 22, 23, 24, 25 and 26)

Refrigerant Discharge Pressure Too High
(See NOTES: 12, 15, and 30)

Refrigerant Discharge Pressure Too Low
(See NOTES: 13, 31, and 32)

Refrigerant Suction Pressure Too High
(See NOTES: 25, 32, 33, 34, 35 and 36)

Refrigerant Suction Pressure Too Low
(See NOTES: 11, 13, 14, 37, 38, and 39)

System Short of Capacity
(See NOTES: 11, 14, 25, 27, 28, and 29)

NOTES

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 1	Frozen compressor due to locked or damaged mechanism.	Compressor is noisy or will not operate.	Overhaul compressor.	See page 455
NOTE 2	Broken or sheared compressor drive shaft.	Excessive noise at engine or compressor not operating.	Repair or properly connect drive shaft.	See page 472
NOTE 3	Clutch drive plate is worn or saturated with grease.	Slipping action. Odor or smoke in compartment.	Replace clutch plate. Check and adjust clutch control air cylinder push rod travel.	See pages 470
NOTE 4	Defective clutch control air cylinder or improper linkage adjustment.	Slipping action. Odor or smoke in compartment.	Check and adjust air cylinder push rod travel.	See page 470
NOTE 5	Insufficient air pressure for clutch operation.	Slipping clutch. Odor or smoke in compartment.	Build up at least 65 psi in air system. Check pressure to air cylinder.	See page 470
NOTE 6	Defective clutch control air solenoid valve.	Clutch fails to engage.	Check for open circuit to valve. Loose connections. Defective valve.	See page 418

TROUBLE ANALYSIS CHART (CONT'D)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 7	Open control circuit. a. Hi-Lo pressure switch defective. b. Engine oil pressure too high (over 15 psi). c. Engine idling too fast (above 600 rpm).	Open circuit to clutch solenoid valve.	Lower engine idling speed. Engine oil pressure must be below 15 psi. Oil may be cold. Check "HI-LO" pressure switch setting.	See page 409 See page 415
NOTE 8	Intermittent contact in electrical control circuit. Compressor valves not in operating position.	Compressor intermittently starts and stops.	Repair or replace faulty electrical control. Check for loose wiring connections. Open compressor valves.	See page 495
NOTE 9	Low pressure switch controller differential set to close.	Frequent starting and stopping.	Check Hi-Lo pressure switch setting.	See page 415
NOTE 10	High pressure switch controls differential too close.	Frequent starting and stopping.	Replace Hi-Lo pressure switch assembly.	See page 417
NOTE 11	Dirty or iced evaporator coil.	Reduced air flow: a. Dirty or clogged air filter screen. b. Underfloor blower inoperative. c. Plugged recirculating air ducts.	Clean air filter screen. Check recirculating ducts for obstructions. Check blower motor.	See page 424 See section 3
NOTE 12	Overcharge of refrigerant or noncondensible gas.	High discharge pressure	Remove excess refrigerant or purge system.	See page 493 See remark No. 7 later.
NOTE 13	Lack of refrigerant.	Too frequent starting and stopping on low pressure control switch.	Repair refrigerant leak and recharge system.	See remark No. 6 later.
NOTE 14	Clogged refrigerant dehydrator-strainer.	Suction pressure too low and frosting at strainer unit.	Replace dehydrator-strainer.	See page 495
NOTE 15	Faulty operation of refrigerant condensing system.	Compressor cuts off and on from high pressure switch. a. Condenser fan motor or pump inoperative. b. Condenser air inlet or exhaust grille obstructed. c. Condenser coil dirty.	Refer to "Condenser Fan Drive System Troubleshooting Chart." Remove obstruction. Clean coil.	See page 447 See page 490
NOTE 16	Insufficient oil.	Oil level too low.	Add proper amount of compressor oil.	See page 496

TROUBLE ANALYSIS CHART (CONT'D)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 17	Traps in hot gas and suction lines.	Oil level gradually drops.	Recheck lines for possible traps. Lines may have been repositioned when body repairs were made.	See remarks Nos. 1 and 5 later.
NOTE 18	Loose expansion valve remote bulb.	Excessive cold suction line.	Provide good contact between remote bulb and suction line.	See remark No. 2.
NOTE 19	Liquid flooding back to compressor.	Excessive cold suction line. Noisy compressor operation.	Readjust superheat setting and check remote bulb contact.	See remarks Nos. 2 and 4 later.
NOTE 20	Short cycling.	Frequent starting and stopping of compressor.	See items previously under "Compressor Short Cycling."	
NOTE 21	Compressor leaking oil.	Oil around base and low oil level on sight glass.	Repair oil leak and add proper refrigerant oil.	See page 496
NOTE 22	Loose compressor drive shaft.	Flange nuts loose.	Tighten bolt nuts.	See page 472
NOTE 23	Dry or scored compressor crankshaft seal.	Squeak or squeal when compressor is running.	Check oil level. Replace compressor seal.	See page 496
NOTE 24	Internal parts of compressor broken.	Noisy compressor.	Overhaul compressor.	See page 455
NOTE 25	Expansion valve stuck in open position.	Abnormal cold suction line. Compressor knocks.	Repair or replace expansion valve.	See remark No. 2 later.
NOTE 26	Compressor hold-down mountings loose.	Compressor vibrates excessively.	Tighten or replace mountings.	See page 455
NOTE 27	Flash gas in liquid line.	Expansion valve hisses.	Add refrigerant.	See remark No. 6 later.
NOTE 28	Excessive pressure drop in evaporation.	Superheat too high.	Check superheat and reset expansion valve.	See remark No. 4 later.
NOTE 29	Improper superheat adjustment.	Short cycling.	Adjust expansion valve.	See remark No. 4 later.
NOTE 30	Air or non-condensible gas in system.	Exceptionally hot condenser and excessive discharge pressure.	Purge system.	See remark No. 8 later.
NOTE 31	Broken or leaky discharge valves within compressor.	Suction pressure rises faster than 5 lbs. per minute after pressure shut-down.	Remove compressor head, examine valves and if necessary, replace.	See remark No. 9 later.

TROUBLE ANALYSIS CHART (CONT'D)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 32	Leaky relief valve in compressor.	Insufficient cooling.	Replace relief valve.	See page 465
NOTE 33	Excessive load on evaporator.	Insufficient cooling.	Check for leaks in evaporator compartment. Check air filter screen and blower motor.	
NOTE 34	Overfeeding of expansion valve.	Abnormally cold suction line. Liquid flooding back to compressor.	Check contact of expansion valve remote bulb in suction line well.	See remarks Nos. 4 and 5 later.
NOTE 35	Broken suction valves within compressor.	Noisy compressor.	Remove compressor head, examine valves and if necessary, replace.	See remark No. 9 later.
NOTE 36	Compressor worn.	Insufficient cooling.	Overhaul compressor.	See page 455
NOTE 37	Expansion valve power unit has lost charge.	No flow of refrigerant through valve.	Replace expansion valve assembly.	See remark No. 3 later.
NOTE 38	Obstructed expansion valve.	Loss of capacity.	Clean or replace expansion valve.	See page 420
NOTE 39	Too much pressure drop through evaporator coil.	Superheat too high.	Check for plugged external equalizer line at expansion valve.	See page 420

TROUBLE ANALYSIS CHART REMARKS

REMARK
NO. 1 - CLOGGED REFRIGERANT DEHYDRATOR-STRAINER (Refer to Fig. 15)

Occasionally the dehydrator-strainer in the liquid line may become clogged with foreign material in the system. When this happens, the liquid line leaving the strainer will feel cooler than the liquid entering. If it is badly clogged, some sweat or frost may appear at strainer outlet.

REMARK
NO. 2 - REFRIGERANT EXPANSION VALVE STUCK IN OPEN POSITION (Refer to Figs. 16, 18, and 19)

If the expansion valve is stuck in an open position, there will be an excessive amount of sweating on the suction line and compressor crankcase due to the large amount of liquid being passed into the suction line.

REMARK
NO. 3 - REFRIGERANT EXPANSION VALVE HAS LOST CHARGE (Refer to Figs. 16, 18, and 19)

The power element of expansion valve consists of the remote bulb, capillary tube and the diaphragm, which actuates the valve cage. If this power element is inoperative or has lost its charge, the valve will either maintain an almost closed position or may close completely. Test for an inoperative power element as follows:

a. Stop compressor.
b. Remove remote bulb from well in suction line at end of evaporator coil.
c. Carefully place remote bulb in container filled with ice water.
d. Start compressor.
e. Remove remote bulb from ice water and warm in hand. At the same time check suction line for rapid temperature change which indicates flood-through of liquid refrigerant. If refrigerant floods through valve, power unit is operating properly.

WARNING: Do not flood-back through suction line for too long a period as excessive liquid flood back could cause severe damage to compressor.

TROUBLE ANALYSIS CHART REMARKS (CONT'D)

REMARK
NO. 4 - REFRIGERANT EXPANSION VALVE IMPROPERLY ADJUSTED (Figs. 16, 18, and 19)

If the expansion valve is adjusted for too low a superheat, too much liquid will be passed into evaporator. The suction line will be normally cold and liquid may slug back to the compressor. If expansion valve is adjusted for too high a superheat, too little liquid will be passed to the evaporator and the suction line will be abnormally warm. Superheat must always be adjusted carefully using thermometer (fig. 19) and suction gauge.

REMARK
NO. 5 - REFRIGERANT EXPANSION VALVE IS OBSTRUCTED (Refer to Figs. 16 and 18)

Foreign material may obstruct the valve port. If the obstruction is small, the resulting operation will be a "hunting" condition which will cause a suction pressure variation of possibly 10 to 15 psi on suction pressure test gauge. If the obstruction is large and only a small trickle of liquid can pass, the compressor will short cycle. If the obstruction holds the valve open during shutdown, liquid will flood back to compressor. This causes liquid slugging to compressor at startup, which is definitely harmful. Compressor will knock when this occurs. An obstructed expansion valve is usually indicated by a partly warm evaporator and frosting at the evaporator inlet.

REMARK
NO. 6 - SHORTAGE OF REFRIGERANT

There should always be sufficient liquid in the receiver tank (1/2 way up on sight glass) to completely submerge the inlet to the liquid line pipe. If there is a shortage of refrigerant, the liquid level will fall below the inlet to the liquid line and a mixture of gas and liquid will pass into the liquid line. Bubbles will appear in the sight glass, the larger the bubbles the more severe the refrigerant shortage. Frequently there will be a hissing or whistle at the expansion valve. The coil and suction line will be relatively warm while the suction pressure will be low due to little or no liquid being supplied to the evaporator if the shortage is severe.

REMARK
NO. 7 - OVERCHARGE OF REFRIGERANT

An overcharge of refrigerant will cause high head pressure. Liquid will back up in the condenser and decrease the amount of surface available for condensing and as a result the head pressure will rise. In extreme cases, it may rise to a point where the high pressure cut-out switch will stop the compressor. This may result in compressor short cycling.

REMARK
NO. 8 - AIR IN SYSTEM, PURGING

If air or non-condensible gases are present in the system, they will usually tend to move toward and collect at the condenser. The head pressure will rise to a point above the pressure corresponding to the temperature at which the vapor is condensing. In extreme cases, the pressure may rise to a point where high pressure cut-out switch will stop the compressor.

To determine whether or not there is air in the system, the compressor must be allowed to stand idle long enough for the entire system to cool down to the temperature of the surrounding air. After the system has attained the same temperature as the surrounding air, the reading of the head pressure test gauge should not be more than 12 lbs. above the saturation pressure corresponding to the surrounding air temperature. See "Refrigerant, Pressure-Temperature Relationship" chart, page 423.

REMARK
NO. 9 - BROKEN VALVES IN COMPRESSOR

Broken suction valves or broken or leaky discharge valves within the compressor are generally indicated by the suction pressure rising rapidly as soon as the compressor is stopped. If the suction pressure rises faster than 5 lbs. per minute, it is an indication that the compressor discharge valves are not holding. Before the compressor is torn down, however, it should be determined that the pressure rise is not due to a leaky expansion valve.

Air Cond. Lubrication and Inspection

The following tabulation lists lubrication and service points, service required, and the recommended intervals at which these services should be accomplished. These services should be accomplished at more frequent intervals when system is operated under severe conditions such as extremely high temperatures. References in right-hand column refer to page numbers where service procedures are covered, or to Lubrication Notes below for recommended lubricant and proper application.

Item	Service Required	Daily	At Inspection	See Footnote	Refer to
Compressor	Check Oil Level - Add if Required	X			Page 496 (Note 1 below)
	Drain and Refill			(A)	--
	Check Tightness of Mounting Bolts		X		--
Compressor Suction and Discharge Valves	Check Tightness of Mounting Bolts and Valve Caps		X		--
Liquid Receiver Tank	Check Refrigerant Level	X			Page 492
	Check Tightness of Mounting Bolts		X		--
Condenser	Clean Coils as Necessary	X			Page 490
Condenser Fan Drive Pump Belts	Check Belt Tension		X		Page 431
Dehydrator Strainer	Replace Cartridge			(B)	Page 496
Underfloor Air Filter Screens	Clean and Re-oil		X		(Note 2 below)
Evaporator Coil	Clean		X		Page 424
Hi-Lo Pressure Switch	Check Adjustment		X		Page 415
Driver's Control Panel	Tighten Connections		X		--
Condenser Fan Fluid Drive	Check Oil Level - Add if Required		X		Page 489 (Note 3 below)
Compressor Drive Propeller Shaft	Lubricate with Hand Gun		X		(Note 4 below)

(A) After initial 200 hours of operation.   (B) Whenever system has been opened.

NOTE 1—COMPRESSOR OIL

A special wax-free dehydrated refrigerant type oil having a viscosity about the equivalent of S.A.E. 10 must be used. This oil is readily available through major oil companies. Approved oils are: Texaco Capella D; Ansul 300 non-foaming; Std. Oil of Calif., Caloil 13W. Oil should be obtained in sealed cans. Never use bulk oil or oil which has been exposed to air for any length of time. Drain and refill after first 200 hours of operation. After this change only at overhauls. The compressor capacity is 14 pints.

NOTE 2—ODORLESS OIL

Air Filter Screens. Thoroughly clean filter screens, then spray, or dip and let drain, with light odorless oil, such as medicinal white oil.

NOTE 3—HYDRAULIC FLUID

Condenser Fan Drive System. Use Type "A" Automatic Transmission Fluid bearing the qualification letters "AQ-ATF." System capacity is 5 quarts. IMPORTANT: Keep fluid container covered while not in use.

NOTE 4—GEAR OIL

Compressor Drive Shaft Universal Joints. Apply small quantity of gear oil (S.A.E. 140) to three fittings (fig. 98) at coach regular lubrication intervals.

Equipment and Materials

The following equipment and materials are required for servicing the Air Conditioning System. This equipment and material can be procured locally or from any reliable air conditioning or refrigeration supply house.

EQUIPMENT

Thermometer with Remote Reading Dial - For use in conjunction with expansion valve adjustment.

Soldering Torch and Cylinder of Gas - For soldering refrigerant line fittings.

Oil Pressure Gauge - For checking compressor oil pump pressure.

Leak Detector - For detecting refrigerant leaks.

Vacuum Pump and Gauge - For evacuating the system. Should be capable of pulling 28 to 29 inches of mercury vacuum.

Test Gauge Fitting Hose Adapters - For adapting service refrigerant hoses to gauge fittings (J-9459 Adapter and J-12148 Adapter Gasket).

Wet Bulb Indicator - For checking amount of air and moisture in system while evacuating system.

Hand Oil Pump - For adding oil to a charged system.

Pressure and Vacuum Gauge Set - For checking Refrigerant-22 system operation.

- With combination vacuum air pressure gauge
  - 0 to 30" vacuum scale.
  - 0 to 150 lbs. pressure scale.
- With high pressure gauge - 0 to 400 lbs. scale.

MATERIALS

Anhydrous Methyl Alcohol - For use in leak detector.

Refrigerant 22 - Monochlorodifluoromethane. Do not use any other type of refrigerant in this system. (Approximately 60 lbs. required in system, available in 22 lb. cans.)

Solder - 95% tin and 5% antimony - For soldering refrigerant line fittings.

Nokorode Soldering Paste - For use on soldered fittings.

Specifications

AIR CONDITIONING REFRIGERANT CONTROL SPECIFICATIONS

COMPRESSOR

Make	Trane
Model	3B-5C40
Trane Part No.	Com-143
GM Part No.	2386650
Rated Capacity at 2000 RPM	
Maximum Head Pressure	425 psi (gauge)
Suction Pressure	10-45 psi (gauge)
Initial Oil Charge	14 pts.

EXPANSION VALVE

Make	Alco Valve Co.
Adjustment	External
Setting	8° - 14° Superheat

DEHYDRATOR-STRAINER

Type	Disposal

HI-LO PRESSURE CUT-OUT SWITCH

GM Part No.	2391762
Make	Penn. Electric Switch Co.
Type	1277MP12
Model	1502
High Pressure Switch	
Opens at	375 psi (gauge)
Closes at	175 psi (gauge)
Low Pressure Switch	
Opens at	10 psi (gauge)
Closes at	30 psi (gauge)

AIR CONDITIONING MISCELLANEOUS SPECIFICATIONS

CONDENSER FAN DRIVE

System Hydraulic Fluid Capacity (Approx.)	5 qts.
Fan Motor Speed (At 1650 Engine RPM - With Hot Oil)	1775 to 1825 rpm

Fluid Pump Assembly

GM Part No.	2392520
Make	Sundstrand Machine Tool Co.
Model No.	32PVS6LT-402-10

AIR CONDITIONING MISCELLANEOUS SPECIFICATIONS (CONT.)

CONDENSER FAN DRIVE (Cont'd.)

Fan Motor Assembly

GM Part No.	2372644
Make	Sundstrand Machine Tool Co.
Model No.	7MCSL-403-5
H.P. Rating	Approx. 3

Fluid Reservoir Assembly

GM Part No.	2372643
Make	Sundstrand Machine Tool Co.
Model No.	30RFS-100-1

AIR CONDITIONING CONTROL RELAY

Make	Delco-Remy
Stamped	1116899
Air Gap (With points closed)	0.014"
Point Opening	0.028"
Closing Voltage Range	8.5-10.5
Opening Voltage	4.3 min.

CLUTCH CONTROL AIR CYLINDER

GM Part No.	2452469
Make	Midland-Ross
Stamped	N-3858-A
Stroke	1.120"

COMPRESSOR DRIVE CLUTCH

Clutch Size	9-1/8"
Type	Single Plate, Dry Disc
Release Bearing Type	Sealed-Ball

AIR CONDITIONING ENGINE OIL PRESSURE SWITCH

Make	AC
Stamped	1509175
Contact Break Pressure	15 ± 2 psi

AIR CONDITIONING CLUTCH CONTROL AIR PRESSURE SWITCH

Make	AC
Stamped	1508844
Contact Closing Pressure	65 psi

ACCESSORY DRIVE GEAR RATIO

All 6V Engine Models	1.388 to 1
All 8V Engine Models	1.588 to 1

FAN PUMP SOLENOID AIR PRESSURE SWITCH

Make	AC
Stamped	1508920
Contact Opening Pressure	55 psi

REFRIGERANT COMPRESSOR WEAR RATE CHART

Part Name	Original Spec.	Recommended Limit	Maximum Recommended Oil Clearance
Main Bearings	1.8765 - 1.8775	1.8800	0.0055
Crank Shaft - Mains	1.8745 - 1.8750	1.8730	
Conrod - Crankpin (Vert.)	1.7522 - 1.7530	1.7560	0.0070
Crankshaft - Crankpin	1.7495 - 1.7500	1.7470	
Piston Pin	.7498 - .7500	0.7494	0.0011
Piston - Pin Bore	.7499 - .7502	0.7504	
Conrod - Pin Bore (Vert.)	.75005 - .7503	0.7505	
Cylinder Liner	2.5000 - 2.5005	2.5020	0.0035
Piston (Perpendicular to Centerline of Pin Bore)	2.4985 - 2.4990	2.4970	
Piston Rings (Gap in 2.500" Gauge)	.007 - .017	(.040 Compression Rings (.060 Oil Rings	

Valves (All) . . . . Valves are .028" - .030" thick - if not broken, valves should be replaced when seat groove wear depth exceeds .010". (.018" thinnest section).

Valve Springs (All) . . . . . Whenever compressor is disassembled for servicing, valve springs should be replaced where they have operated in excess of 3000 hours.

Special Tools

References are made to special tools in some sections of this manual. These tools, or their equivalent, are necessary and are recommended to readily and efficiently accomplish certain service operations. These tools, however, are not supplied by GMC Truck & Coach Division. Information regarding availability of these tools can be obtained from your GM Coach Service Representative or from the Factory. Following is a list of all special tools referred to throughout the manual with the exception of tools required to service the air conditioning system. These tools are listed at end of Section 26.

SECTION 2 - REAR AXLE

J-8176	Bearing Puller Set
J-3940	Bearing Cup Remover
J-4856	Differential Bearing Remover Plug

SECTION 3 - BODY

J-2189	Glass Seal and Insert Installer
80-0202	Heater Water Pump Remover

SECTION 4 - BRAKES

AIR BRAKES

CVT-8	Valve Reseating Tool (Expello Valve)
CVT-7	Valve Stem Service Fixture (Expello Valve)

ROTARY AIR COMPRESSOR

AL51	Bearing Guide Sleeve
AL52	Arbor (for replacing bearings)
AL53	Burnishing Bar
AL74	Spanner Wrench

SECTION 7 - ELECTRICAL

1568147	Electric Speedometer Test Light
J-6663	T-3 Headlight Safety Aimer

SECTION 14 - AIR SUSPENSION

J-6888	Valve Core Remover and Installer (Height Control Valve)
J-8424	Overtravel Control Shaft Remover and Installer (Height Control Valve)

SECTION 16 - STEERING

MECHANICAL STEERING

J-544-01	Spring Scale
J-489	Bearing Puller
J-21143	Pitman Arm Puller
J-3187-A	Side Cover Bearing Puller
J-2619	Slide Hammer (Use with J-3187-A)
J-5529	Pitman Shaft Bearing Remover and Installer
J-8176	Bearing Remover Plates

POWER STEERING

J-5631-01	Pressure Checking Gauge

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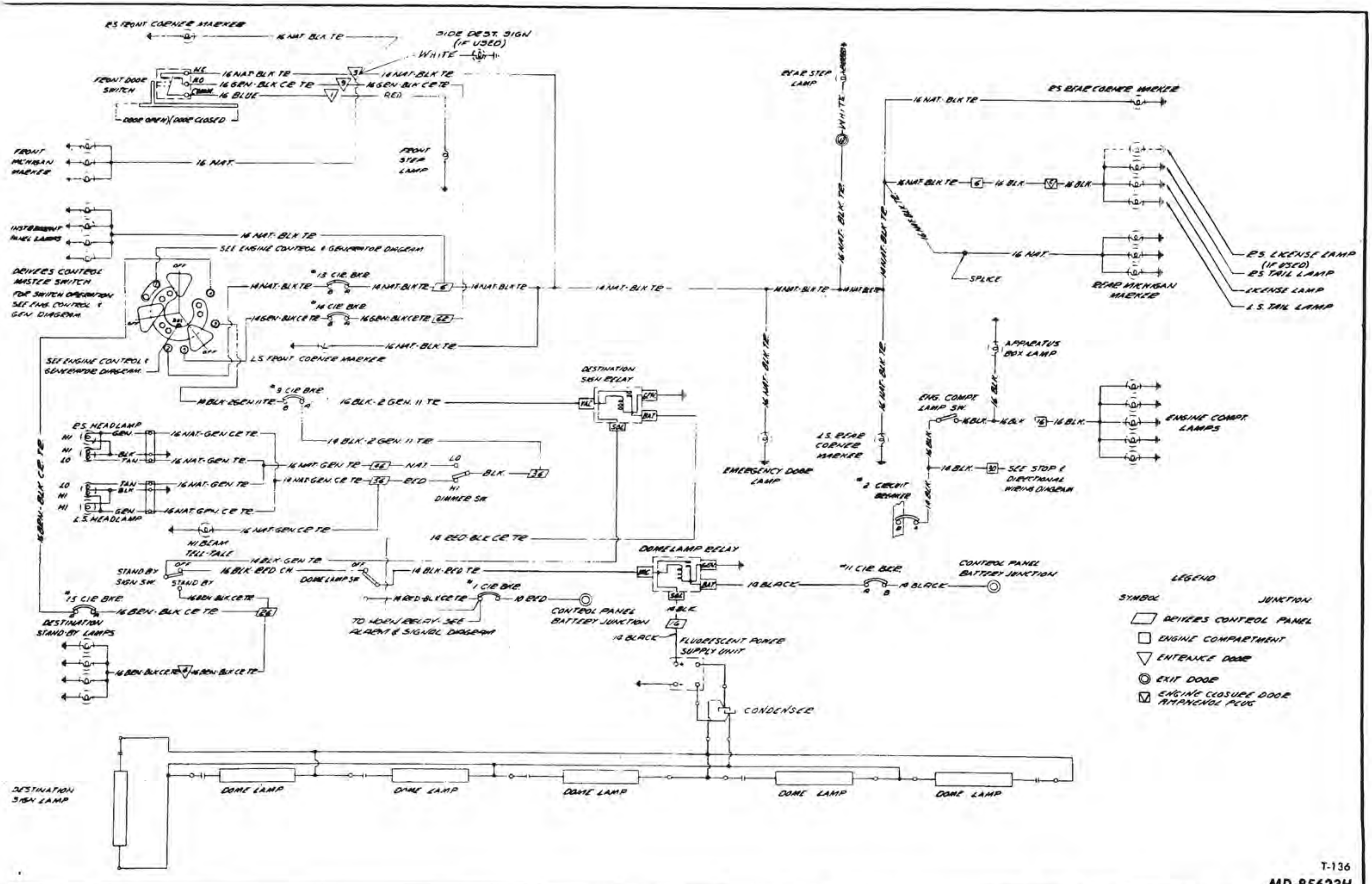
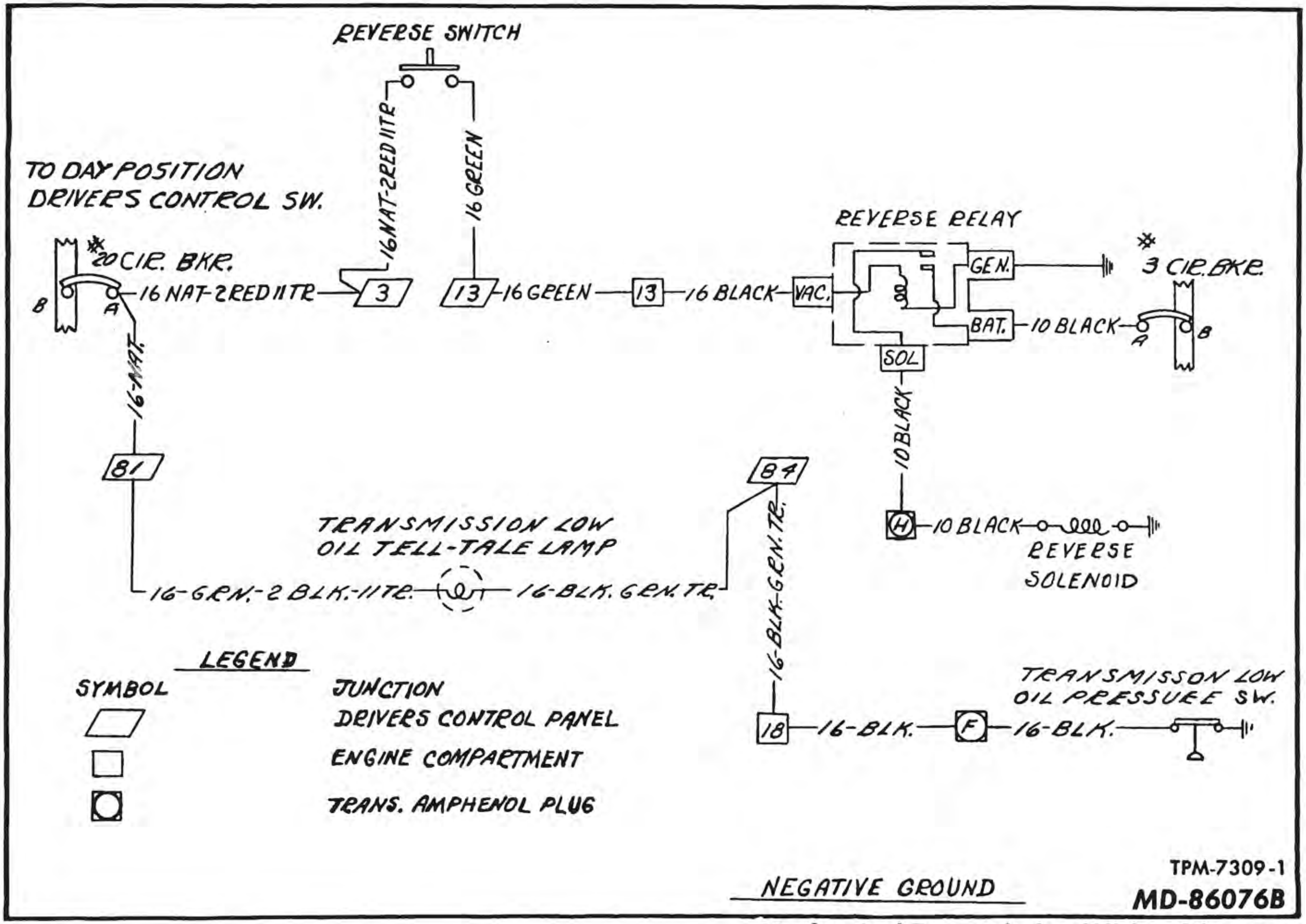
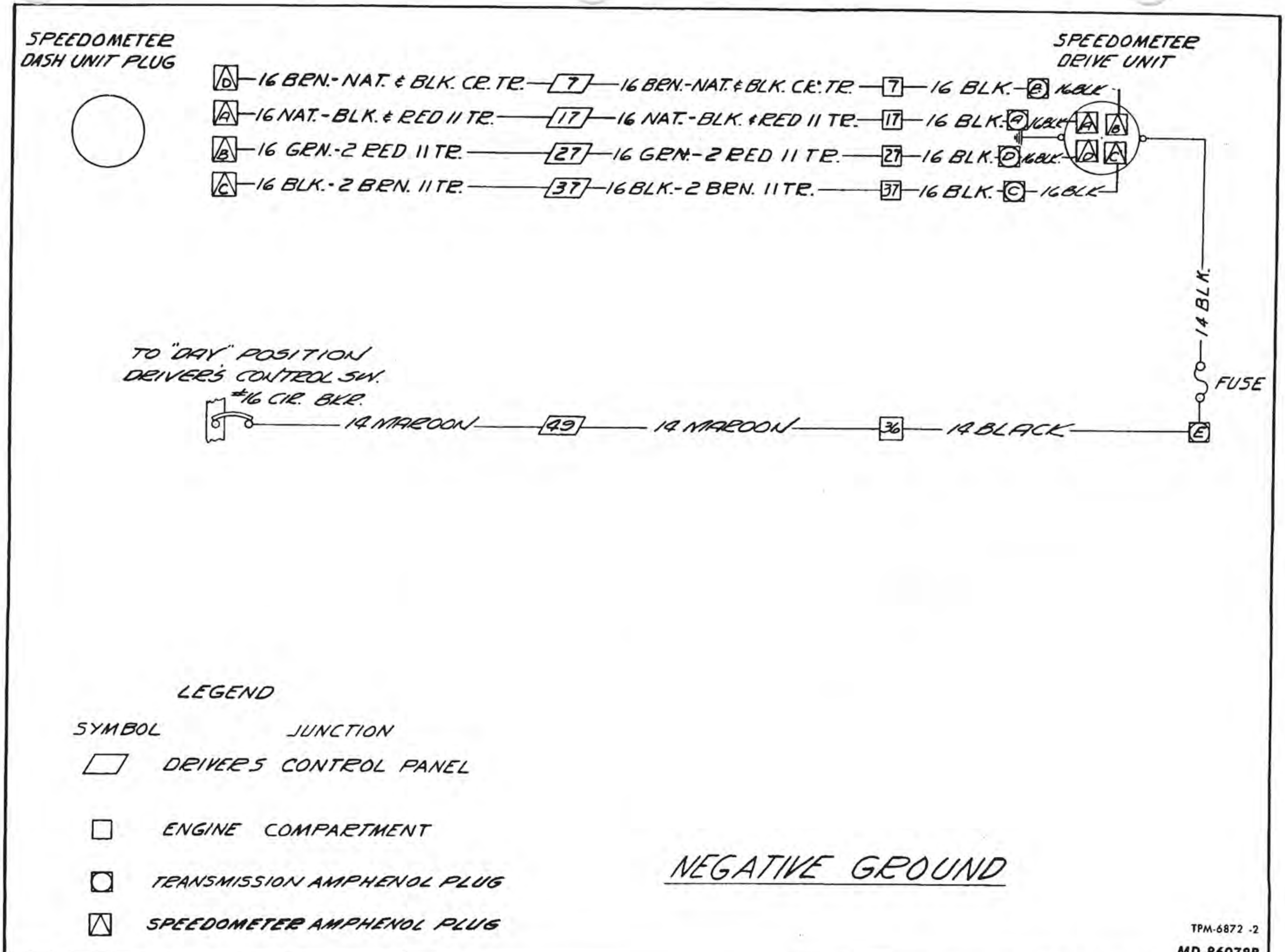


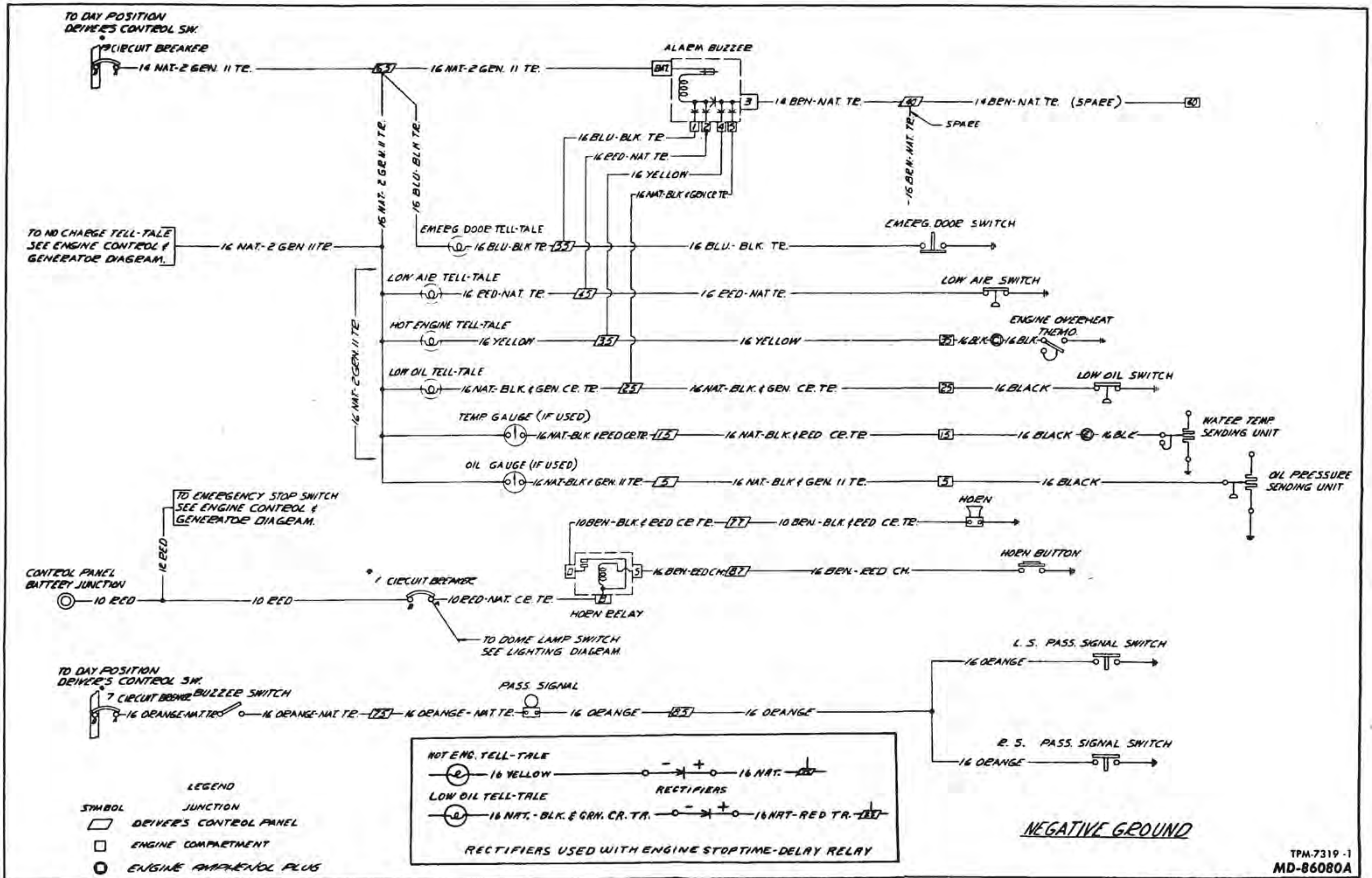
Lighting System Wiring Diagram—TDH and TDM



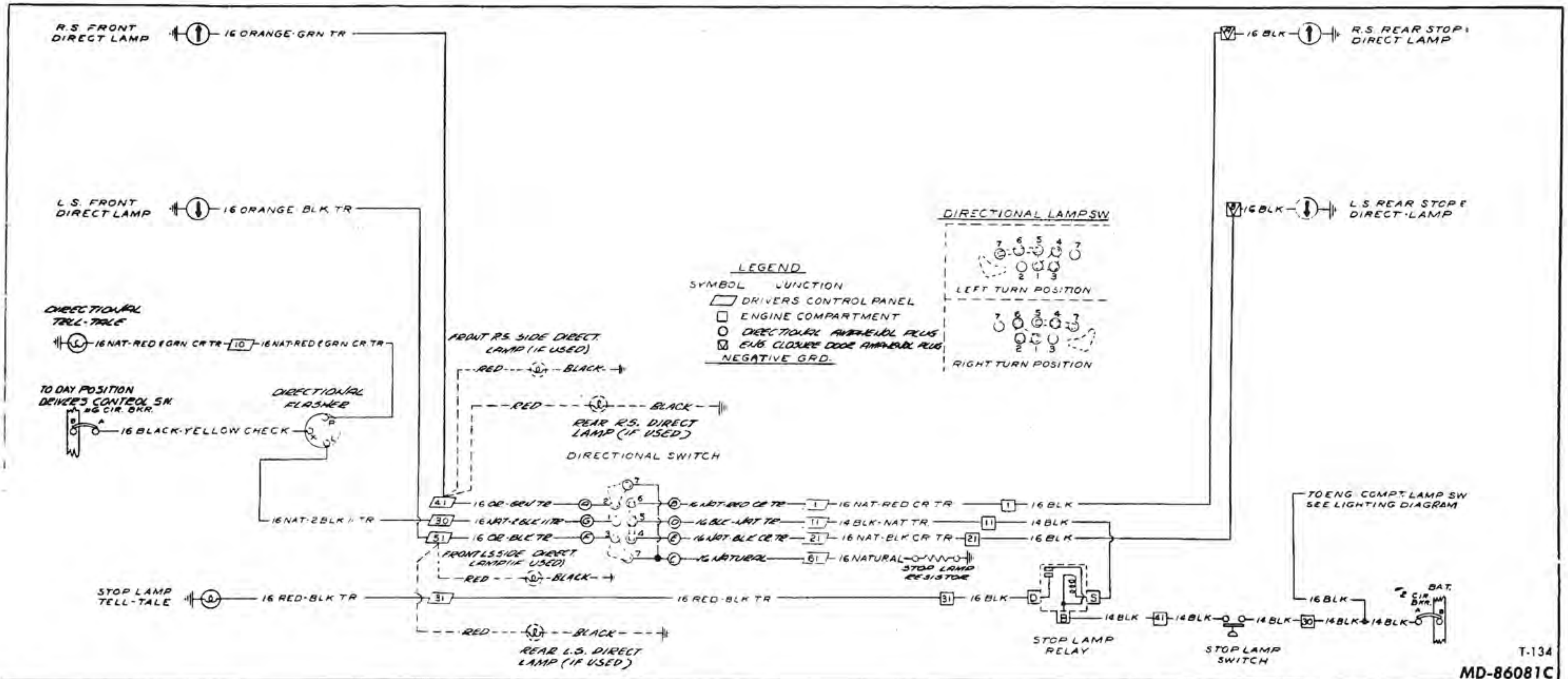
Mechanical Transmission Wiring Diagram



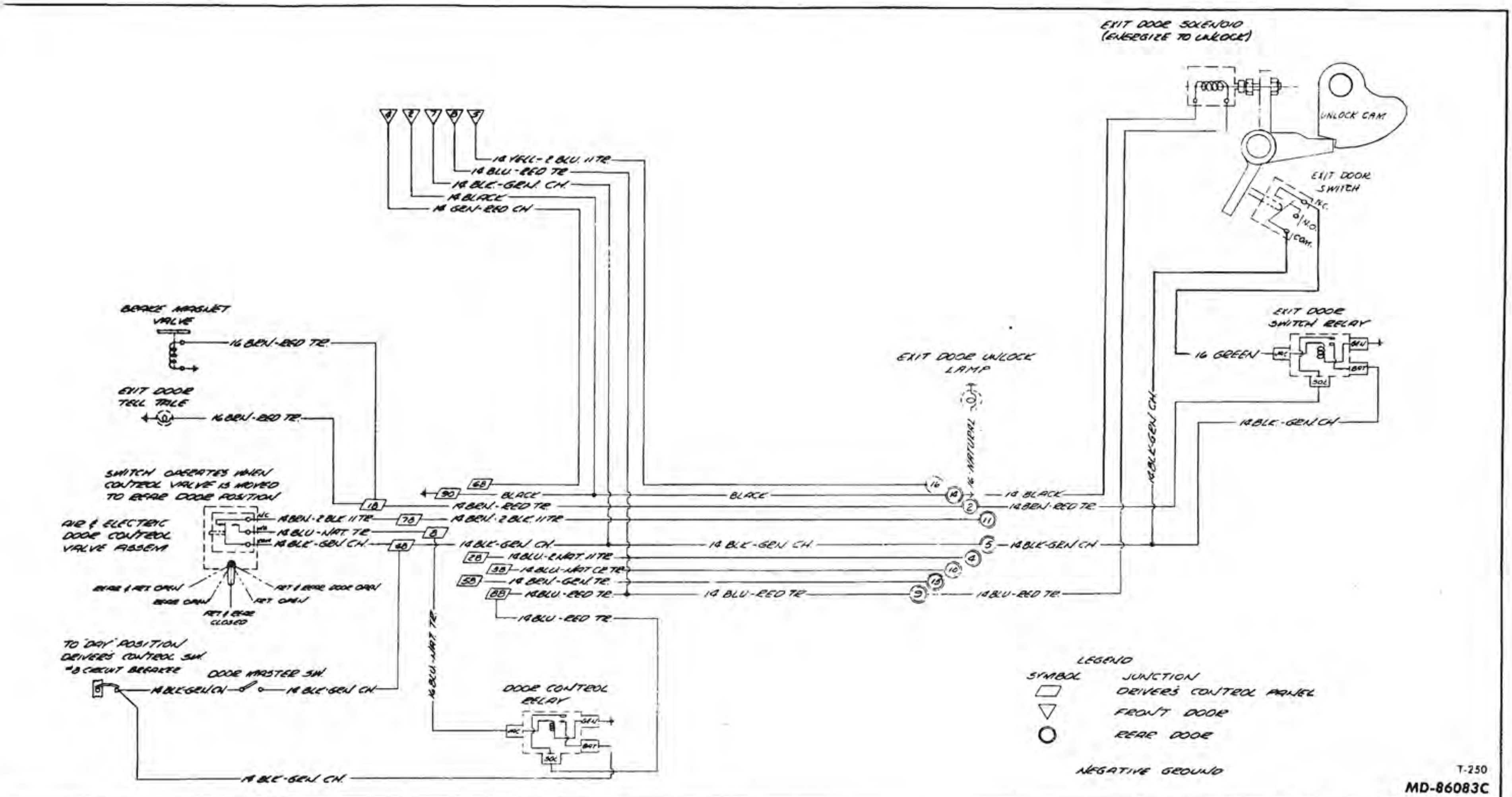
Speedometer Wiring Diagram



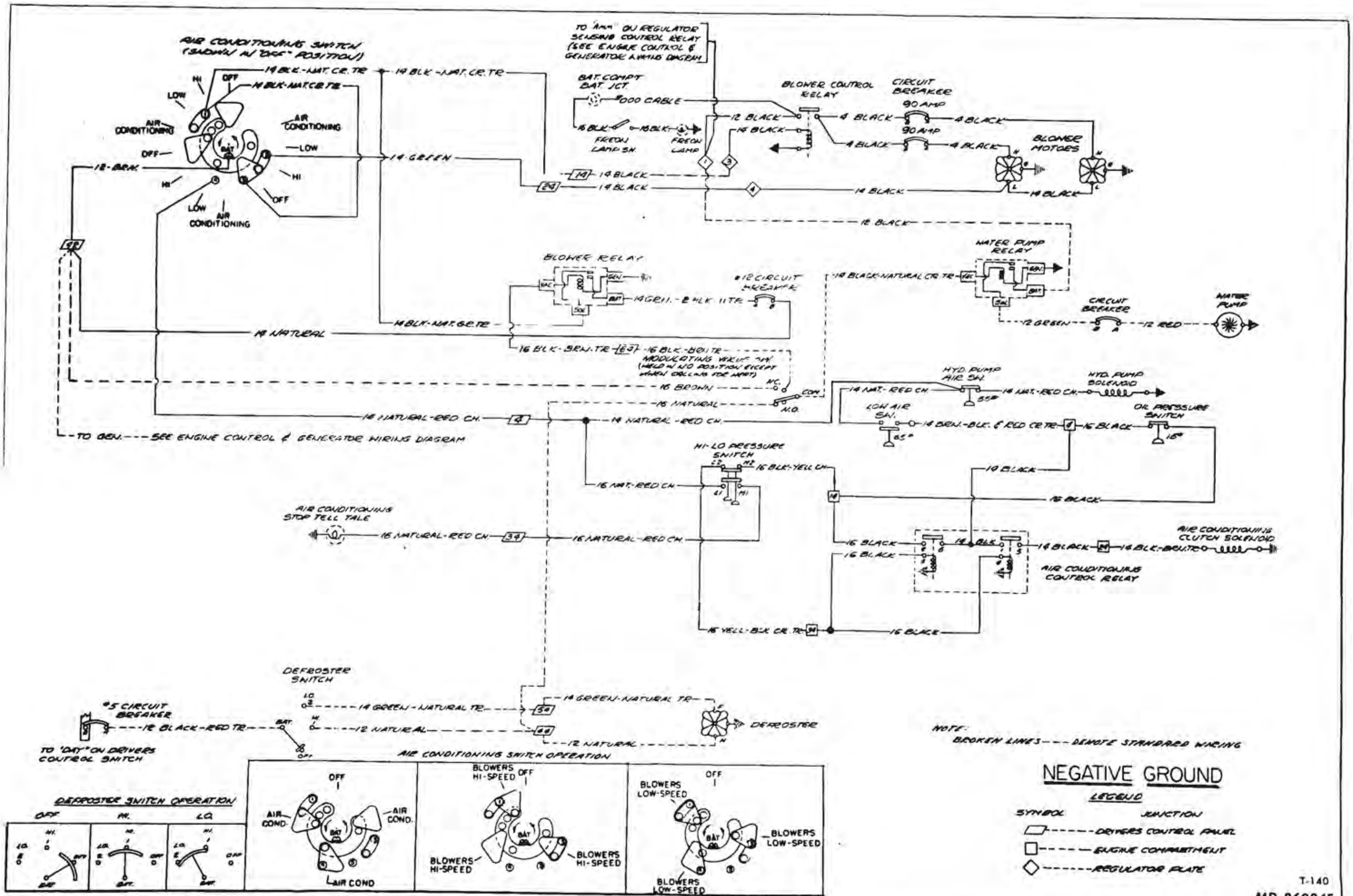
Alarm and Signal Wiring Diagram



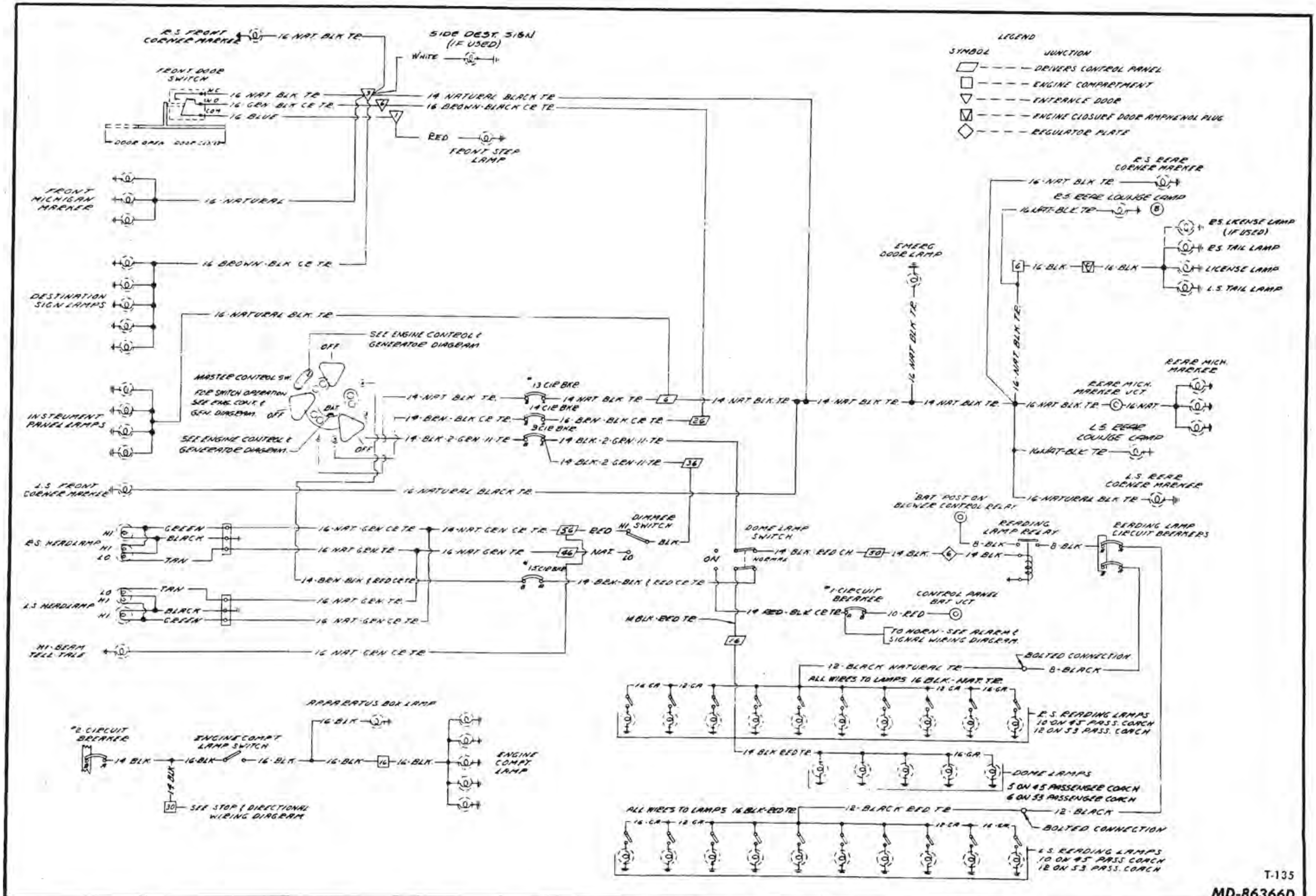
Stop and Directional Lamp Wiring Diagram—Standard



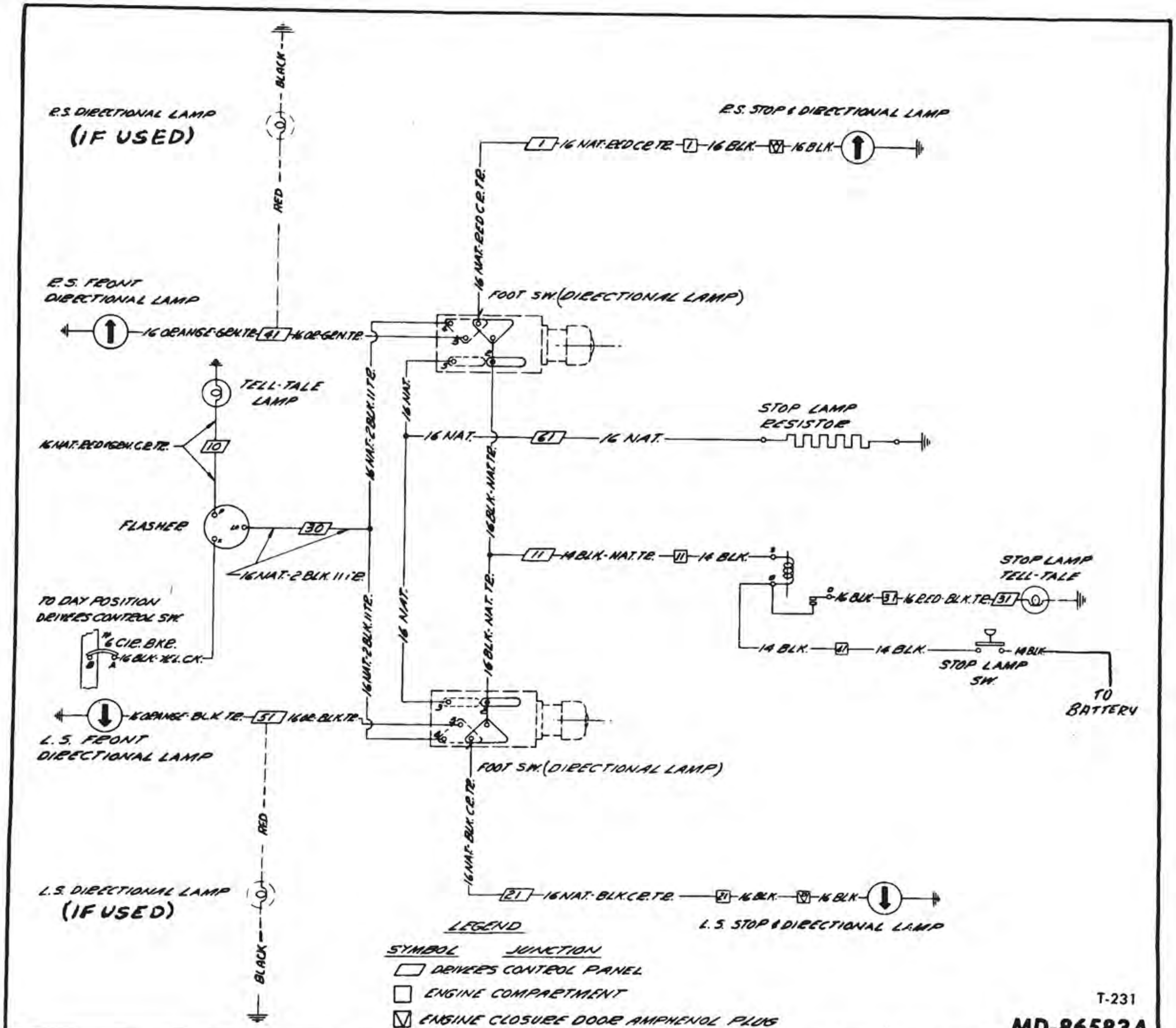
Door Control Wiring Diagram—Standard Equipment only



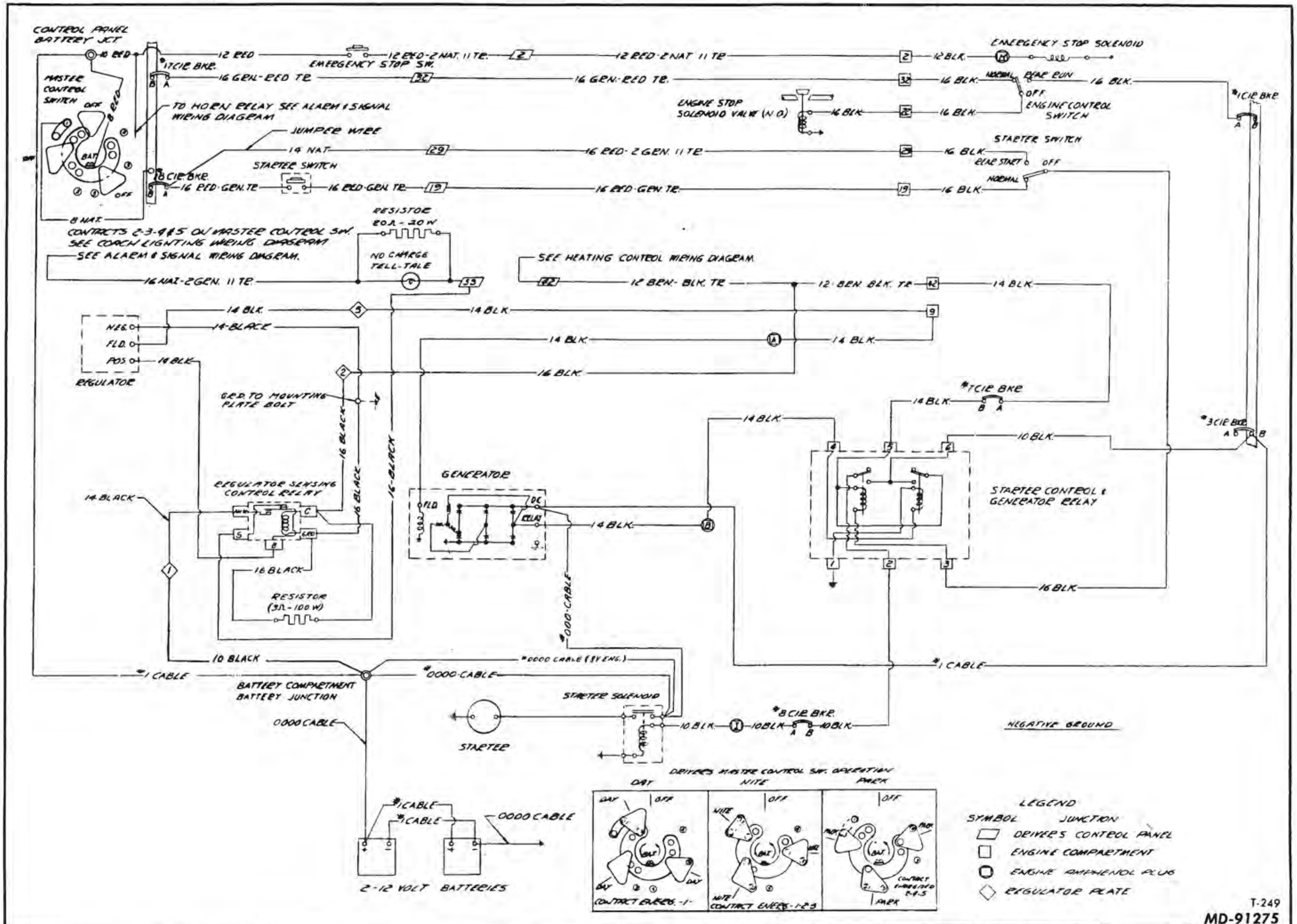
Air Conditioning Wiring Diagram —Early Models



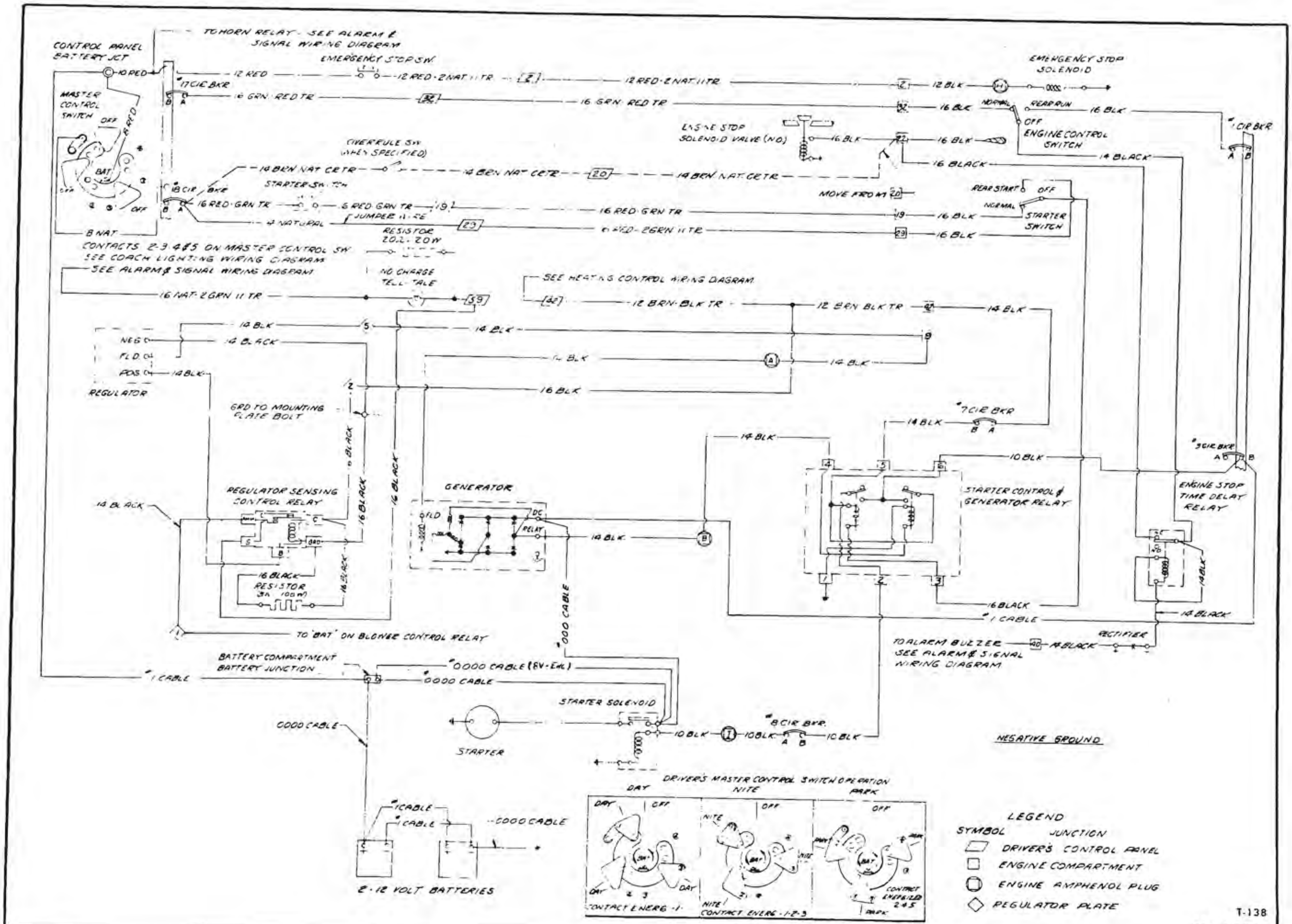
Lighting System Wiring Diagram — SDH and SDM



Foot-Operated Stop and Directional Signal Wiring Diagram



Standard Engine Control and Generator Wiring Diagram—TDM and SDM



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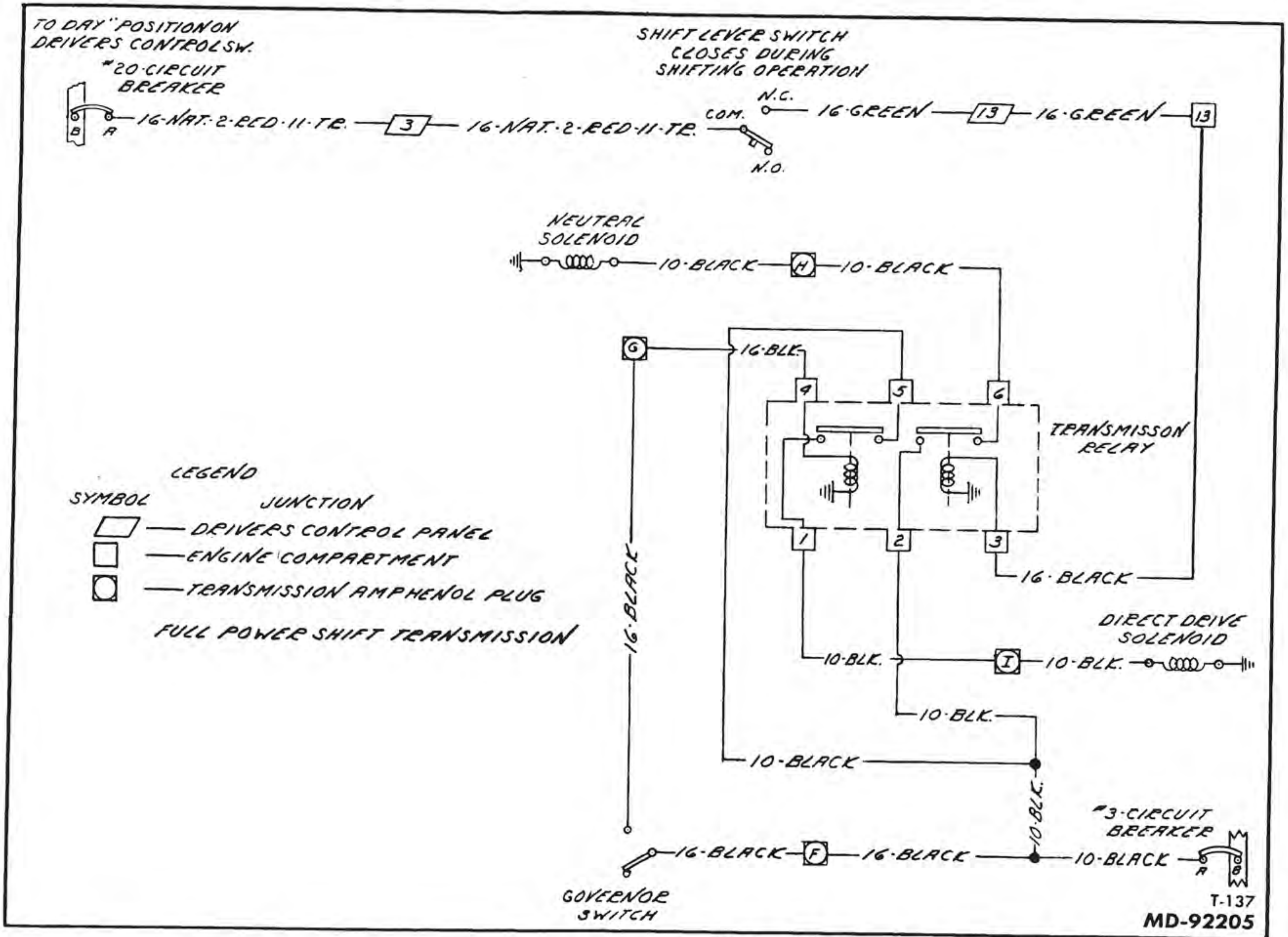
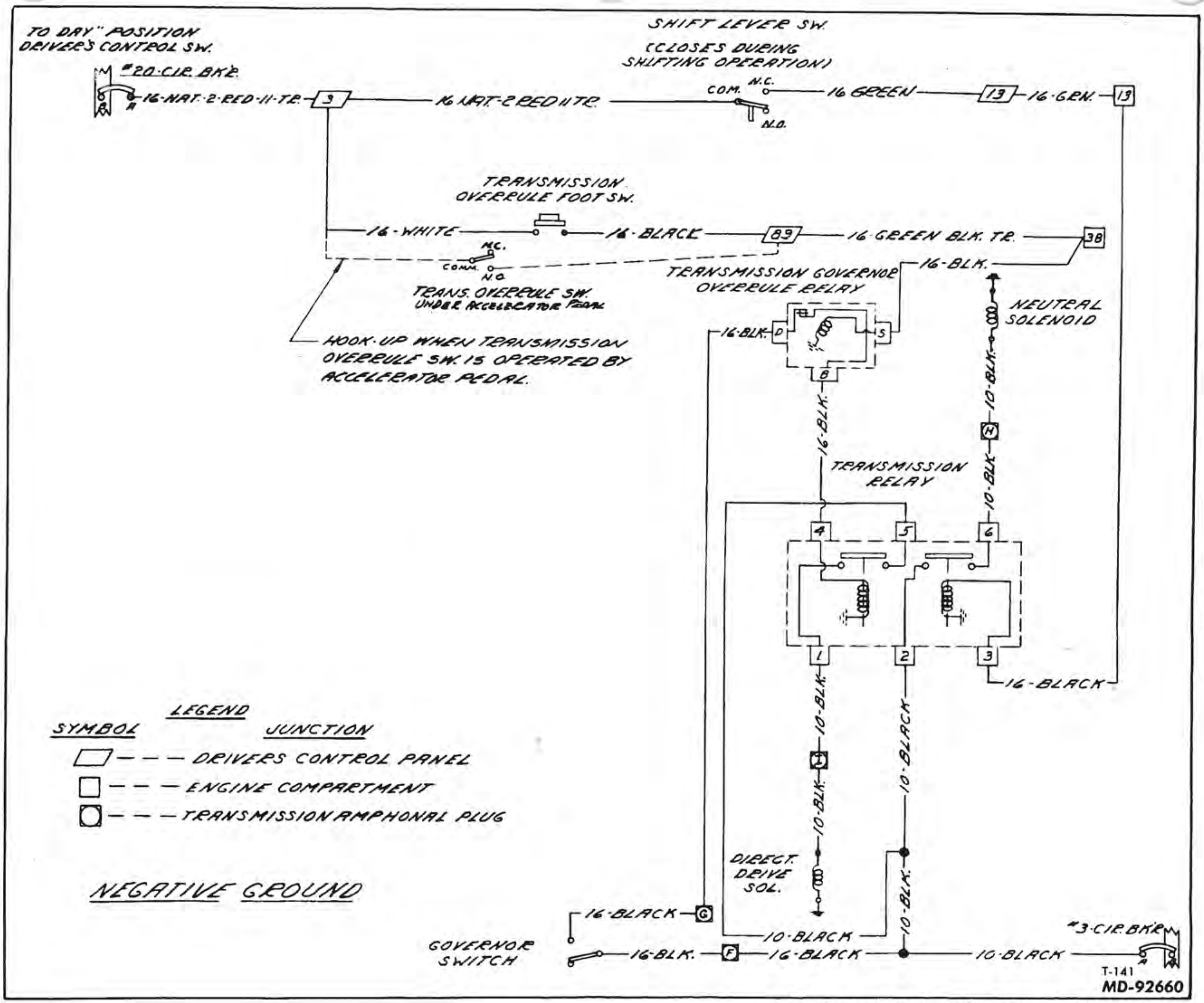
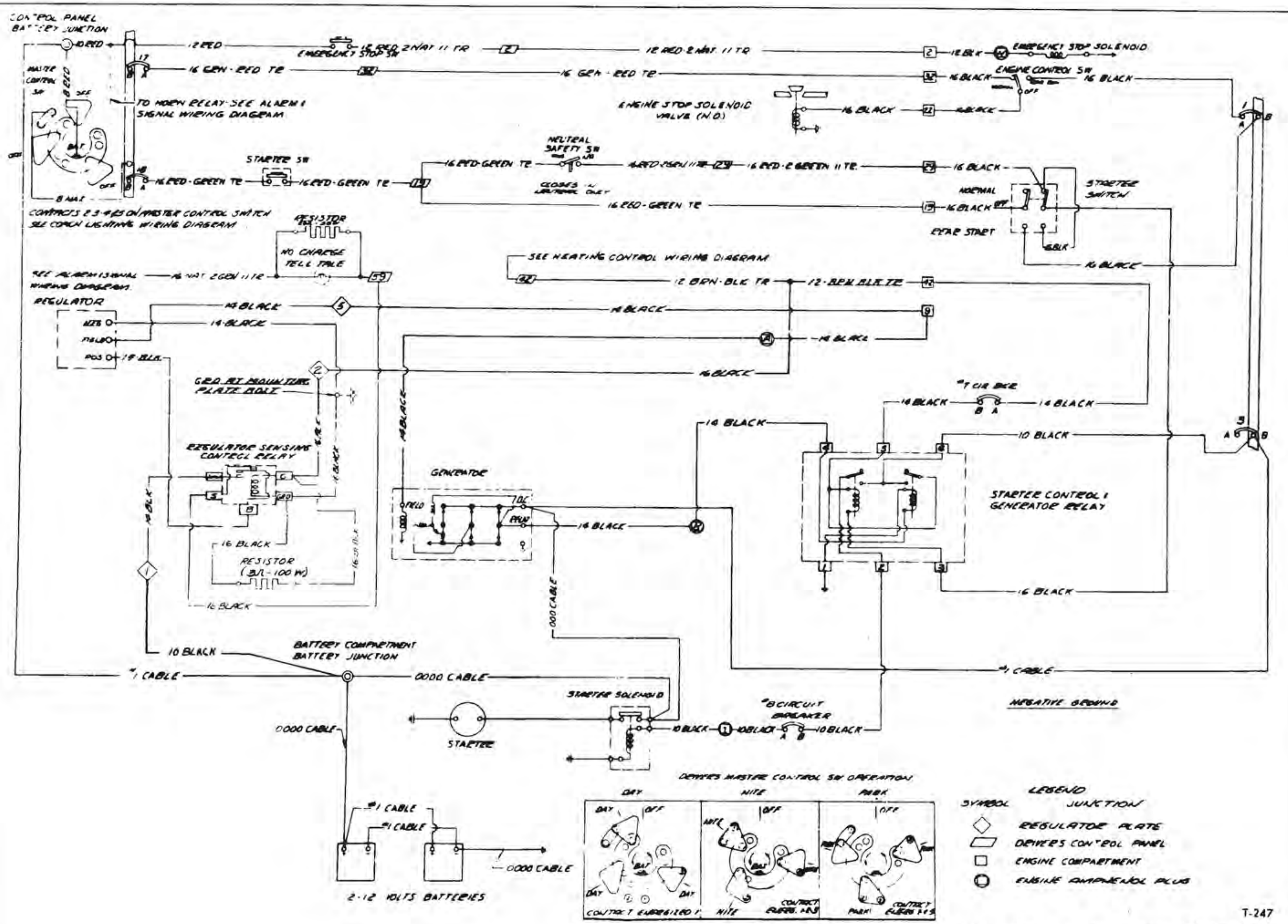
Engine Control and Generator Wiring Diagram—with Automatic Engine Shut-Off—TDM and SDM



Hydraulic Transmission Wiring Diagram—Standard



Hydraulic Transmission Wiring Diagram With Overrule



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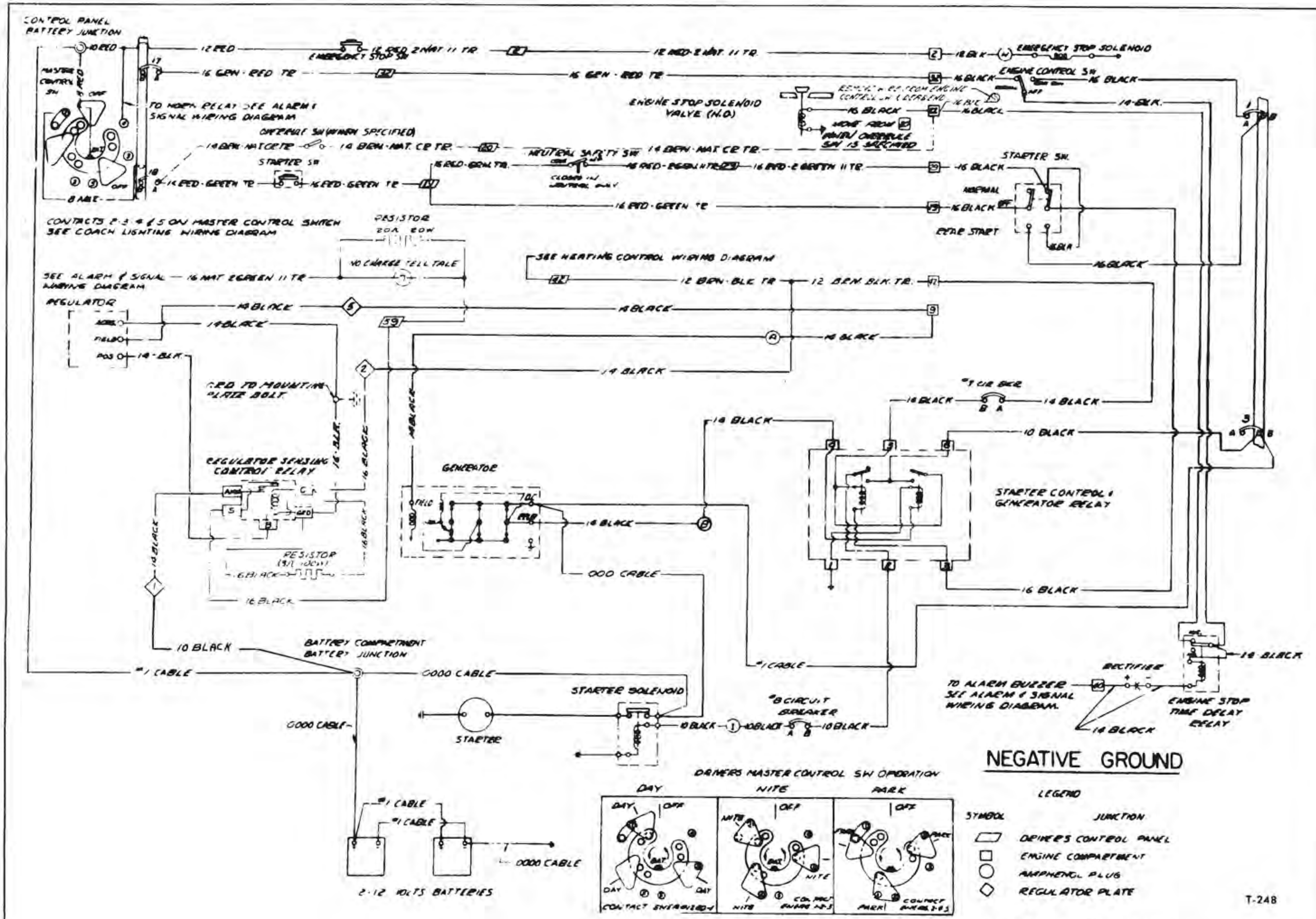
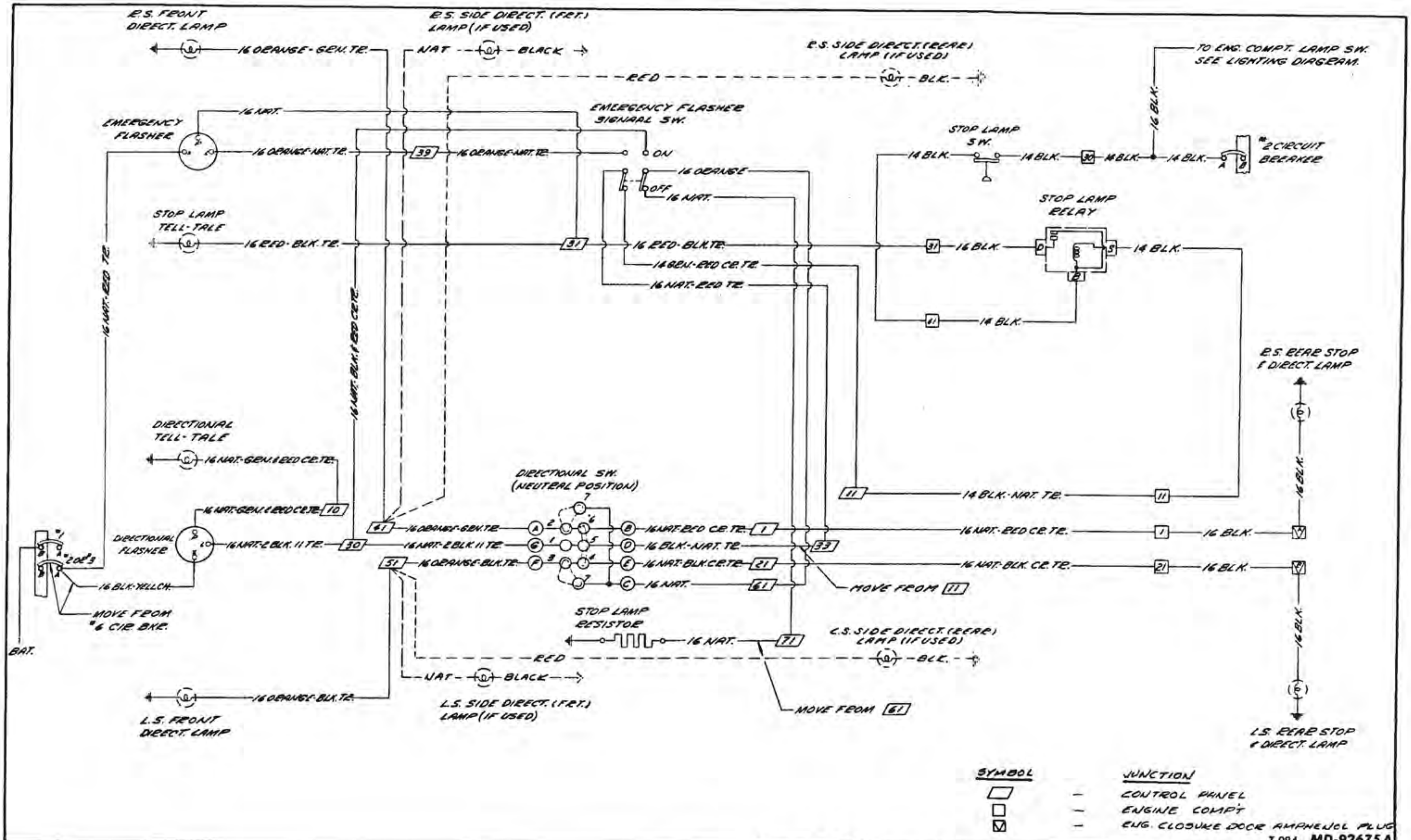
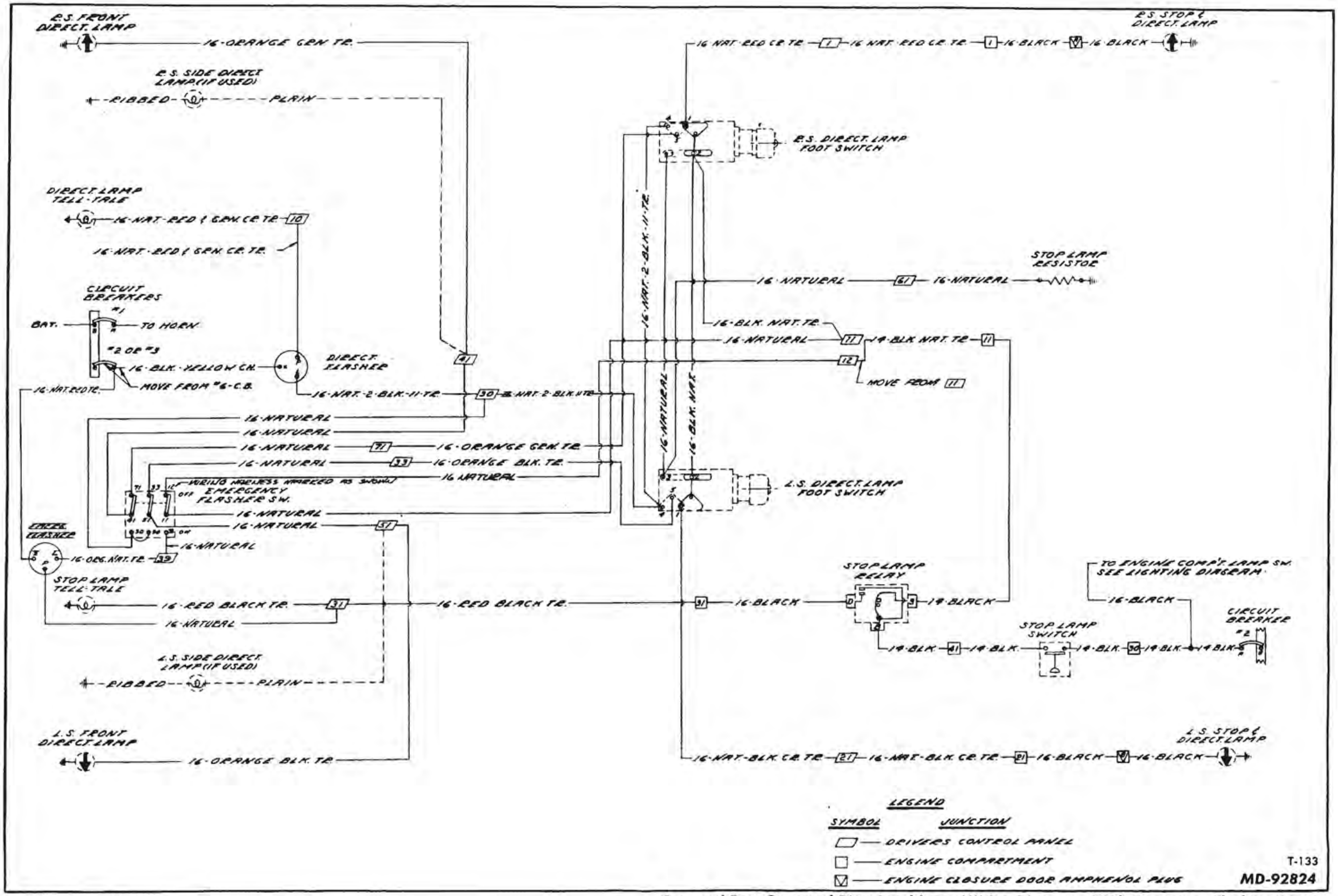
Engine Control and Generator Wiring Diagram - Standard TDH and SDH Models - ...92662



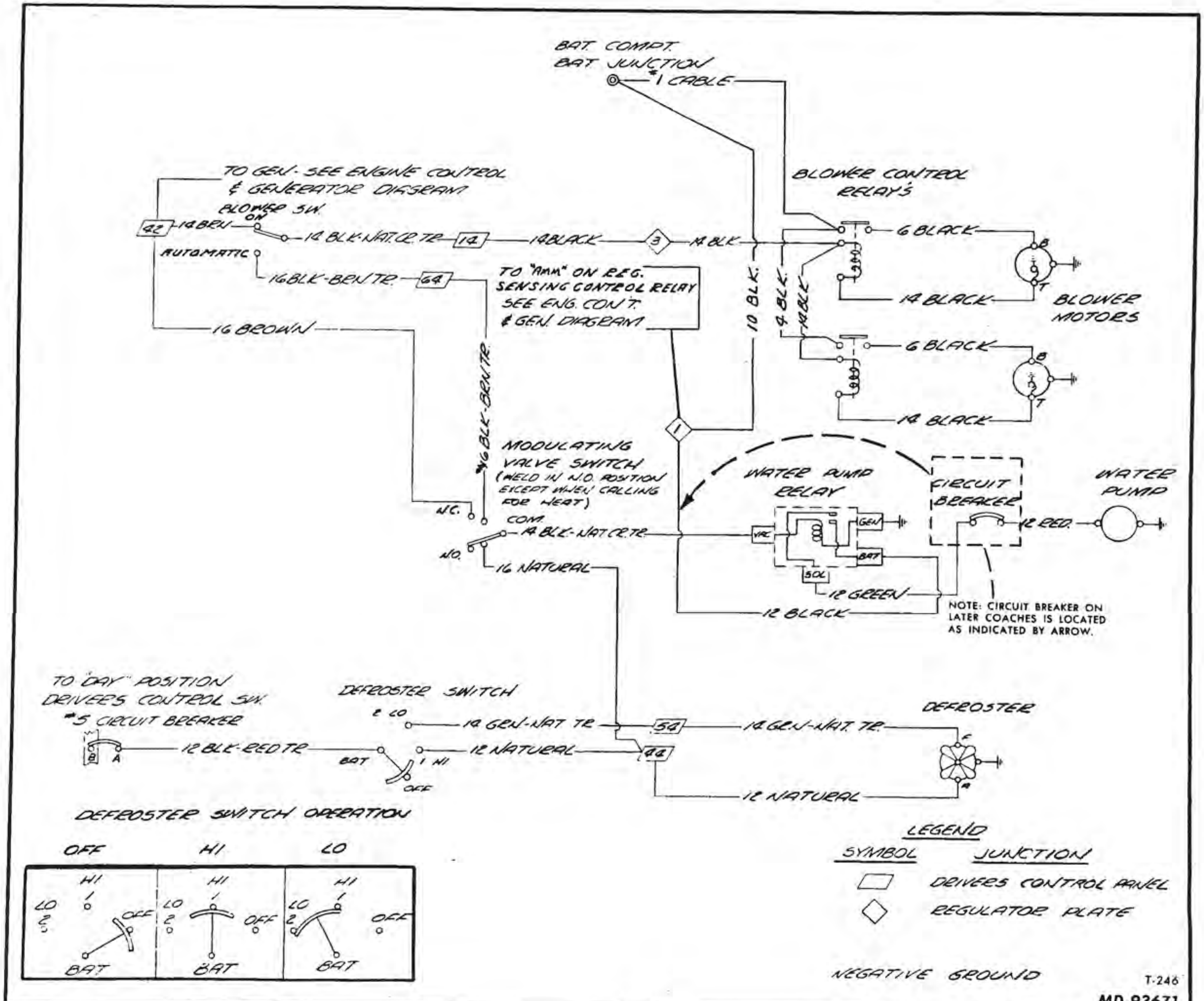
Engine Control and Generator Wiring Diagram - With Automatic Engine Shut-off System - TDH and SDH Models - MD-92663



Stop and Self-Cancelling Directional Lamp Wiring Diagram—With Emergency Flashing System



Stop and Foot-Operated Directional Lamp Wiring Diagram—With Emergency Flashing System



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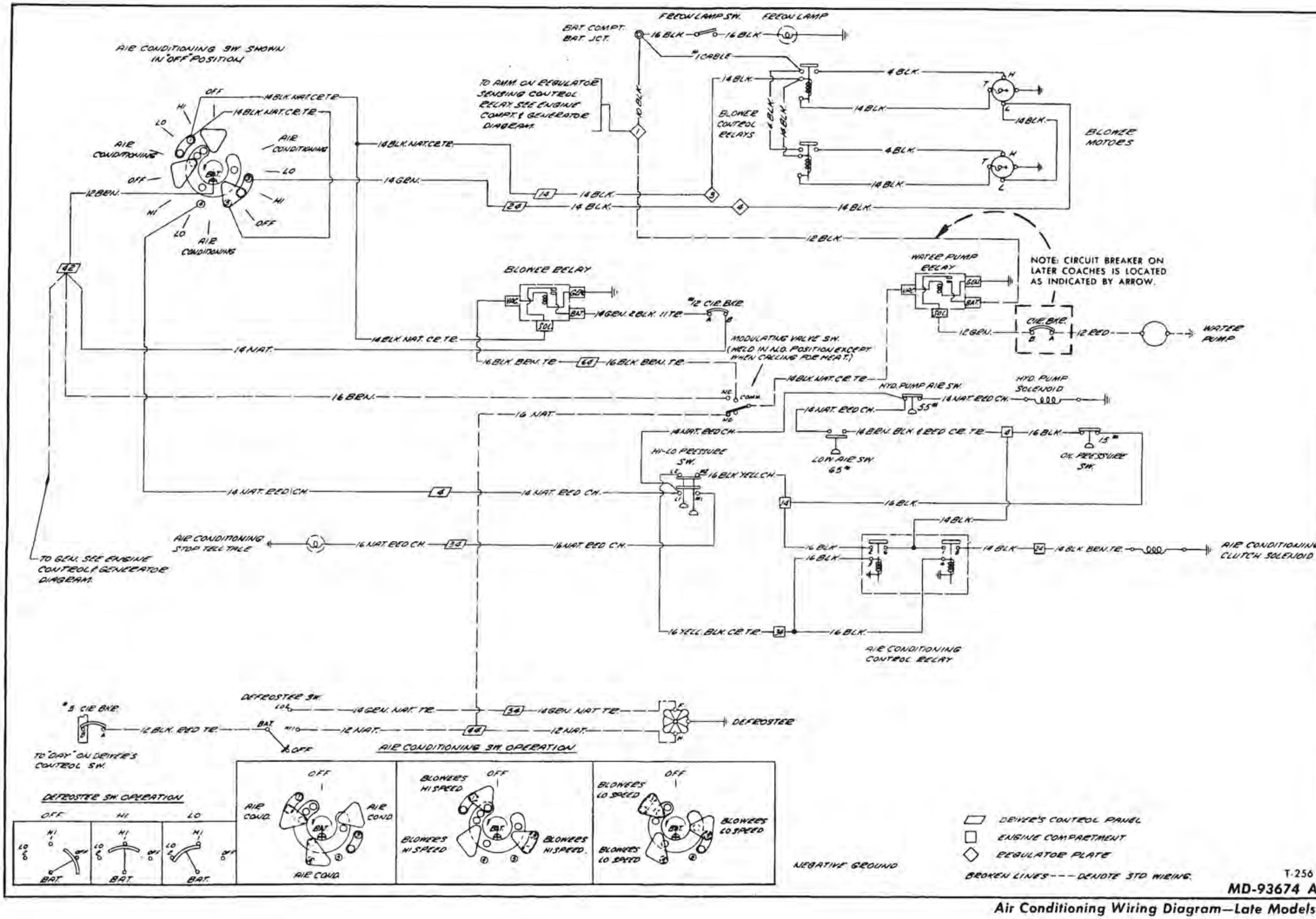
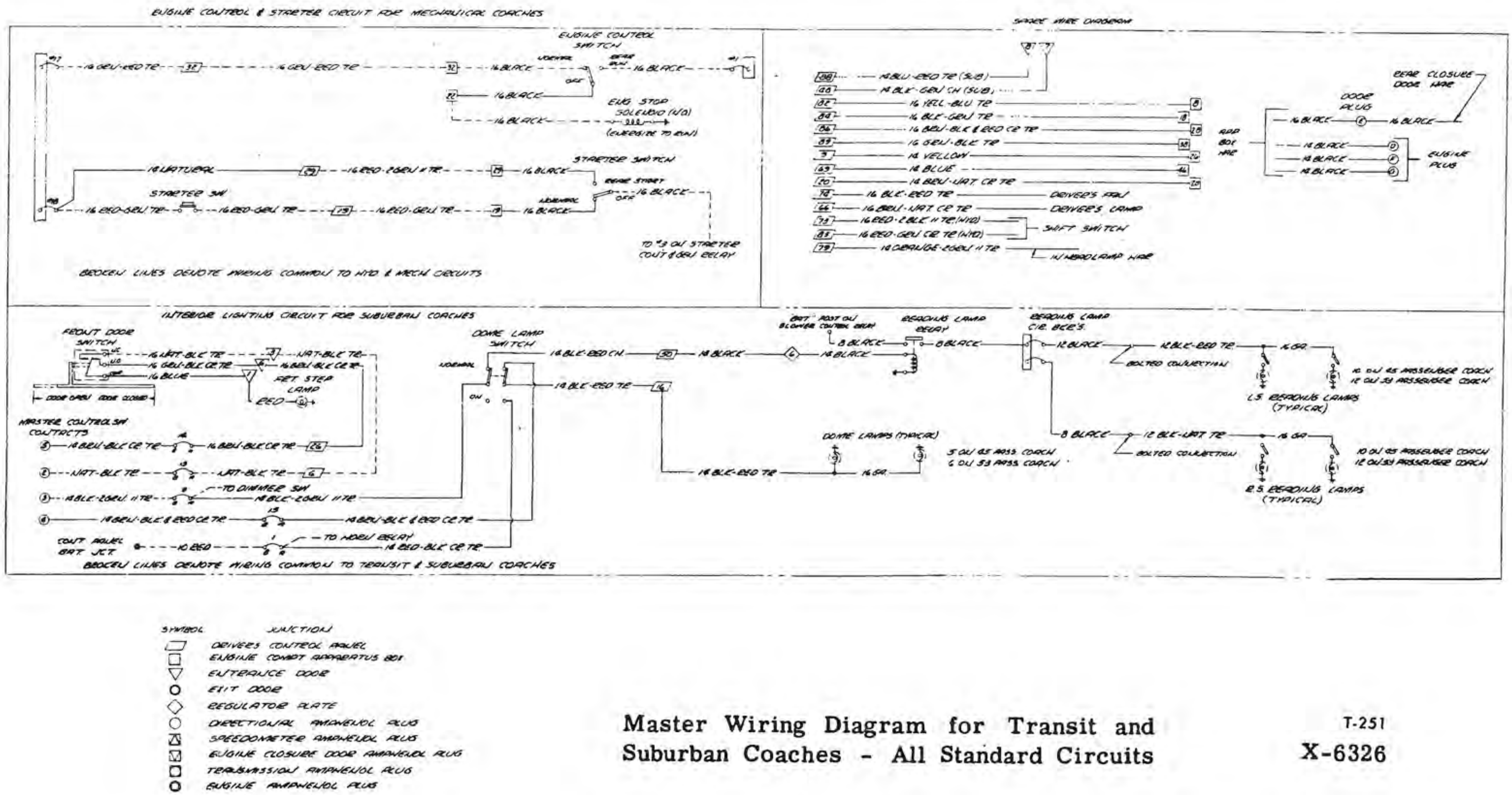
Heating and Ventilation Wiring Diagram



Air Conditioning Wiring Diagram—Late Models



Master Wiring Diagram for Transit and Suburban Coaches - All Standard Circuits

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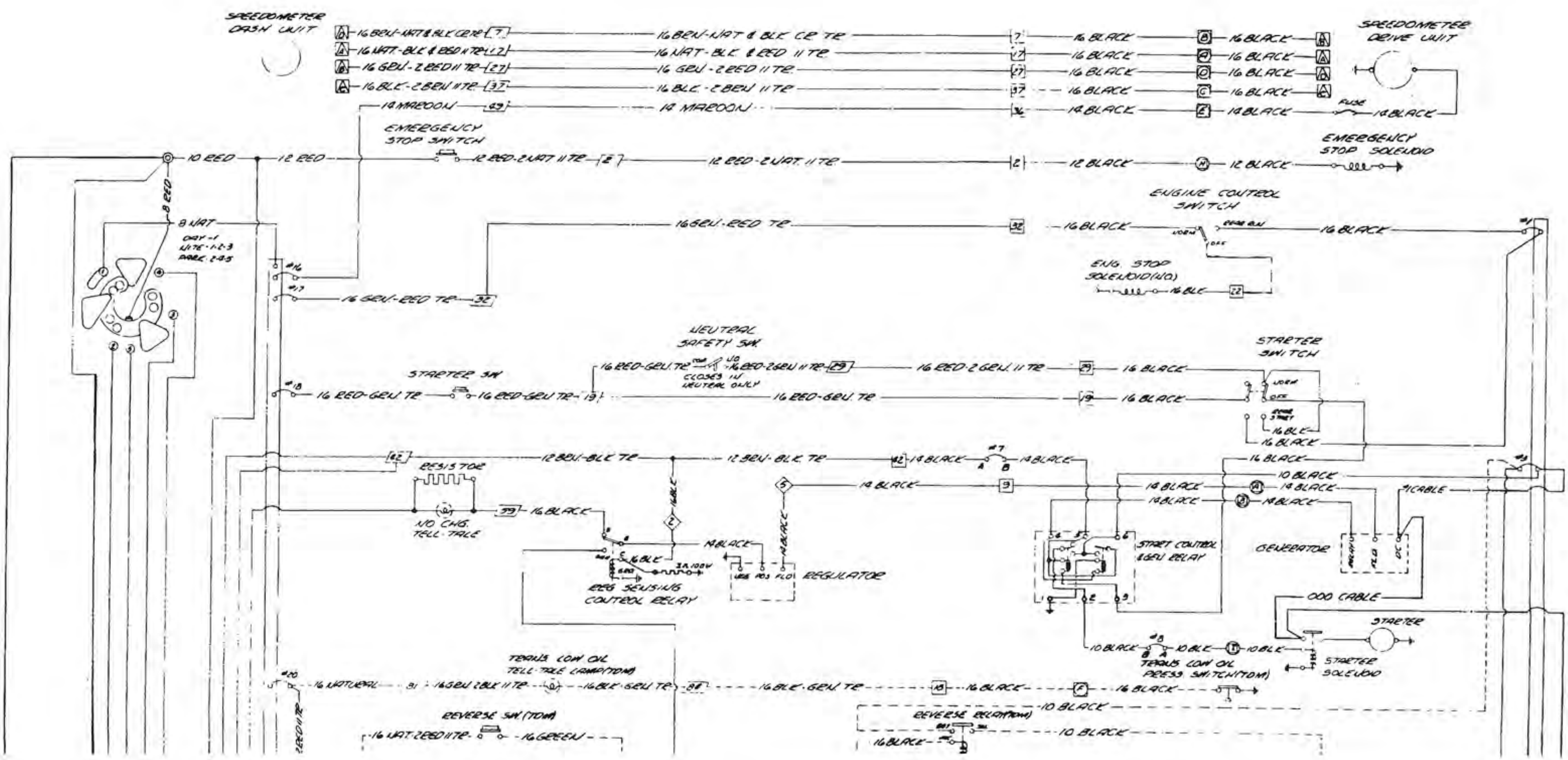
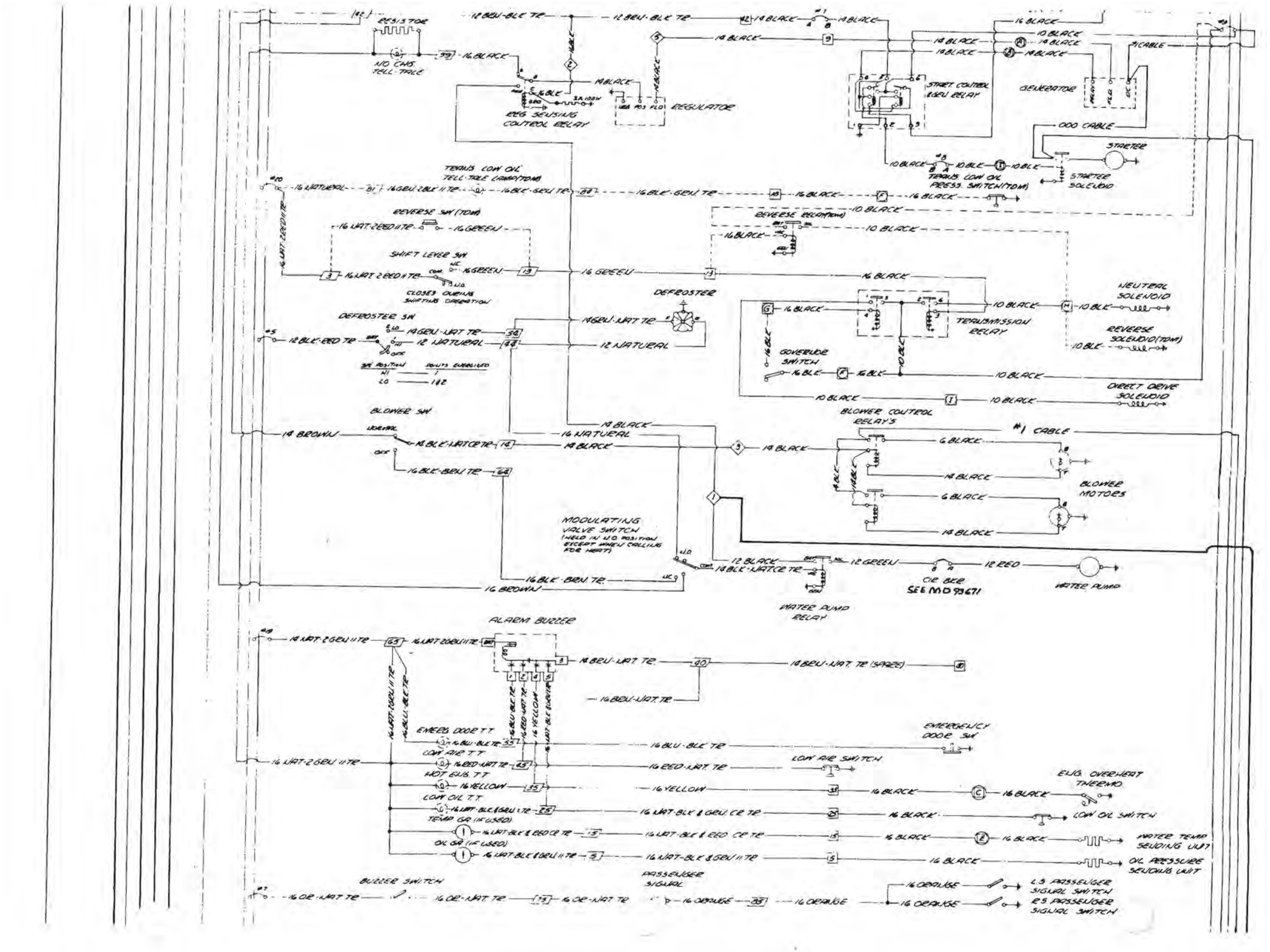
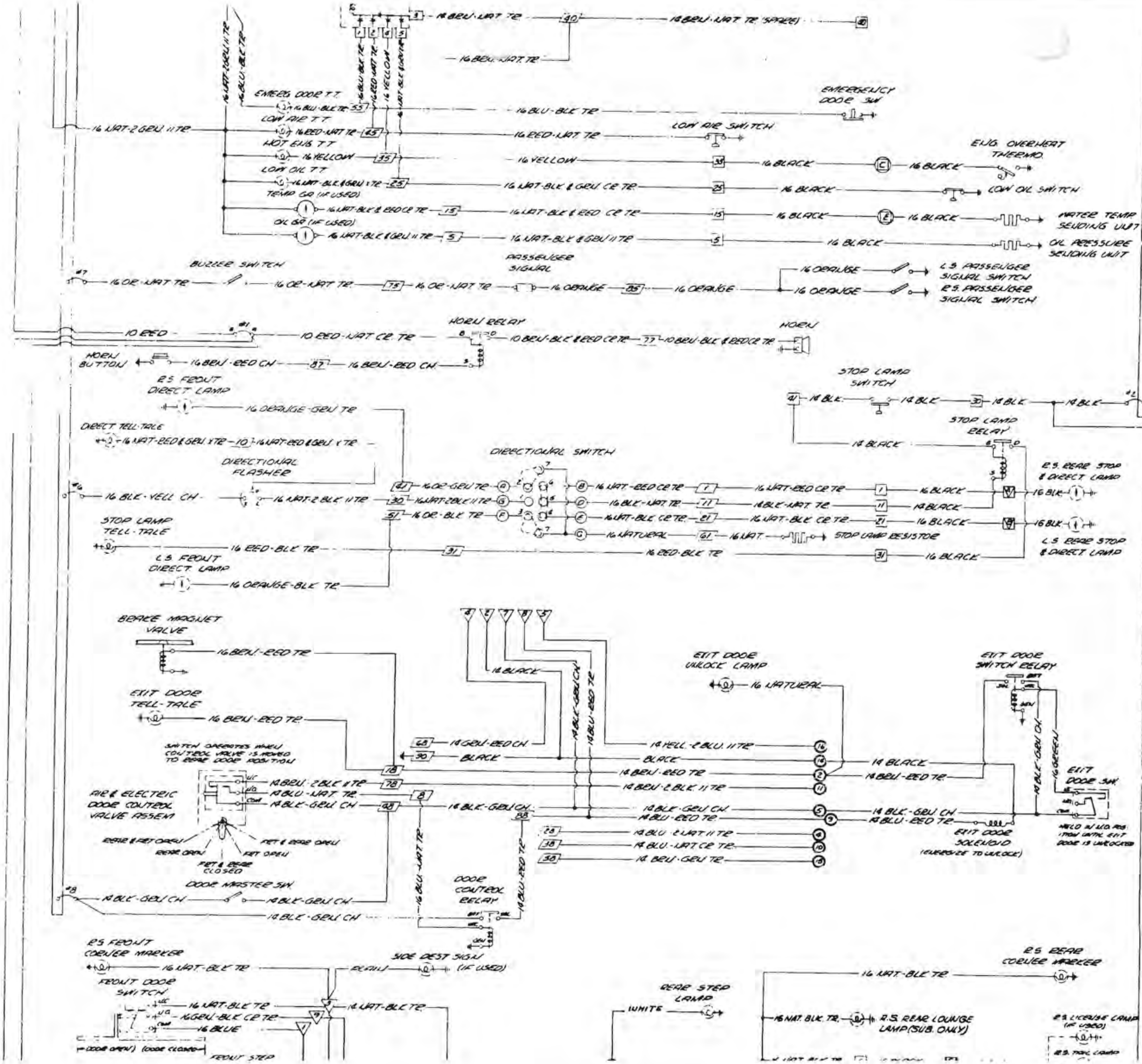
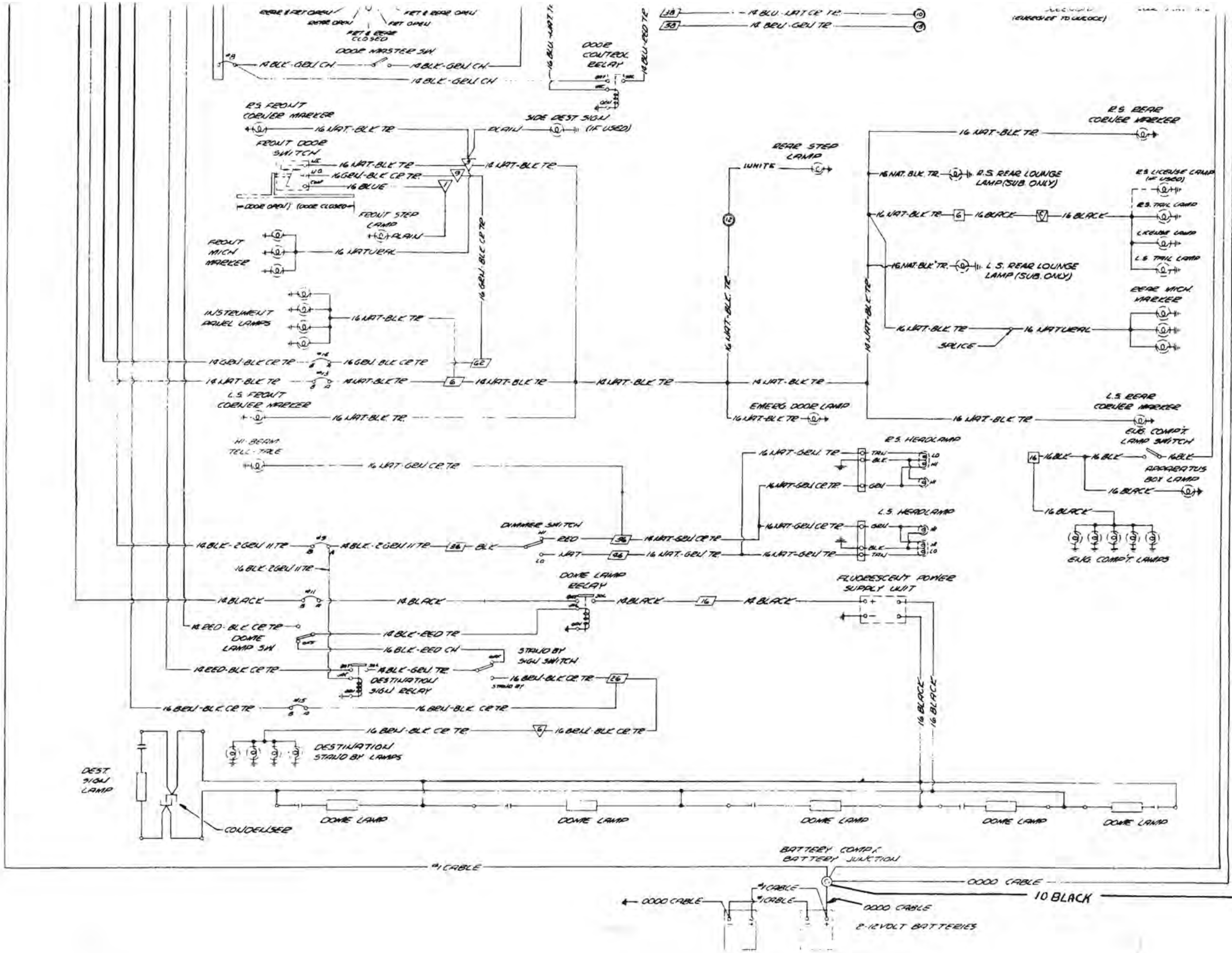


SPEEDOMETER DASH UNIT
SPEEDOMETER DRIVE UNIT
EMERGENCY STOP SWITCH
EMERGENCY STOP SOLENOID
ENGINE CONTROL SWITCH
ENG. STOP SOLENOID(N.O.)
NEUTRAL SAFETY SW.
CLOSES IN NEUTRAL ONLY
STARTER SW
STARTER SWITCH
RESISTOR
NO CHG. TELL-TALE
REG SENSING CONTROL RELAY
REGULATOR
START CONTROL & GEN RELAY
GENERATOR
STARTER
STARTER SOLENOID
000 CABLE
TRANS LOW OIL TELL-TALE LAMP(TOM)
TRANS LOW OIL PRESS. SWITCH(TOM)
REVERSE SW.(TOM)
REVERSE RELAY(TOM)
10 RED
12 RED
8 RED
8 NAT
14 MAROON
16 BLACK
12 BLACK
10 BLACK
14 BLACK
16 GREEN


RESISTOR
N/O CHS. TELL-TALE
REG SENSING CONTROL RELAY
REGULATOR
START CONTROL & GEN RELAY
GENERATOR
000 CABLE
STARTER
STARTER SOLENOID
TRANS LOW OIL PRESS. SWITCH (TDM)
TRANS LOW OIL TELL-TALE LAMP (TDM)
REVERSE SW (TDM)
REVERSE RELAY (TDM)
SHIFT LEVER SW
CLOSES DURING SHIFTING OPERATION
DEFROSTER
DEFROSTER SW
NEUTRAL SOLENOID
REVERSE SOLENOID (TDM)
TRANSMISSION RELAY
GOVERNOR SWITCH
DIRECT DRIVE SOLENOID
BLOWER SW
BLOWER CONTROL RELAYS
#1 CABLE
BLOWER MOTORS
MODULATING VALVE SWITCH (HELD IN N.O. POSITION EXCEPT WHEN CALLING FOR HEAT)
CIR BKR SEE MD 93671
WATER PUMP
WATER PUMP RELAY
ALARM BUZZER
EMERG. DOOR T.T.
LOW AIR T.T.
HOT ENG. T.T.
LOW OIL T.T.
TEMP GA (IF USED)
OIL GA (IF USED)
EMERGENCY DOOR SW
LOW AIR SWITCH
ENG. OVERHEAT THERMO
LOW OIL SWITCH
WATER TEMP SENDING UNIT
OIL PRESSURE SENDING UNIT
BUZZER SWITCH
PASSENGER SIGNAL
L.S. PASSENGER SIGNAL SWITCH
R.S. PASSENGER SIGNAL SWITCH


EMERG. DOOR T.T.
LOW AIR T.T.
HOT ENG. T.T.
LOW OIL T.T.
TEMP GA (IF USED)
OIL GA (IF USED)
EMERGENCY DOOR SW
LOW AIR SWITCH
ENG. OVERHEAT THERMO.
LOW OIL SWITCH
WATER TEMP SENDING UNIT
OIL PRESSURE SENDING UNIT
BUZZER SWITCH
PASSENGER SIGNAL
L.S. PASSENGER SIGNAL SWITCH
R.S. PASSENGER SIGNAL SWITCH
HORN RELAY
HORN
HORN BUTTON
R.S. FRONT DIRECT LAMP
STOP LAMP SWITCH
STOP LAMP RELAY
DIRECT TELL-TALE
DIRECTIONAL FLASHER
DIRECTIONAL SWITCH
R.S. REAR STOP & DIRECT LAMP
L.S. REAR STOP & DIRECT LAMP
STOP LAMP RESISTOR
STOP LAMP TELL-TALE
L.S. FRONT DIRECT LAMP
BRAKE MAGNET VALVE
EXIT DOOR UNLOCK LAMP
EXIT DOOR SWITCH RELAY
EXIT DOOR TELL-TALE
AIR & ELECTRIC DOOR CONTROL VALVE ASSEM
EXIT DOOR SW.
EXIT DOOR SOLENOID (ENERGIZE TO UNLOCK)
DOOR MASTER SW.
DOOR CONTROL RELAY
R.S. FRONT CORNER MARKER
SIDE DEST SIGN (IF USED)
FRONT DOOR SWITCH
REAR STEP LAMP
R.S. REAR CORNER MARKER
R.S. REAR LOUNGE LAMP (SUB. ONLY)
R.S. LICENSE LAMP (IF USED)
FRONT STEP



DOOR MASTER SW.
14 BLK-GRN CH
DOOR CONTROL RELAY
14 BLU-NAT CR TR
14 BRN-GRN TR
R.S. FRONT CORNER MARKER
16 NAT-BLK TR
SIDE DEST SIGN (IF USED)
FRONT DOOR SWITCH
16 BLUE
FRONT STEP LAMP
PLAIN
FRONT MICH MARKER
16 NATURAL
INSTRUMENT PANEL LAMPS
14 GRN-BLK CR TR
14 NAT-BLK TR
L.S. FRONT CORNER MARKER
HI-BEAM TELL-TALE
16 NAT-GRN CR TR
REAR STEP LAMP
WHITE
EMERG. DOOR LAMP
R.S. REAR CORNER MARKER
R.S. REAR LOUNGE LAMP (SUB. ONLY)
L.S. REAR LOUNGE LAMP (SUB. ONLY)
R.S. LICENSE LAMP (IF USED)
R.S. TAIL LAMP
LICENSE LAMP
L.S. TAIL LAMP
16 BLACK
REAR MICH. MARKER
SPLICE
L.S. REAR CORNER MARKER
ENG. COMP'T. LAMP SWITCH
APPARATUS BOX LAMP
ENG. COMP'T. LAMPS
R.S. HEADLAMP
L.S. HEADLAMP
DIMMER SWITCH
RED
NAT
14 BLK-2GRN II TR
16 BLK-2GRN II TR
14 BLACK
DOME LAMP RELAY
FLUORESCENT POWER SUPPLY UNIT
14 RED-BLK CR TR
DOME LAMP SW.
14 BLK-RED TR
16 BLK-RED CH
STAND BY SIGN SWITCH
14 BLK-GRN TR
DESTINATION SIGN RELAY
16 BRN-BLK CR TR
DESTINATION STAND BY LAMPS
DEST. SIGN LAMP
CONDENSER
DOME LAMP
#1 CABLE
BATTERY COMP'T. BATTERY JUNCTION
0000 CABLE
10 BLACK
2-12 VOLT BATTERIES

Lubrication Chart

MODELS–TDH 4518, 4519, 5303, 5304, AND SDH–4502, 5302

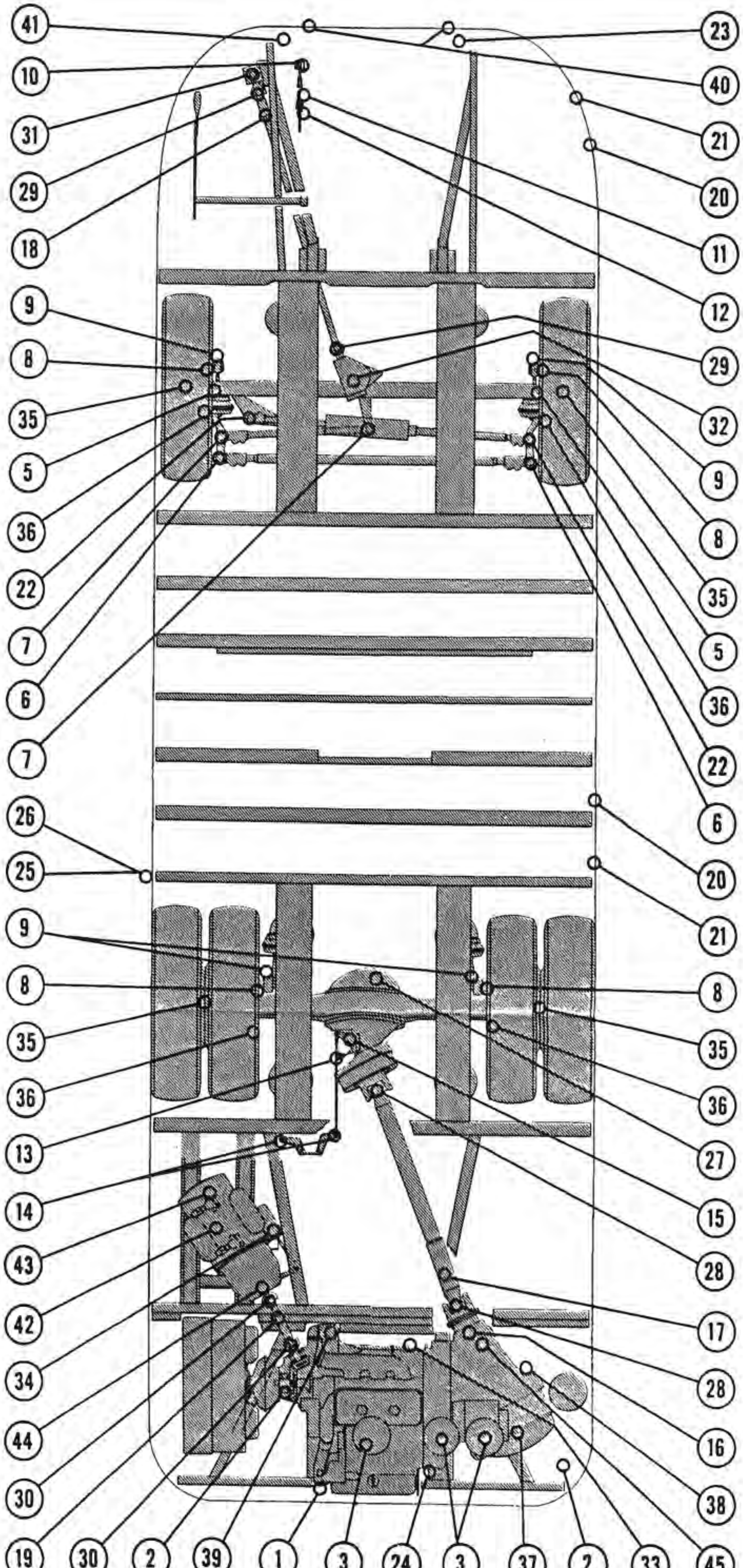
Item No.			Miles	Symbol
1	Engine	Keep to "FULL" mark - 27 Qts.	Daily	E
2	Engine Oil Filters	Replace Element at Engine Drain	4,000	-
3	Blower Air Cleaners	Keep to Level Mark - 2 Qts. Each	1,500	E
4	Control Linkage - Other Than Shutter Linkage	Oil Can, Brush, or Spray	1,500	E
5	Steering Knuckles	Four Fittings - Two Each Side	1,500	C
6	Steering Tie Rod Ends	Two Fittings - One Each End	1,500	C
7	Steering Drag Link Ends	Two Fittings - One Each End	1,500	C
8	Brake Camshafts - F. & R.	Four Fittings - One Each - Apply Sparingly	1,500	C
9	Slack Adjusters	Four Fittings - One Each	1,500	C
10	Accelerator Pedal	One Fitting	1,500	C
11	Accelerator Interlock Lever	One Fitting	1,500	C
12	Accelerator Control Lever	One Fitting	1,500	C
13	Parking Brake Camshaft	One Fitting	1,500	C
14	Parking Brake Relay Levers	Two Fittings - One Each	1,500	C
15	Parking Brake Bell Crank	One Fitting	1,500	C
16	Speedometer Adapter	One Fitting	1,500	C
17	Propeller Shaft Slip Joint	One Fitting	1,500	C
18	Steering Drive Shaft Slip Joint	One Fitting	1,500	C
19	Air Cond. Compressor Drive Slip Joint	One Fitting	1,500	C
20	Door Hinge Bushings & Levers	Three Fittings - F. - 2 Upper, 1 Lower	1,500	C
		Four Fittings - R. - 2 Upper, 2 Lower	1,500	C
21	Door Engine & Cylinder - F. & R.	Thru Plug - 1 Oz.	15,000	E
22	Power Steering Cylinder Ends (When Used)	Two Fittings	1,500	C
23	Destination Sign Gear and Chain	Apply Sparingly	1,500	C
24	Power Steering System (When Used)	To Level Mark on Dipstick	1,500	S19
25	Battery Slide	Apply	As Req'd.	C
26	Battery Terminals	Keep Coated	As Req'd.	S3
27	Rear Axle Differential	To Level of Filler Plug	1,500	MP
		Drain and Refill - 26 Pts. - 53 Pass.	15,000	MP
		22 Pts. - 45 Pass.	15,000	MP
28	Propeller Shaft "U" Joints	Two Fittings - One Each Joint	1,500	G
29	Steering Drive Shaft "U" Joints	Two Fittings - One Each Joint	1,500	G
30	Air Cond. Compressor Drive "U" Joints	Two Fittings - One Each Joint	1,500	G
31	Steering Bevel Gear Housing	Fitting - To Level of Breather	1,500	SG
32	Steering Gear Housing	Fitting - To Level of Breather	1,500	SG
33	Starter	Thru Plug - Commutator End	3,000	E
		Thru Plug - Drive End	At Inst.	E
34	Air Cond. Clutch Air Cylinder	Thru Plug Opening - 1 Oz.	10,000	E
35	Wheel Bearings	Hand Pack or Use Lubricator Do Not Use Pressure Gun	15,000	S2
36	Brake Shoe Anchor Pins	8 Fittings - 2 Each Wheel	15,000	S2
37	Transmission	Refer to GM Hydraulic Drive Manual (Model VH)		
		Check Level	3,000	
		Drain and Refill (26 Qts.)	25,000	
38	Transmission Oil Filter	Replace Element	6,000	-
39	Radiator Shutter Air Filter (When Used)	1 Oz. Thru Plug	3,000	S13
40	Windshield Wiper Shaft	Two Fittings (Apply Sparingly	5,000	C
41	Windshield Wiper Oiler (When Used)	To Level of Filler Plug	5,000	S7
42	Air Cond. Condenser Fan Drive	See "Instructions"	-	S19
43	Air Cond. Compressor	See "Instructions"	-	S25
44	Air Cond. Compressor Clutch Shaft	Pack at Assembly	-	S26
45	Speedometer & Tachometer Cables (When Used)	Coat Inside Cable	25,000	SG

*Push Type Doors Only.

X-6326

LUBRICANT SYMBOLS

E - Engine Oil
MP - Multi-Purpose Gear Lubricant
G - Straight Mineral Gear Lubricant
C - Chassis Lubricant
SG - Steering Gear Lubricant
S2 - High Temperature Grease
S3 - Petrolatum - Petroleum Jelly
S7 - Refrigeration Machine Oil
S13 - Radiator Shutter Fluid
S19 - Type A Fluid
S25 - Air Conditioning Compressor Oil
S26 - Special Multi-Purpose Grease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Lubrication Chart

MODELS–TDM 4518, 4519, 5303, 5304, AND SDM–4502, 5302

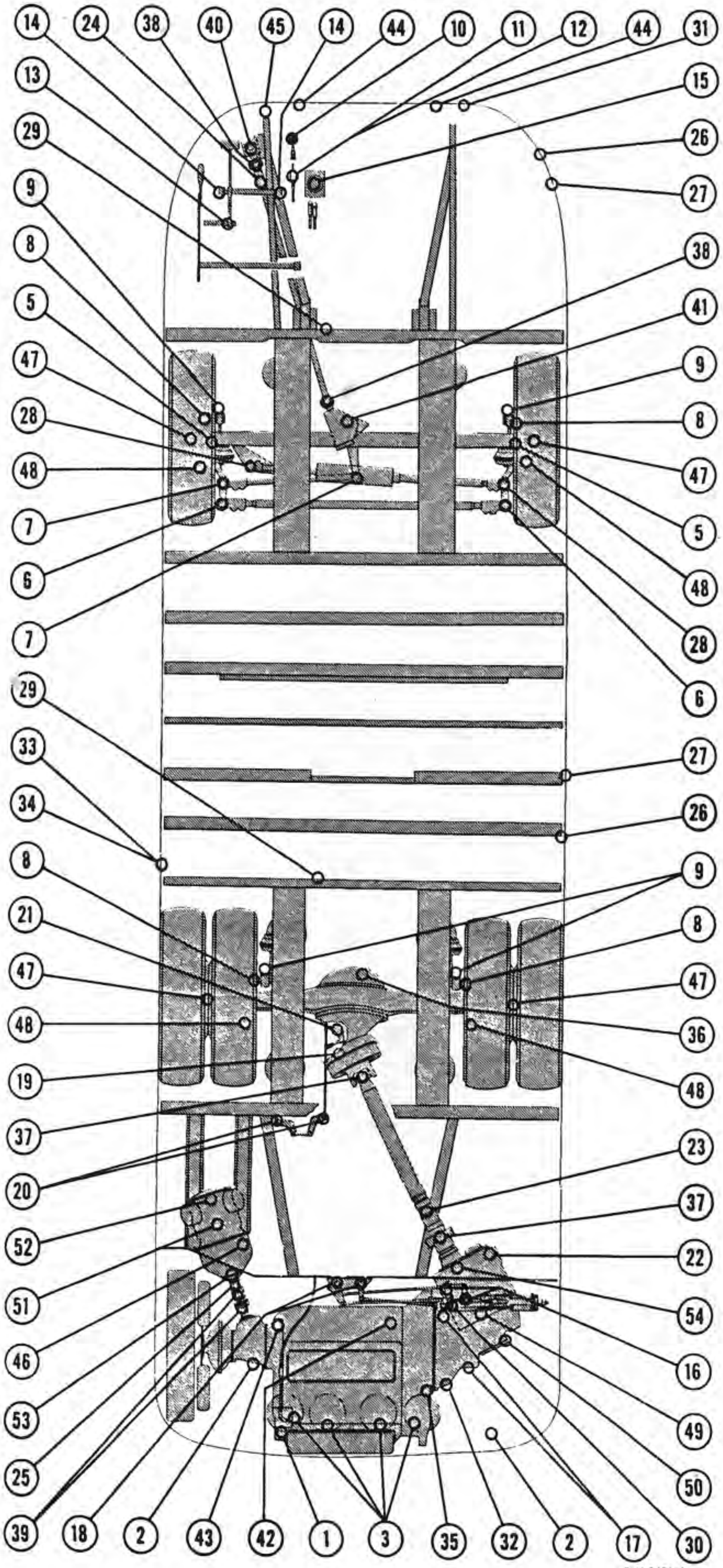
Item No.	Item	Remarks & Capacities	Miles	Symbol
1	Engine	Keep to "FULL" mark - 27 Qts. - 6 Cyl.	Daily	E
		33 Qts. - 8 Cyl.	Daily	E
2	Engine Oil Filters	Replace Element at Engine Drain	4,000	-
3	Blower Air Cleaners	Keep to Level Mark - 2 Qts. Each	1,500	E
4	Control Rod Linkage	Oil Can, Brush, or Spray	1,500	E
5	Steering Knuckles	Four Fittings - Two Each Side	1,500	C
6	Steering Tie Rod Ends	Two Fittings - One Each End	1,500	C
7	Steering Drag Link Ends	Two Fittings - One Each End	1,500	C
8	Brake Camshafts - F. & R.	Four Fittings - One Each - Apply Sparingly	1,500	C
9	Slack Adjusters	Four Fittings - One Each	1,500	C
10	Accelerator Pedal	One Fitting	1,500	C
11	Accelerator Interlock Lever	One Fitting	1,500	C
12	Accelerator Control Lever	One Fitting	1,500	C
13	Clutch Pedal	One Fitting	1,500	C
14	Clutch Control Cross Shaft	One Fitting Each End	1,500	C
15	Transmission Control Tower	One Fitting	1,500	C
16	Transmission Control Levers	Two Fittings	1,500	C
17	Clutch Release Shaft - 8 Cyl.	One Fitting Each End	1,500	C
18	Control Rods Bell Crank Pins	Two Fittings 6V - Three Fittings 8V	1,500	C
19	Parking Brake Camshaft	One Fitting	1,500	C
20	Parking Brake Relay Levers	Two Fittings - One Each	1,500	C
21	Parking Brake Bell Crank	One Fitting	1,500	C
22	Speedometer Adapter	One Fitting	1,500	C
23	Propeller Shaft Slip Joint	One Fitting	1,500	C
24	Steering Drive Shaft Slip Joint	One Fitting	1,500	C
25	Air Cond. Compressor Drive Slip Joint	One Fitting	1,500	C
26	Door Hinge Bushings & Levers	Three Fittings - F. - 2 Upper, 1 Lower	1,500	C
		Four Fittings - R. - 2 Upper, 2 Lower	1,500	C
27	Door Engine & Cylinder - F. & R.	Thru Plug - 1 Oz.	15,000	E
28	Power Steering Cylinder Ends (When Used)	Two Fittings	1,500	C
29	Intermediate Control Levers - SDM	Three Fittings - 2 F. - 1 R.	15,000	C
30	Clutch Control Linkage - 8 Cyl.	Two Fittings	1,500	C
31	Destination Sign Gear and Chain	Apply Sparingly	1,500	C
32	Clutch Release Bearing - 8 Cyl.	Grease Cup - One Turn	1,500	S2
33	Battery Slide	Apply	As Req'd.	C
34	Battery Terminals	Keep Coated	As Req'd.	S3
35	Power Steering System (When Used)	To Level Mark on Dipstick	1,500	S19
36	Rear Axle Differential	To Level of Filler Plug	1,500	MP
		Drain and Refill - 26 Pts. - 53 Pass.	15,000	MP
		- 22 Pts. - 45 Pass.	15,000	MP
37	Propeller Sha ft "U" Joints	Two Fittings - One Each Joint	1,500	G
38	Steering Drive Shaft "U" Joints	Two Fittings - One Each Joint	1,500	G
39	Air Cond. Compressor Drive "U" Joints	Two Fittings - One Each Joint	1,500	G
40	Steering Bevel Gear Housing	Fitting - To Level of Breather	1,500	SG
41	Steering Gear Housing (At Axle)	Fitting - To Level of Breather	1,500	SG
42	Starter	Thru Plug - Commutator End	3,000	E
		Thru Plug - Drive End	At Inst.	E
43	Radiator Shutter Air Filter (When Used)	1 Oz. Thru Plug	3,000	S13
44	Windshield Wiper Shaft	Two Fittings (Sparingly)	5,000	C
45	Windshield Wiper Oiler (When Used)	To Level of Filler Plug	5,000	S7
46	Air Cond. Clutch Air Cylinder	Thru Plug Opening - 1 Oz.	10,000	E
47	Wheel Bearings	Hand Pack or Use Lubricator Do Not Use Pressure Gun	15,000	S2
48	Brake Shoe Anchor Pins	8 Fittings - 2 Each Wheel	15,000	S2
49	Transmission	To Mark on Dipstick	1,500	E
		Drain and Refill - 11.5 Qts.8V - 12.5 Qts.6V	15,000	E
50	Transmission Oil Filter	Replace Assembly	4,000	-
51	Air Cond. Condenser Fan Drive	See "Instructions"	-	S19
52	Air Cond. Compressor	See "Instructions"	-	S25
53	Air Cond. Compressor Clutch Shaft	Pack at Assembly	-	S26
54	Speedometer & Tachometer Cables (When Used)	Coat Inside Cable	25,000	SG

*Push Type Doors Only.

X-6326

LUBRICANT SYMBOLS

- E - Engine Oil
- MP - Multi-Purpose Gear Lubricant
- G - Straight Mineral Gear Lubricant
- C - Chassis Lubricant
- SG - Steering Gear Lubricant
- S2 - High Temperature Grease
- S3 - Petrolatum - Petroleum Jelly
- S7 - Refrigeration Machine Oil
- S13 - Radiator Shutter Fluid
- S19 - Type A Fluid
- S25 - Air Conditioning Compressor Oil
- S26 - Special Multi-Purpose Grease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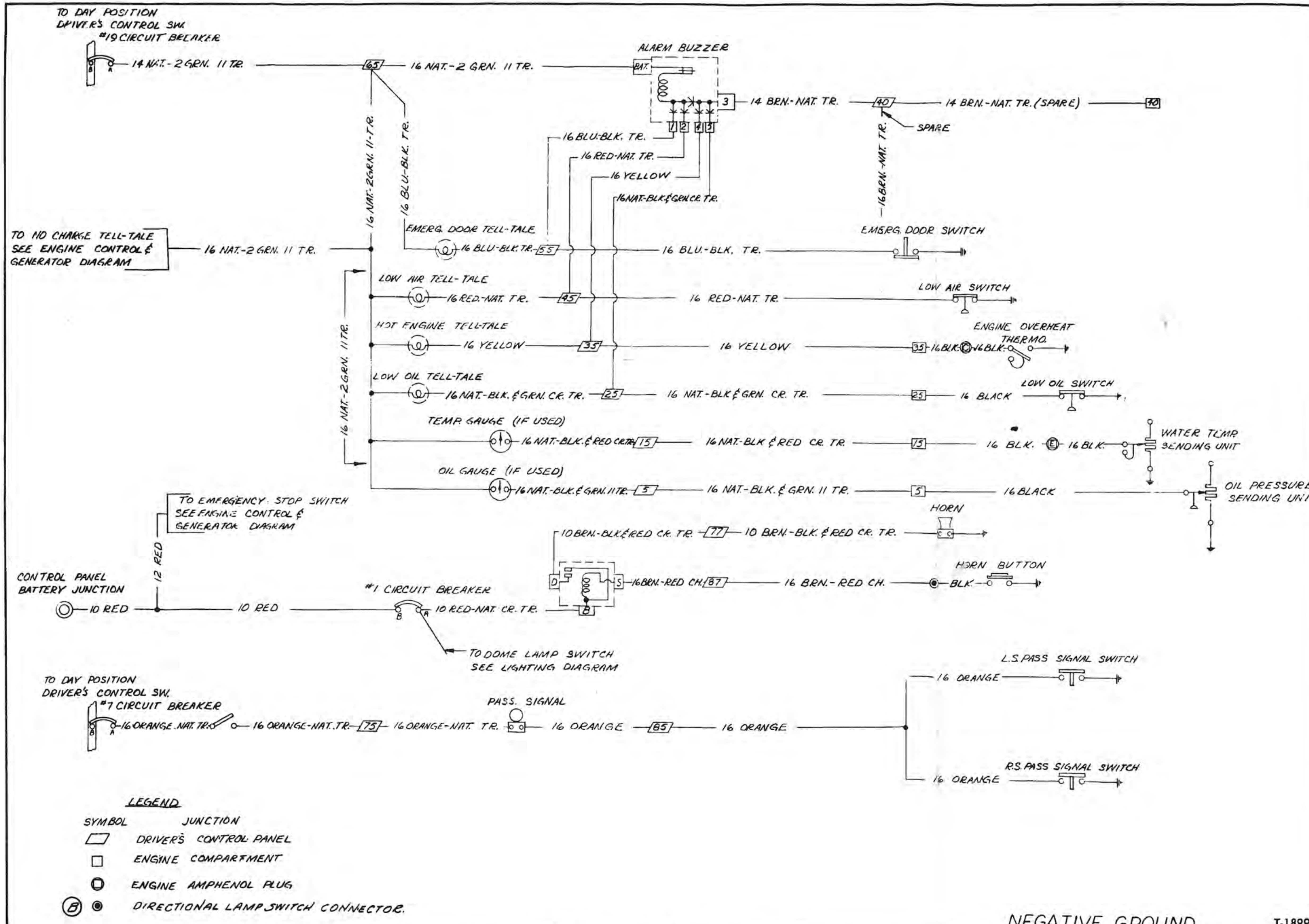
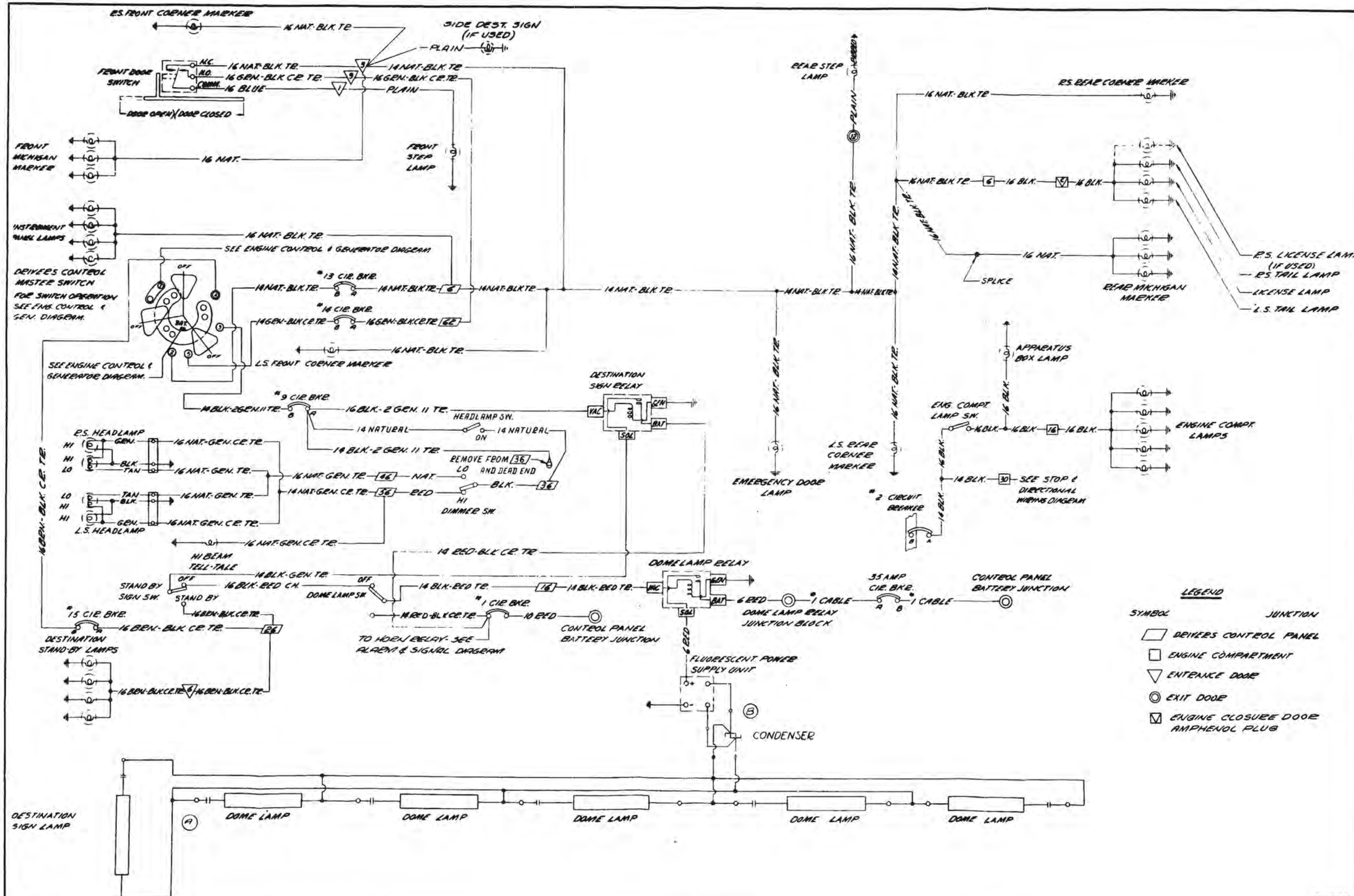


MD-86080-B—Alarm and Signal Wiring Diagram



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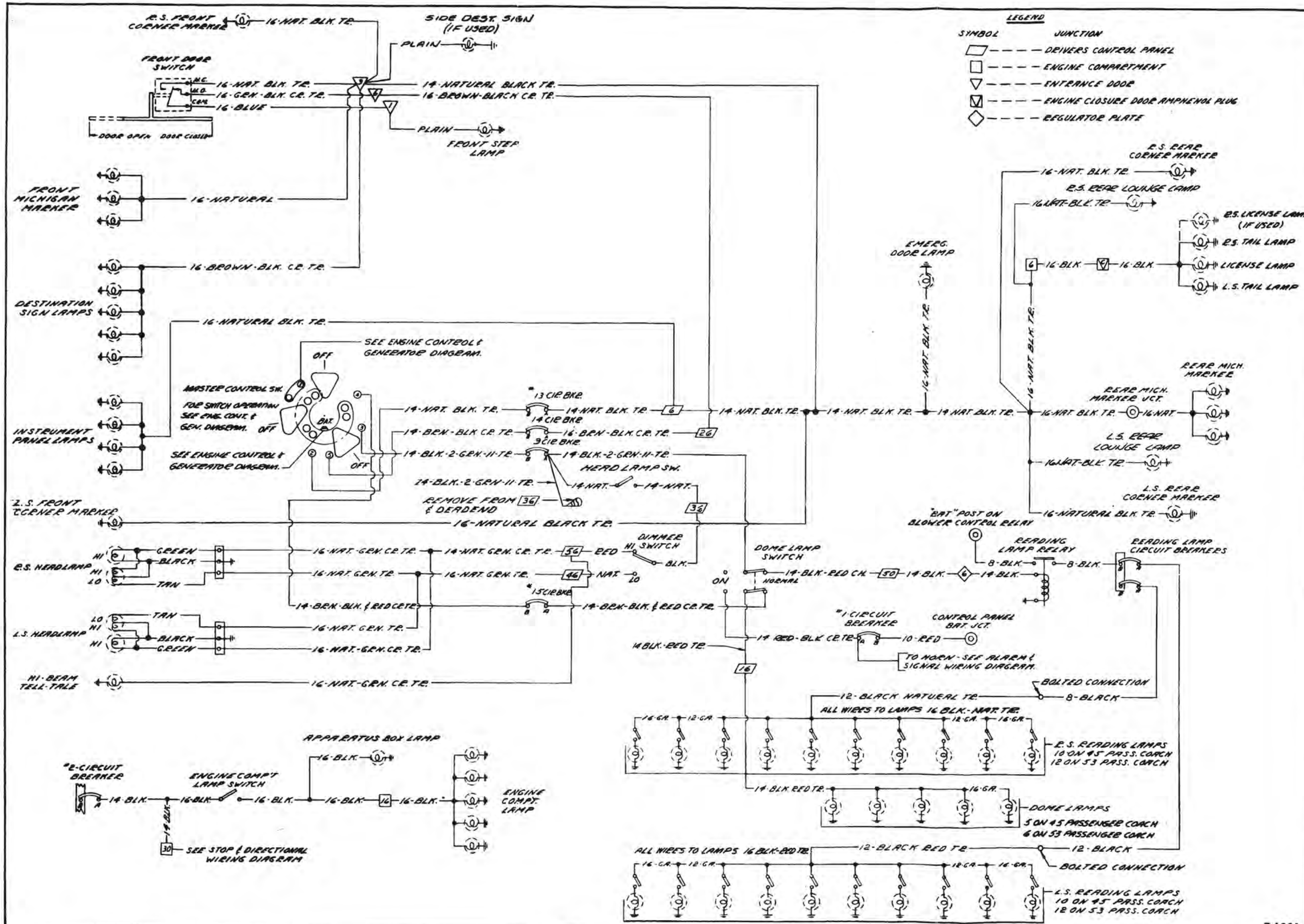
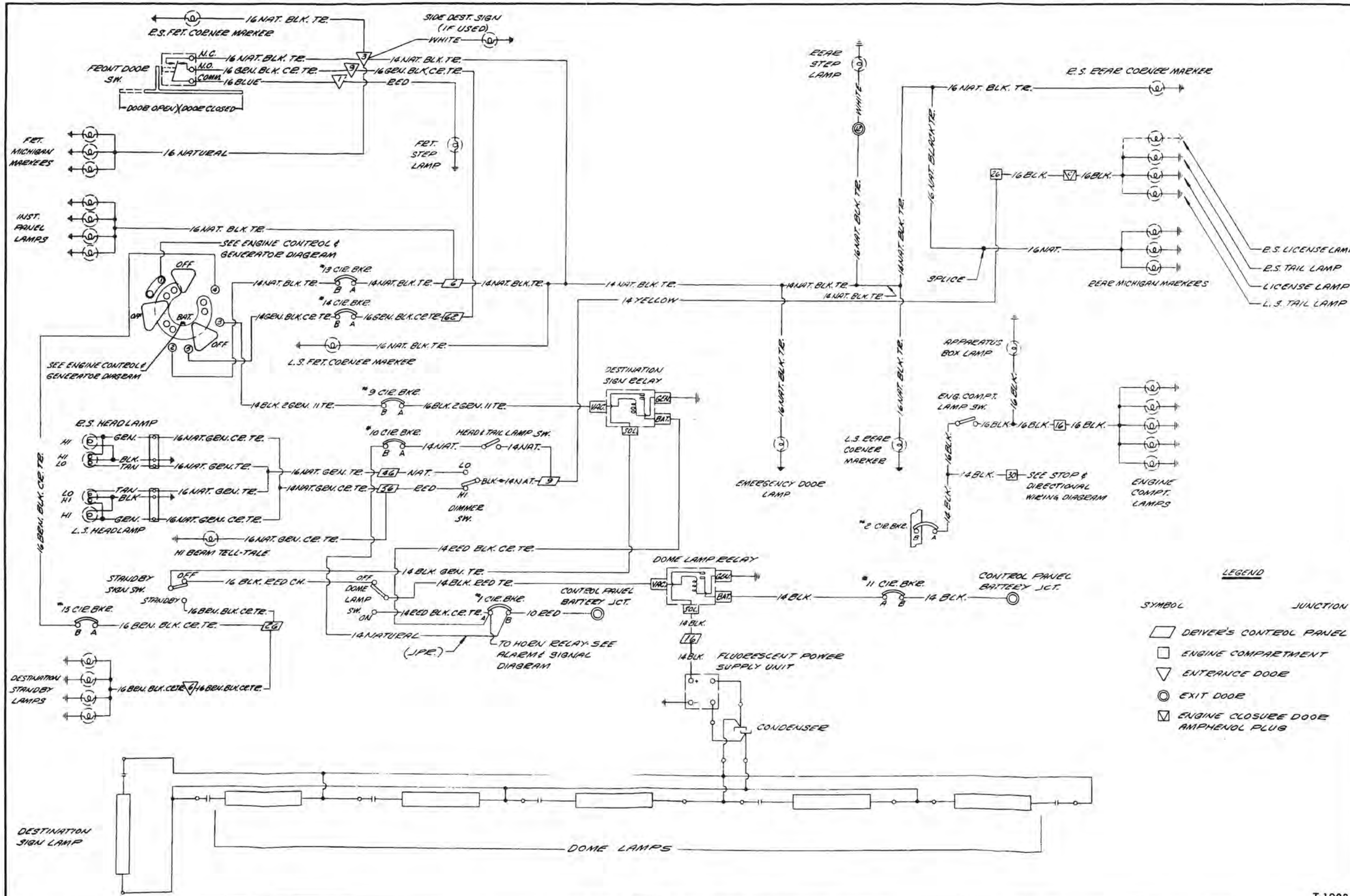
MD-89473-B—Coach Lighting Wiring Diagram



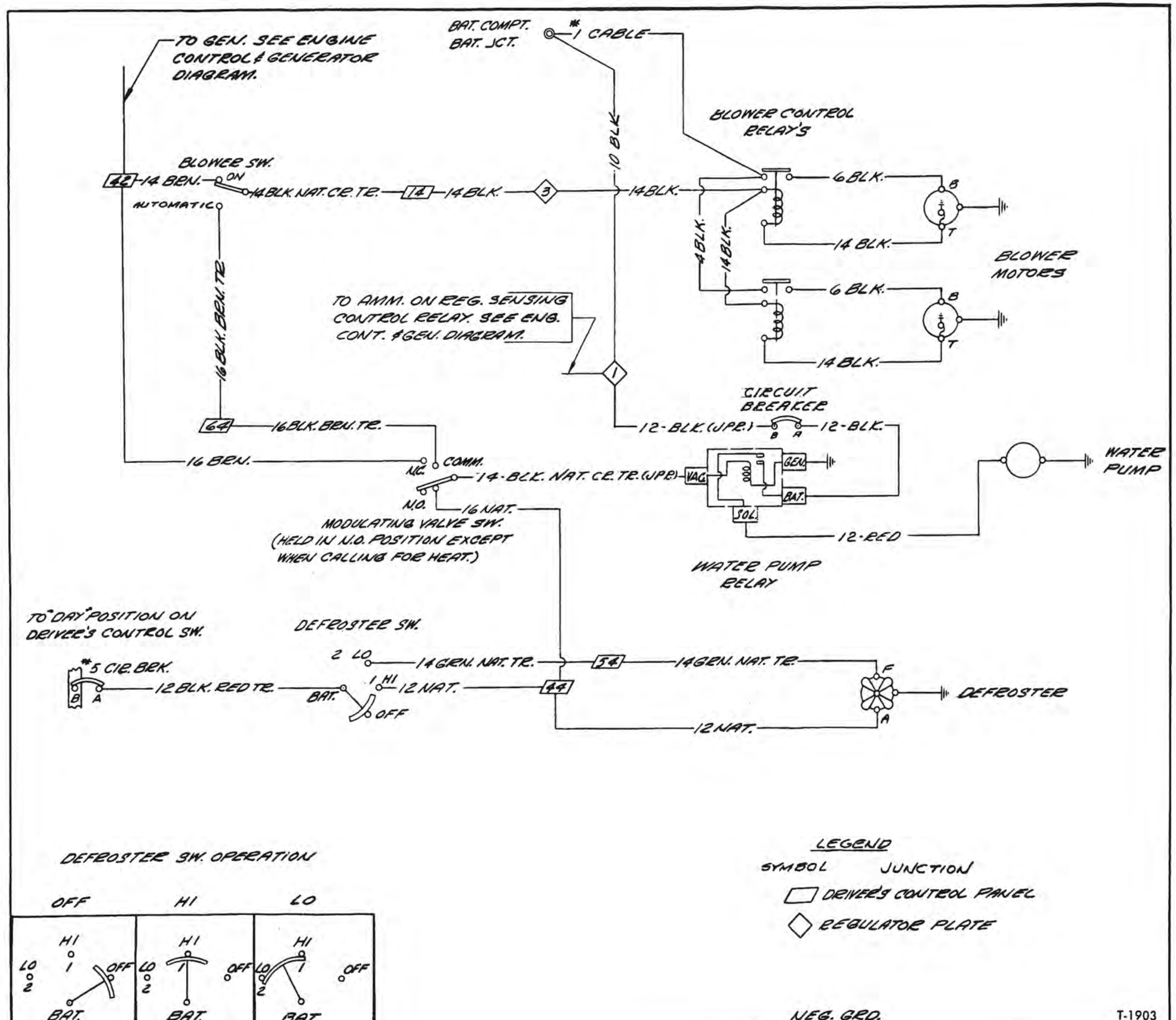
MD-89676—Coach Lighting Wiring Diagram

MD-89676

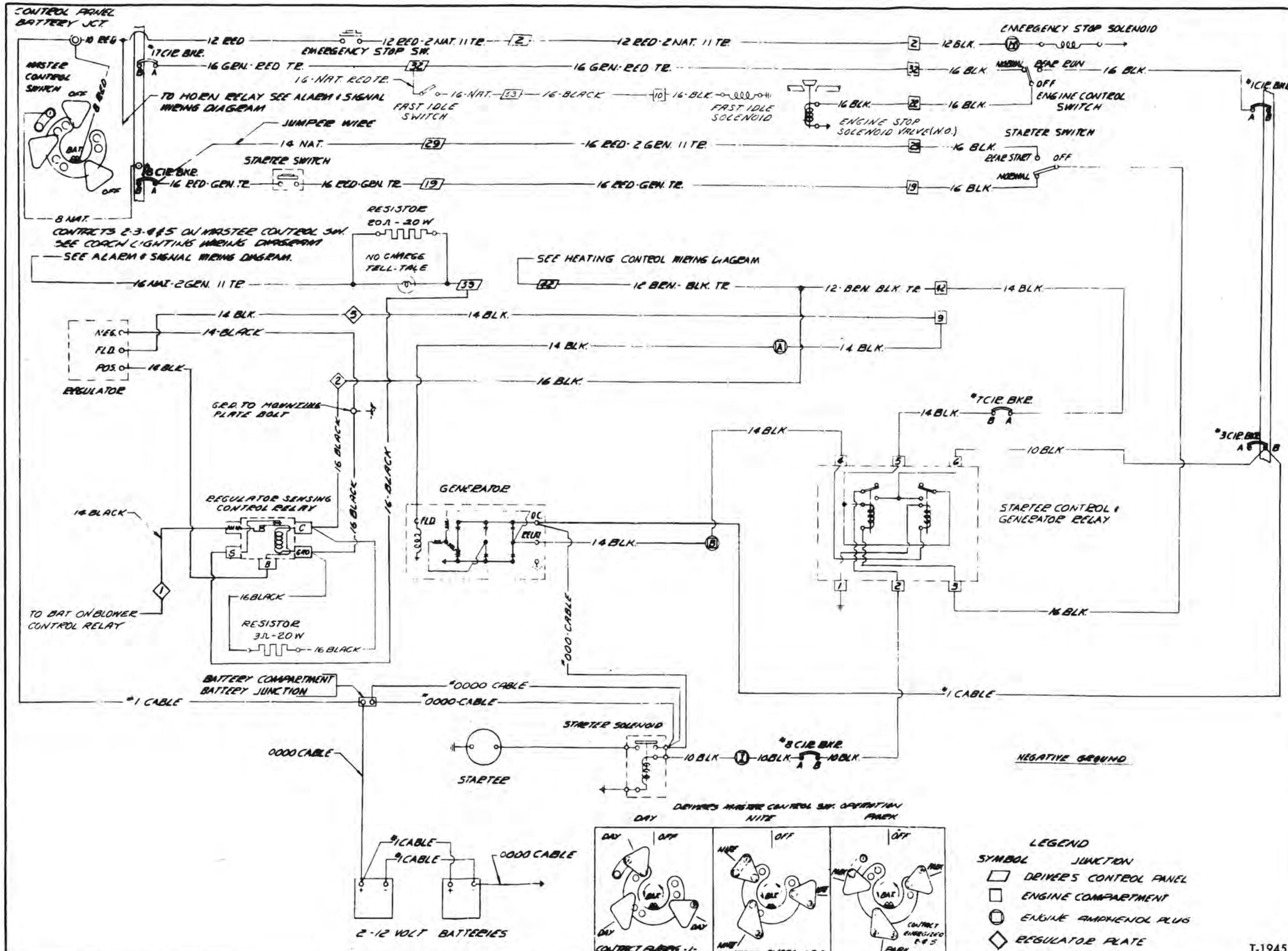


MD-93651—Coach Lighting Wiring Diagram

MD-93651

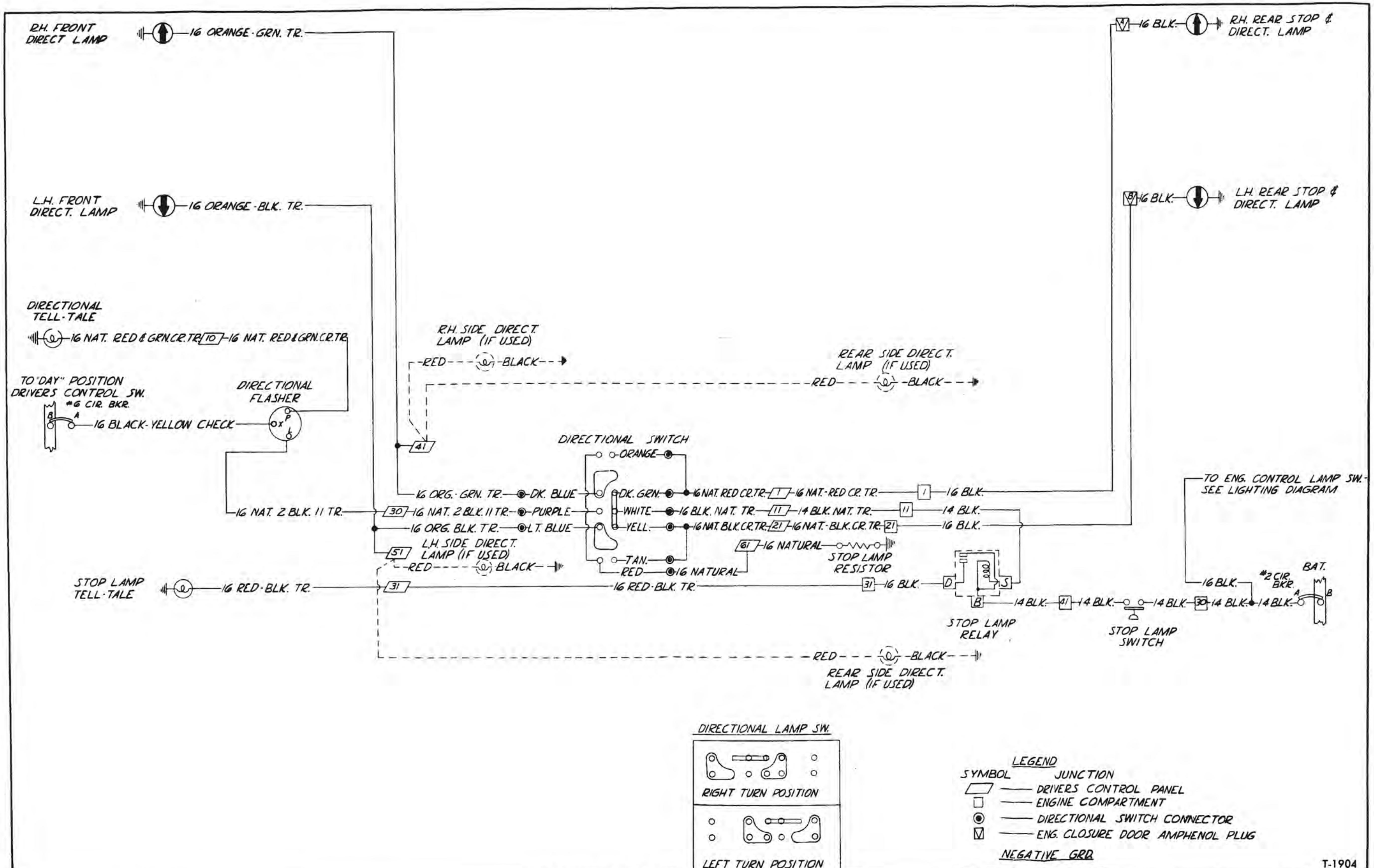


MD-93671-A—Heating and Ventilating Wiring Diagram



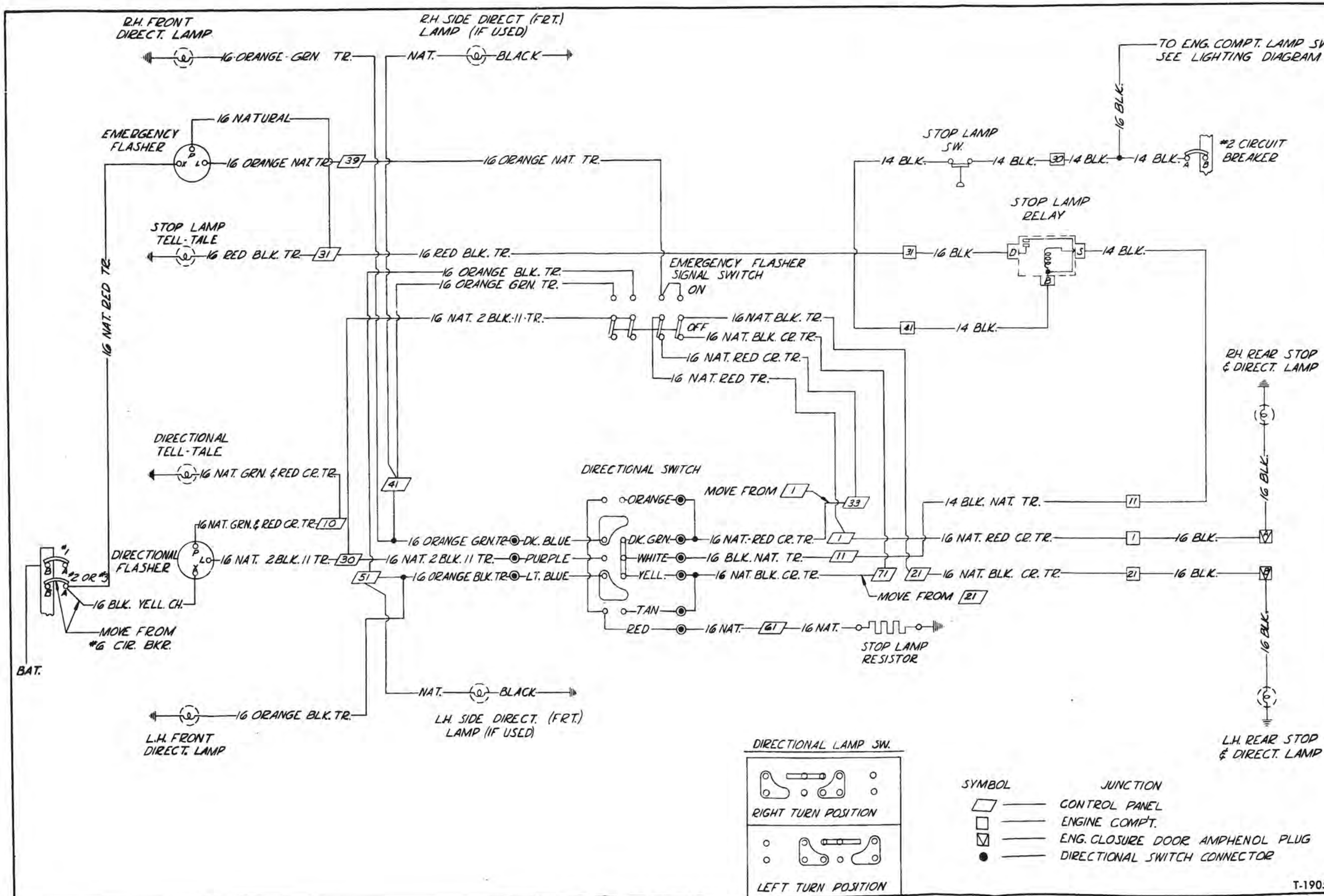
MD-93974—Engine Control and Generator Wiring Diagram—With Fast Idle Device

MD-93974

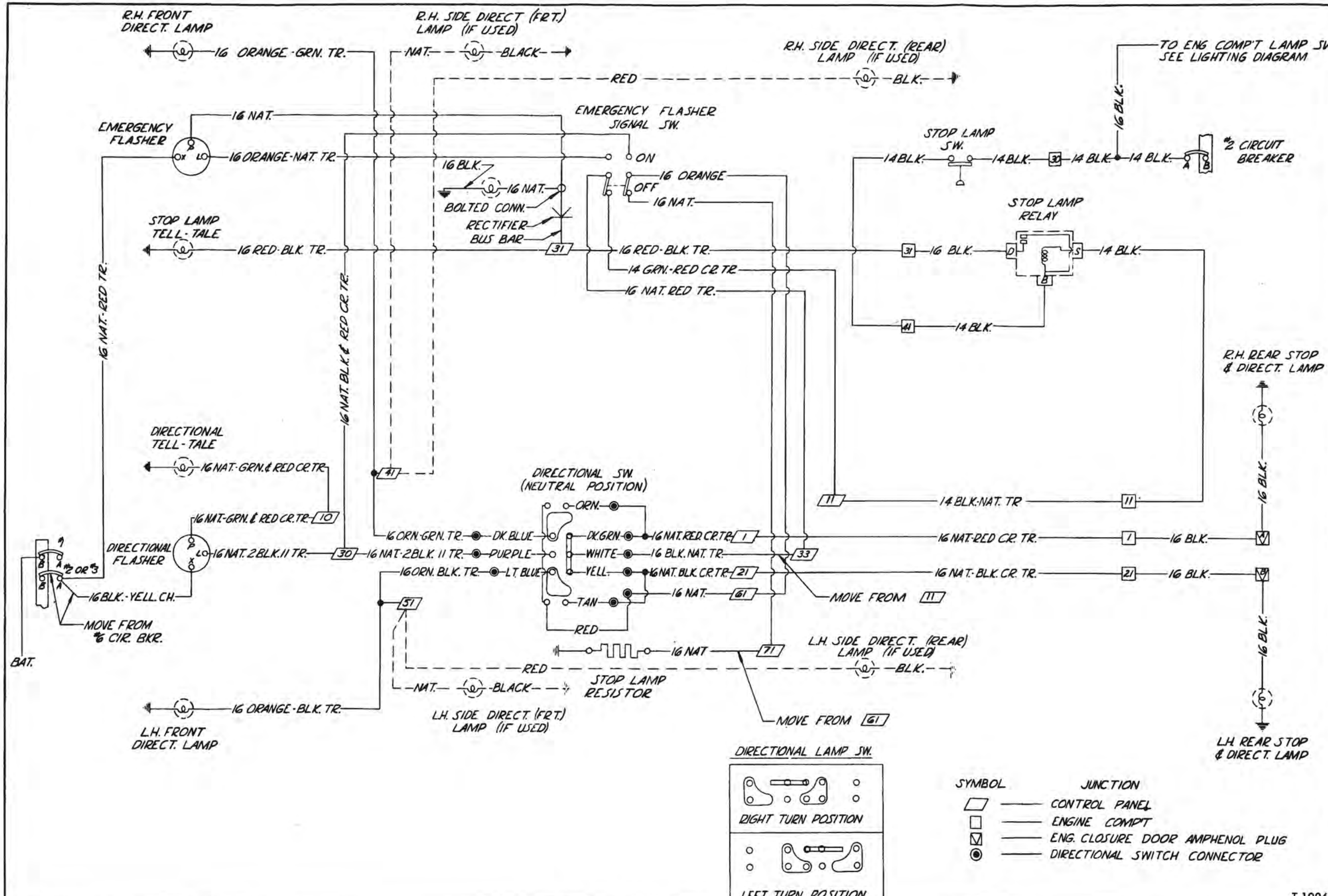


MD-96422—Stop and Directional Lamp Wiring Diagram

MD-96422

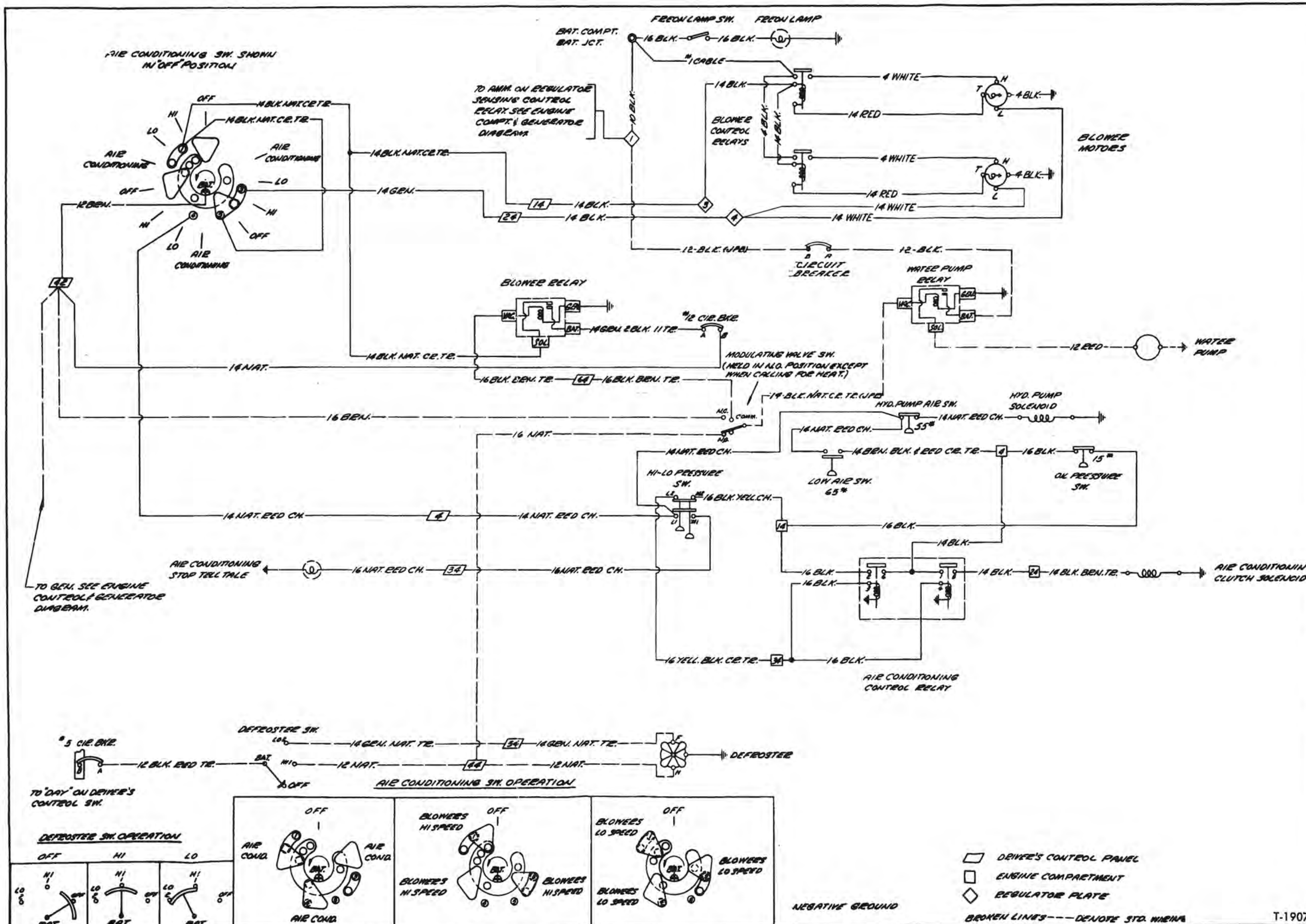


MD-96442—Stop and Directional Lamp Wiring Diagram



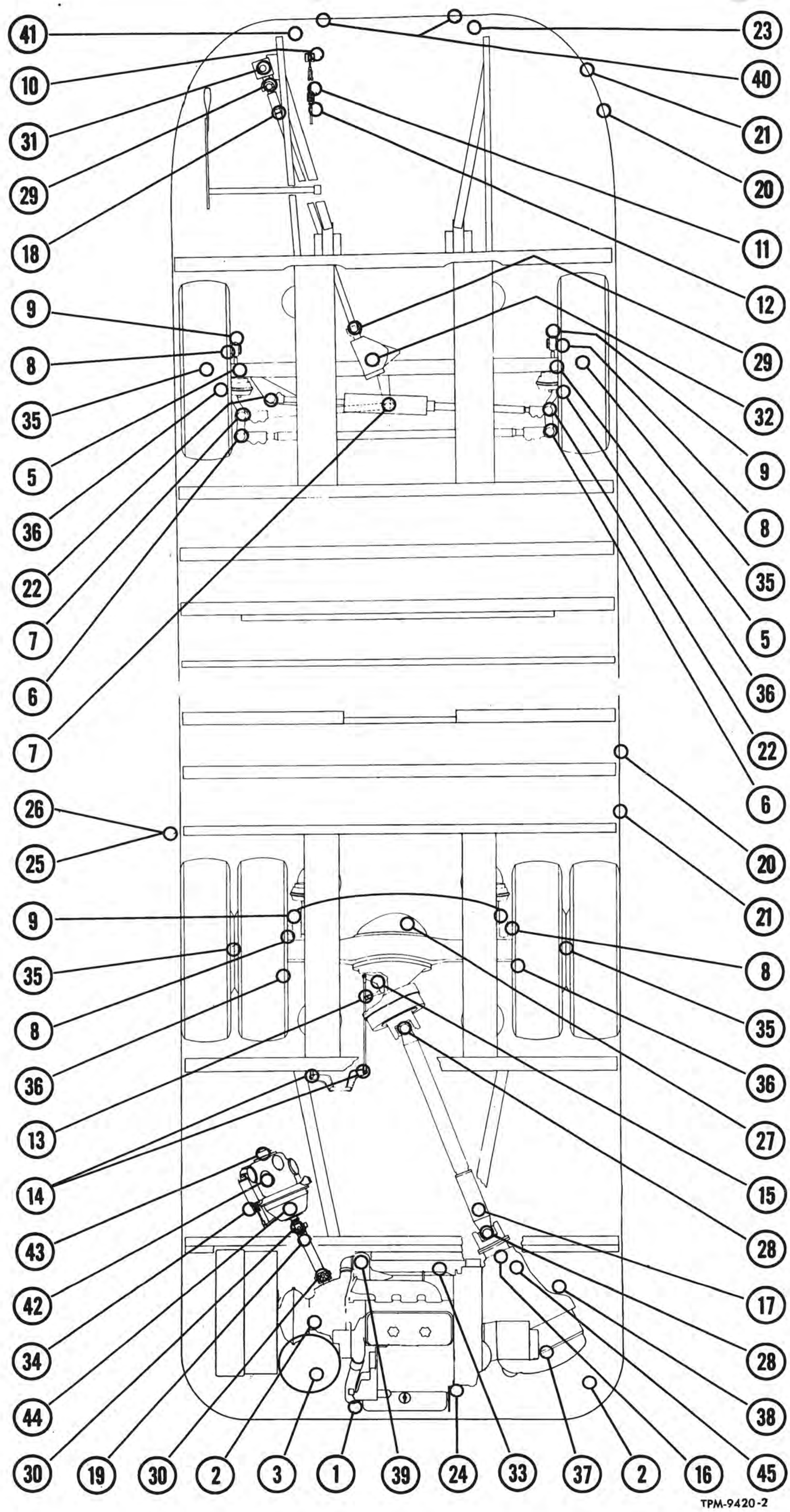
MD-96627—Stop and Directional Lamp Wiring Diagram

MD-96627



MD-97714—Air Conditioning Wiring Diagram

MD-97714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Lubrication Chart

MODELS—TDH 4518, 4519, 5303, 5304, AND SDH 4502, 5302

Item No.	Item	Remarks and Capacities	Miles	Symbol
1	Engine	Keep to "FULL" mark - 27 Qts.	Daily	E
2	Engine Oil Filters	Replace Element at Engine Drain	4,000	-
3	Blower Air Cleaners	Keep to Level Mark - 11 Pts. Ea.	1,500	E
4	Control Rod Linkage	Oil Can, Brush, or Spray	1,500	E
5	Steering Knuckles	Four Fittings - Two Each Side	1,500	C
6	Steering Tie Rod Ends	Two Fittings - One Each End	1,500	C
7	Steering Drag Link Ends	Two Fittings - One Each End	1,500	C
8	Brake Camshafts - F. & R.	Four Fittings - One Ea. - Apply Sparingly	1,500	C
9	Slack Adjusters	Four Fittings - One Each	1,500	C
10	Accelerator Pedal	One Fitting	1,500	C
11	Accelerator Interlock Lever	One Fitting	1,500	C
12	Accelerator Control Lever	One Fitting	1,500	C
13	Parking Brake Camshaft	One Fitting	1,500	C
14	Parking Brake Relay Levers	Two Fittings - One Each	1,500	C
15	Parking Brake Bell Crank	One Fitting	1,500	C
16	Speedometer Adapter	One Fitting	1,500	C
17	Propeller Shaft Slip Joint	One Fitting	1,500	C
18	Steering Drive Shaft Slip Joint	One Fitting	1,500	C
19	Air Cond. Compressor Drive Slip Joint	One Fitting - Very Sparingly	3,000	S26
20	Door Hinge Bushings and Levers	One Fitting - F. - Upper	1,500	C
		Four Fittings - R. - 2 Upper, 2 Lower	1,500	C
21	Door Engine and Cylinder - F. & R.	Thru Plug - 1 Oz.	15,000	E
22	Power Steering Cylinder Ends (*)	Two Fittings	1,500	C
23	Destination Sign Gear and Chain	Apply Sparingly	1,500	C
24	Power Steering System (*)	To Level Mark on Dipstick	1,500	S19
25	Battery Slide	Apply	As Req'd.	C
26	Battery Terminals	Keep Coated	As Req'd.	S3
27	Rear Axle Differential	To Level of Filler Plug	1,500	MP
		Drain and Refill - 26 Pts. - 53 Pass.	15,000	MP
		22 Pts. - 45 Pass.	15,000	MP
28	Propeller Shaft U-Joints	Two Fittings - One Each Joint	1,500	GO
29	Steering Drive Shaft U-Joints	Two Fittings - One Each Joint	1,500	GO
30	Air Cond. Compressor Drive U-Joints	Two Fittings - One Each Joint	1,500	S26
31	Steering Bevel Gear Housing	To Level of Breather	1,500	SG
32	Steering Gear Housing (At Axle)	To Level of Breather	1,500	SG
33	Starter	See Instructions	-	-
34	Air Cond. Clutch Air Cylinder	Thru Plug Opening - 1 Oz.	10,000	E
35	Wheel Bearings	Hand Pack or Use Lubricator Do Not Use Pressure Gun	15,000	S2
36	Brake Shoe Anchor Pins	8 Fittings - 2 Each Wheel	15,000	S2
37	Transmission	Refer to GM Hydraulic Drive Manual (Model VH)		
		Check Level	3,000	
		Drain and Refill (26 Qts.)	25,000	
38	Transmission Oil Filter	Replace Element	6,000	-
39	Radiator Shutter Air Filter (*)	1 Oz. Thru Plug	3,000	S13
40	Windshield Wiper Shaft	Two Fittings (Apply Sparingly)	5,000	C
41	Windshield Wiper Oiler (*)	To Level of Filler Plug	5,000	S7
42	Air Cond. Condenser Fan Drive	See Instructions	-	S19
43	Air Cond. Compressor	See Instructions	-	S25
44	Air Cond. Compressor Clutch Shaft	Pack at Assembly	-	S26
45	Speedometer and Tachometer Cables (*)	Coat Inside Cable	25,000	SG

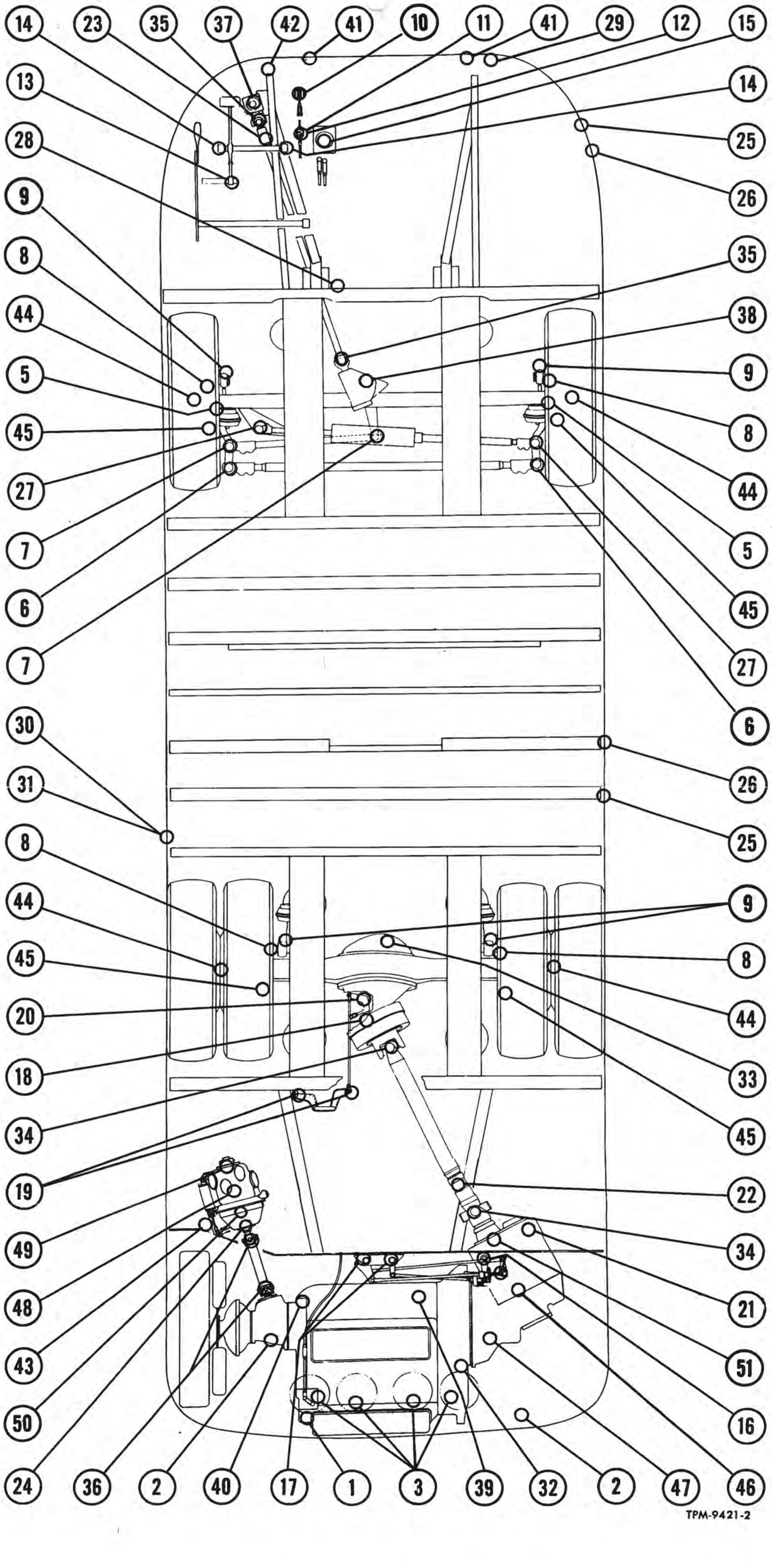
* When Used.

X-6526

LUBRICANT SYMBOLS

E - Engine Oil
MP - Multi-Purpose Gear Lubricant
GO - Straight Mineral Gear Lubricant
C - Chassis Lubricant
SG - Steering Gear Lubricant
S2 - High Temperature Grease

S3 - Petrolatum - Petroleum Jelly
S7 - Refrigeration Machine Oil
S13 - Radiator Shutter Fluid
S19 - Type A Fluid
S25 - Air Conditioning Compressor Oil
S26 - Special Multi-Purpose Grease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Lubrication Chart

MODELS—TDM 4518, 4519, 5303, 5304, AND SDM 4502, 5302

Item No.	Item	Remarks & Capacities	Miles	Symbol
1	Engine	Keep to "FULL" mark - 27 Qts. - 6 Cyl.	Daily	E
		33 Qts. - 8 Cyl.	Daily	E
2	Engine Oil Filters	Replace Element at Engine Drain	4,000	-
3	Blower Air Cleaners	Keep to Level Mark - 8 Cyl. - 2 Qts. Ea.	1,500	E
		6 Cyl. - 5-1/2 Qts.	1,500	E
4	Control Rod Linkage	Oil Can, Brush, or Spray	1,500	E
5	Steering Knuckles	Four Fittings - Two Each Side	1,500	C
6	Steering Tie Rod Ends	Two Fittings - One Each End	1,500	C
7	Steering Drag Link Ends	Two Fittings - One Each End	1,500	C
8	Brake Camshafts - F. & R.	Four Fittings - One Ea. - Apply Sparingly	1,500	C
9	Slack Adjusters	Four Fittings - One Each	1,500	C
10	Accelerator Pedal	One Fitting	1,500	C
11	Accelerator Interlock Lever	One Fitting	1,500	C
12	Accelerator Control Lever	One Fitting	1,500	C
13	Clutch Pedal	One Fitting	1,500	C
14	Clutch Control Cross Shaft	One Fitting Each End	1,500	C
15	Transmission Control Tower	One Fitting	1,500	C
16	Transmission Control Levers	Two Fittings	1,500	C
17	Control Rods Bell Crank Pins	Two Fittings 6V - Three Fittings 8V	1,500	C
18	Parking Brake Camshaft	One Fitting	1,500	C
19	Parking Brake Relay Levers	Two Fittings - One Each	1,500	C
20	Parking Brake Bell Crank	One Fitting	1,500	C
21	Speedometer Adapter	One Fitting	1,500	C
22	Propeller Shaft Slip Joint	One Fitting	1,500	C
23	Steering Drive Shaft Slip Joint	One Fitting	1,500	C
24	Air Cond. Compressor Drive Slip Joint	One Fitting - Very Sparingly	3,000	S26
25	Door Hinge Bushings and Levers	One Fitting - F. - Upper	1,500	C
		Four Fittings - R. - 2 Upper, 2 Lower	1,500	C
26	Door Engine and Cylinder - F. & R.	Thru Plug - 1 oz.	15,000	E
27	Power Steering Cylinder Ends (*)	Two Fittings	1,500	C
28	Intermediate Control Levers - SDM	Two Fittings - 2 F. - 1 R.	15,000	C
29	Destination Sign Gear and Chain	Apply Sparingly	1,500	C
30	Battery Slide	Apply	As Req'd.	C
31	Battery Terminals	Keep Coated	As Req'd.	S3
32	Power Steering System (*)	To Level Mark on Dipstick	1,500	S19
33	Rear Axle Differential	To Level of Filler Plug	1,500	MP
		Drain and Refill - 26 Pts. - 53 Pass.	15,000	MP
		22 Pts. - 45 Pass.	15,000	MP
34	Propeller Shaft U-Joints	Two Fittings - One Each Joint	1,500	GO
35	Steering Drive Shaft U-Joints	Two Fittings - One Each Joint	1,500	GO
36	Air Cond. Compressor Drive U-Joints	Two Fittings - One Each Joint	1,500	S26
37	Steering Bevel Gear Housing	To Level of Breather	3,000	SG
38	Steering Gear Housing (At Axle)	To Level of Breather	3,000	SG
39	Starter	See Instructions	-	-
40	Radiator Shutter Air Filter (*)	1 Oz. Thru Plug	3,000	S13
41	Windshield Wiper Shaft	Two Fittings (Sparingly)	5,000	C
42	Windshield Wiper Oiler (*)	To Level of Filler Plug	5,000	S7
43	Air Cond. Clutch Air Cylinder	Thru Plug Opening - 1 Oz.	10,000	E
44	Wheel Bearings	Hand Pack or Use Lubricator Do Not Use Pressure Gun	15,000	S2
45	Brake Shoe Anchor Pins	8 Fittings - 2 Each Wheel	15,000	S2
46	Transmission	To Mark on Dipstick	1,500	E
		Drain and Refill - 11.5 Qts.8V - 12.5 Qts.6V	15,000	E
47	Transmission Oil Filter	Replace Assembly	4,000	-
48	Air Cond. Condenser Fan Drive	See Instructions	-	S19
49	Air Cond. Compressor	See Instructions	-	S25
50	Air Cond. Compressor Clutch Shaft	Pack at Assembly	-	S26
51	Speedometer and Tachometer Cables (*)	Coat Inside Cable	25,000	SG

* When Used.

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LUBRICANT SYMBOLS

E - Engine Oil
MP - Multi-Purpose Gear Lubricant
GO - Straight Mineral Gear Lubricant
C - Chassis Lubricant
SG - Steering Gear Lubricant
S2 - High Temperature Grease
S3 - Petrolatum - Petroleum Jelly
S7 - Refrigeration Machine Oil
S13 - Radiator Shutter Fluid
S19 - Type A Fluid
S25 - Air Conditioning Compressor Oil
S26 - Special Multi-Purpose Grease