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DEPARTMENT OF THE ARMY
TECHNICAL MANUAL

DEPARTMENT OF THE AIR
FORCE TECHNICAL ORDER

TM 9-1827A
TO 19-75CAAB-1

ORDNANCE MAINTENANCE

POWER BRAKE SYSTEMS

(BENDIX-WESTINGHOUSE)

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DEPARTMENTS OF THE ARMY and THE AIR FORCE
UNCLASSIFIED FEBRUARY 1953

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TM 9-1827A/TO 19-75CAAB-1

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POWER BRAKE SYSTEMS

(BENDIX-WESTINGHOUSE)

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DEPARTMENTS OF THE ARMY AND
THE AIR FORCE
WASHINGTON 25, D. C., 13 February 1953

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CHAPTER 1

INTRODUCTION

1. Scope

- a. This manual is published for the information and guidance of personnel responsible for field and for depot maintenance of this matériel. It contains information on maintenance which is beyond the scope of the tools, equipment, or supplies normally available to using organizations. This manual does not contain information which is intended primarily for the using organization, since such information is available to ordnance maintenance personnel in the pertinent operator's technical manuals or field manuals.
- b. This manual contains a description of and procedures for disassembly, inspection, repair, rebuild, and assembly of Bendix-Westinghouse air brake equipment. The appendix contains a list of current references, including supply catalogs, technical manuals, and other available publications applicable to the matériel.
- c. This manual differs from TM 9-1827A, 21 December 1943, as follows:
 - (1) Adds information on field and depot maintenance allocating; forms, records, and reports; improvised tools for field and depot maintenance; description of air brake systems; types of compressors; trouble shooting; serviceability standards; type D-1 and type TC brake valves; rotochambers; tubing and tubing fittings; two-way valve; and combined limiting and quick release valve.
 - (2) Revises information on special tools; removal, installation, and rebuild procedure; and illustrations.

2. Field and Depot Maintenance Allocation

The publication of instructions for complete disassembly and rebuild is not to be construed as authority for the performance by field maintenance units of those functions which are restricted to depot shops and arsenals. In general, the prescribed maintenance responsibilities will apply as reflected in the allocation of maintenance parts listed in the appropriate columns of the current ORD 8 supply catalog pertaining to the Ordnance vehicles on which this air brake equipment is used. Instructions for depot maintenance are to be used by maintenance companies in the field only when the tactical situation makes the repair

functions imperative. Supply of parts listed in the depot guide column of ORD 8 supply catalogs will be made to field maintenance only when the emergency nature of the maintenance to be performed has been certified by a responsible officer of the requisitioning organization.

3. Forms, Records, and Reports

a. General. Responsibility for the proper execution of forms, records, and reports rests upon the officers of all units maintaining this equipment. However, the value of accurate records must be fully appreciated by all persons responsible for their compilation, maintenance, and use. Records, reports, and authorized forms normally are utilized to indicate the type, quantity, and condition of matériel to be inspected, to be repaired, or to be used in repair. Properly executed forms convey authorization and serve as records for repair or replacement of matériel in the hands of troops and for delivery of materiel requiring further repair to ordnance shops in arsenals, depots, etc. The forms, records, and reports establish the work required, the progress of the work within the shops, and the status of the matériel upon completion of its repair.

b. Authorized Forms. The forms, records, and reports generally applicable to units maintaining this equipment are listed in the appendix. No forms other than those approved for the Department of the Army will be used. Pending availability of forms listed, old forms may be used. For a current and complete listing of all forms, see current SR 310-20-6.

c. Field Reports of Accidents. The reports necessary to comply with the requirements of the Army safety program are prescribed in detail in the SR 385-10-40 series of special regulations. These reports are required whenever accidents occur involving injury to personnel or damage to matériel.

d. Report of Unsatisfactory Equipment or Materials. Any suggestions for improvement in design, maintenance, safety, and efficiency of operation prompted by chronic failure or malfunction of the matériel, spare parts, or equipment or as to defects in the application or effect of prescribed petroleum fuel, lubricants, and/or preserving materials will be reported through technical channels, as prescribed in SR 700-45-5, to the Chief of Ordnance, Washington 25, D. C., ATTN: ORDFM, using DA Form 468. Such suggestions are encouraged in order that other organizations may benefit.

Note. Do not report all failures that occur. Report only REPEATED or RECURRENT failures or malfunctions which indicate unsatisfactory design or material. However, reports will always be made in the event that exceptionally costly equipment is involved. See also SR 700-45-5 and the printed instructions on DA Form 468.

CHAPTER 2

PARTS, SPECIAL TOOLS, AND EQUIPMENT FOR FIELD AND DEPOT MAINTENANCE

4. General

Tools and equipment and additional spare parts over and above those available to the using organization are supplied to ordnance field maintenance units and depots for maintaining, repairing, and/or rebuilding the matériel.

5. Parts

Parts are listed in ORD 8 portion of the Department of the Army Supply Catalog covering the Ordnance vehicles on which the matériel is used. These catalogs are the authority for requisitioning replacements. Parts not listed in an ORD 8 catalog, but required by depot shops in rebuild operations may be requisitioned from the listing in the corresponding ORD 9 catalog. Requisitions for ORD 9 parts will contain a complete justification of requirements.

6. Common Tools and Equipment

Standard and commonly used tools and equipment having general application to this matériel are listed in Department of the Army Supply Catalogs ORD 6 SNL J-8, Section 7, Motor Vehicle Assembly Company (Field) Maintenance Tool Set; ORD 6 SNL J-8, Section 13, Automotive (Field) Maintenance Shop Set; ORD 6 SNL J-9, Section 2, Automotive or Armament Depot Maintenance Headquarters and Service Company Shop Set; and ORD 6 SNL J-10, Section 4, General Mechanic's Tool Set. The above catalogs are the authority for requisitioning replacements. Such tools and equipment are not specifically identified in this manual.

7. Special Tools and Equipment

The special tools and equipment tabulated in table I are listed in Department of the Army Supply Catalog ORD 6 SNL J-16, Section 11. The tabulation contains only those special tools and equipment necessary to perform the operations described in this manual, is included for information only, and is not to be used as a basis for requisitions.

Note. Special tool sets in ORD 6 SNL J-16, Section 11, also contain standard and commonly used tools and equipment specifically applicable to this matériel in addition to the special tools.

Table I. Special Tools and Equipment for Field and Depot Maintenance

Item	Identifying number	References		Use
		Fig.	Par.	
BIT, valve grinding, ¾ x 2½ in. lg. 41-B-660		1, 29, 122, 149	31, 94, 103	Grinding unloader valves, relay emergency, and relay supply valves. Used with tool 41-T-3381-15.
BIT, valve grinding, exhaust, ¾ x 2½ in. lg. 41-B-661		1, 88	63	Grinding exhaust valve of B-4-B brake valve. Used with tool 41-T-3381-15.
BIT, inlet valve grinding, ¾ x 2½ in. lg. 41-B-662		1, 81	63	Grinding inlet valve of B-4-B brake valve. Used with tool 41-T-3381-15.
BUSHING, pilot ... 7083458 (41-B-2180-800) ..		3, 133	98	Pilot for reaming emergency valve seat, RE-1 and RE-1C valves. Used with reamer 7083457.
COLLET, slip 7083459 (41-C-2485-300) ..		1, 132	98	Used with valve grinding tool 41-T-3381-15 for grinding supply valve, RE-1 and RE-1C valves.
DISK, lapping, con- sisting of stone and holder 7083460 (41-D-1261-425) ..		1	31	Lapping discharge valve seat, types E and F-12 compressors.
DISK, lapping, valve seat, disk type 41-D-1261-500		1	31	Lapping discharge valve seats, type U compressor cylinder heads. Used with tool 41-T-3381-15 and bit 41-B-660.
GAGE, pressure, air, test, 3½ in. dial, 0 to 150 lb. range .. 45-G-140		3		Accurate testing of various compressed air devices.

Table I. Special Tools and Equipment for Field and Depot Maintenance
—Continued

Item	Identifying number	References		Use
		Fig.	Par.	
REAMER, carb-S, hand, stght-flute, emergency valve ..	41-R-830	2	103	Reaming type RE emergency valve seat.
REAMER, carb-S, hand, stght-flute, exhaust valve ..	41-R-832	2	63	Reaming exhaust valve seat, B- 4-B brake valve.
REAMER, carb-S, hand, stght-flute, intake valve	41-R-834	2	63, 94	Reaming inlet valve seat, B- 4-B brake valve.
REAMER, carb-S, hand, valve seat, disk type, seating, assy	41-R-1396	2, 31	31	Facing discharge valve seats, type U compressor cylinder head.
REAMER, carb-S, T handle, emer- gency valve	41-R-2125	3, 148	103	Reaming emer- gency valve seat, type RE valve.
REAMER, carb-S, T handle, valve seat, exhaust	41-R-2175	3, 84	63	Final seating ex- haust valve seat, B-4-B brake valve.
REAMER, carb-S, T handle, valve seat, intake	41-R-2178	3, 82, 123	63, 94	Final seating in- let valve seat, B-4-B brake valve.
REAMER, HSS, hand, stght-shank, stght - flute, un- loading valve seat, 5 and 7½ cu. ft. compressor	41-R-2309	1,30	31	Reaming unloader valve seat for type U-7½ cu ft compressor.

Table I. Special Tools and Equipment for Field and Depot Maintenance
—Continued

Item	Identifying number	References		Use
		Fig.	Par.	
REAMER, HSS, hand, stght-shank, stght - flute, unloading valve seat, 12 cu. ft. compressor	41-R-2309-25	1	31	Reaming unloader valve seat for type U 12 cu ft compressor.
REAMER, hand, stght-shank, stght-flute (blade diam. 0.2505 in.)	7950050	1	31	Reaming unloader valve seat for type F-12 compressor.
TOOL, ream and fac-ing, lgh. overall $5\frac{1}{16}$ in.	7083456 (41-T-3308-415) ..	3, 150	103	Reaming and fac-ing emergency valve seat, RE-1 and RE-1C valve.
TOOL, ream and fac-ing, lgh. overall $5\frac{1}{16}$ in.	7083457 (41-T-3308-400) ..	3, 133	98	Reaming and fac-ing supply valve seat, RE-1 and RE-1C valve.
TOOL, lapping, valve seats, disk type ..	41-T-3224	1	31	Lapping discharge valve seat, type U $7\frac{1}{4}$ cu ft cylinder head.
TOOL, valve grind-ing, lower valve ..	41-T-3381-10	2, 69	56	Grinding lower valve compressor governor.
TOOL, valve grind-ing, reciprocating ..	41-T-3381-15	1, 81, 83, 122, 132, 149	31, 63, 94, 98, 103	Reciprocating tool for driving vari-ous grinding tools.
TOOL, valve grind-ing, upper valve ..	41-T-3381-20	2, 68	56	Grinding upper valve compressor governor.
TOOL, valve seating ..	41-T-3383-10	2, 69	56	Seating governor lower valve.
WRENCH, brake ad-justing (comb, hex box and open end, size of opngs $\frac{5}{8}$ and $\frac{1}{4}$ in.)	41-W-867-265	2, 61	55, 57	Removing and re-placing gov-ernor upper valve guide.

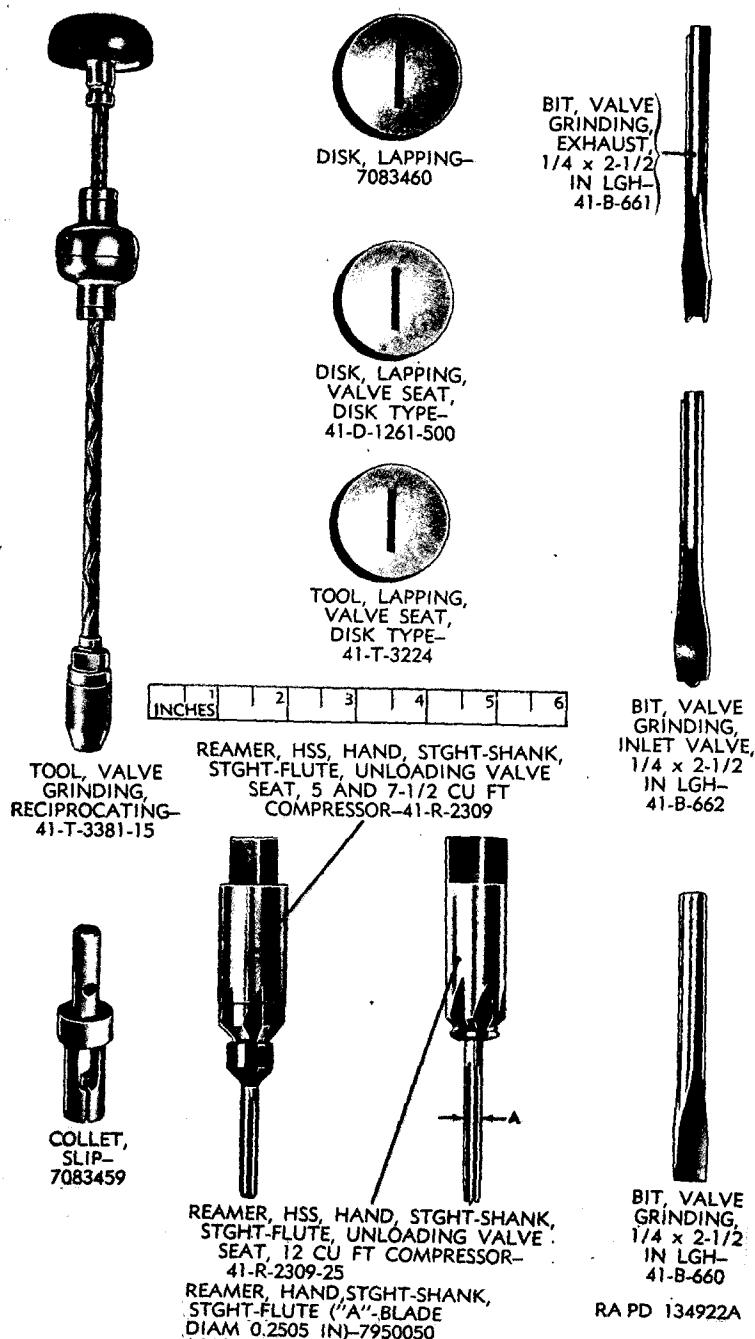


Figure 1. Lapping, grinding, and reaming tools.



TOOL, VALVE
SEATING-
41-T-3383-10



TOOL, VALVE
GRINDING,
UPPER VALVE-
41-T-3381-20

WRENCH, BRAKE ADJUSTING (COMB, HEX)
BOX, AND OPEN END, SIZE OF OPENINGS
3/8 AND 1/4 IN)-41-W-867-265



TOOL, VALVE
GRINDING,
LOWER VALVE-
41-T-3381-10



INCHES	1	2	3



REAMER, CARB-S,
HAND, STGHT-
FLUTE, EMERGENCY
VALVE-41-R-830



REAMER, CARB-S,
HAND, STGHT-
FLUTE, EXHAUST
VALVE-41-R-832



REAMER, CARB-S,
HAND, VALVE
SEAT, DISK
TYPE, SEATING,
ASSY-41-R-1396



REAMER, CARB-S,
HAND, STGHT-
FLUTE, INTAKE
VALVE-
41-R-834
RA PD 134923A

Figure 2. Reaming, grinding, and valve replacement tools.

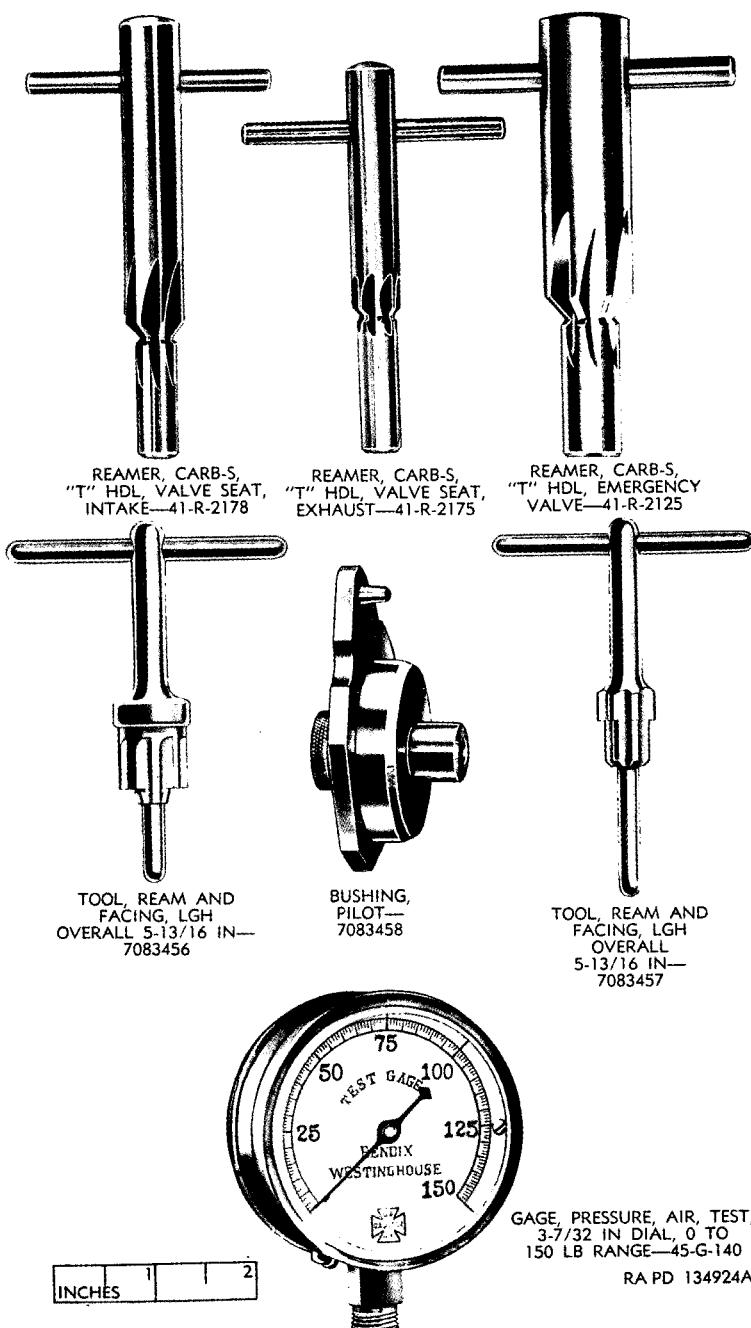


Figure 3. Reaming tools and air gage.

8. Improvised Tools for Field and Depot Maintenance

The improvised tools listed in table II and the dimensioned detail drawings, furnished herein, apply only to field and depot shops. The dimensioned detail drawings are intended to enable these maintenance organizations to fabricate these tools locally, if desired. These tools are of chief value to maintenance organizations engaged in rebuilding a large number of identical components; however, they are not essential for rebuild and are not available for issue. The following data are furnished for information only.

Table II. Improvised Tools for Field and Depot Maintenance

Item	References		Use
	Fig.	Par.	
ADAPTER, orifice	8	25	Mounting orifice plates for compressor efficiency tests.
COVERS, inlet chamber	8	24	Restricting compressor intake for oil passing tests.
Fixture, unloader valve test	5	33	Testing unloader valve leakage of two-cylinder 7 $\frac{1}{4}$ cu. ft. compressors.
Fixture, unloader valve test	6	33	Testing unloader valve leakage of three-cylinder 12 cu. ft. compressors.
Fixture, unloader valve test	7	33	Testing unloader valve leakage of two-cylinder, type E and F-12 compressors.
PLATES, orifice	8	25	Testing compressor efficiency.
WRENCH, diaphragm nut ...	4	62	Removing diaphragm nut from B-4-B brake valve.

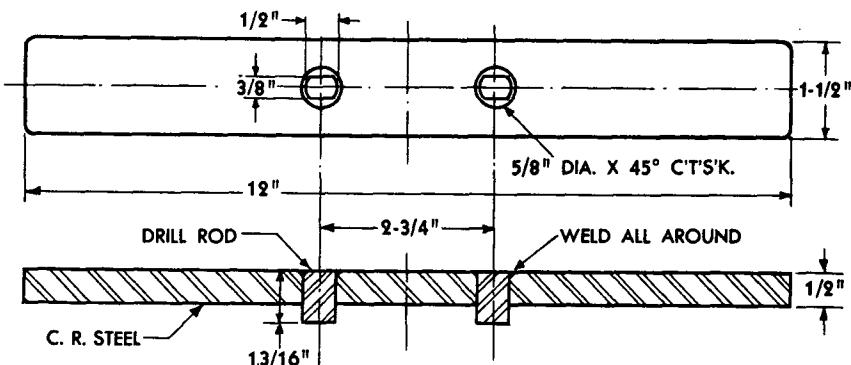


Figure 4. Diaphragm ring wrench for B-4-B brake valve.

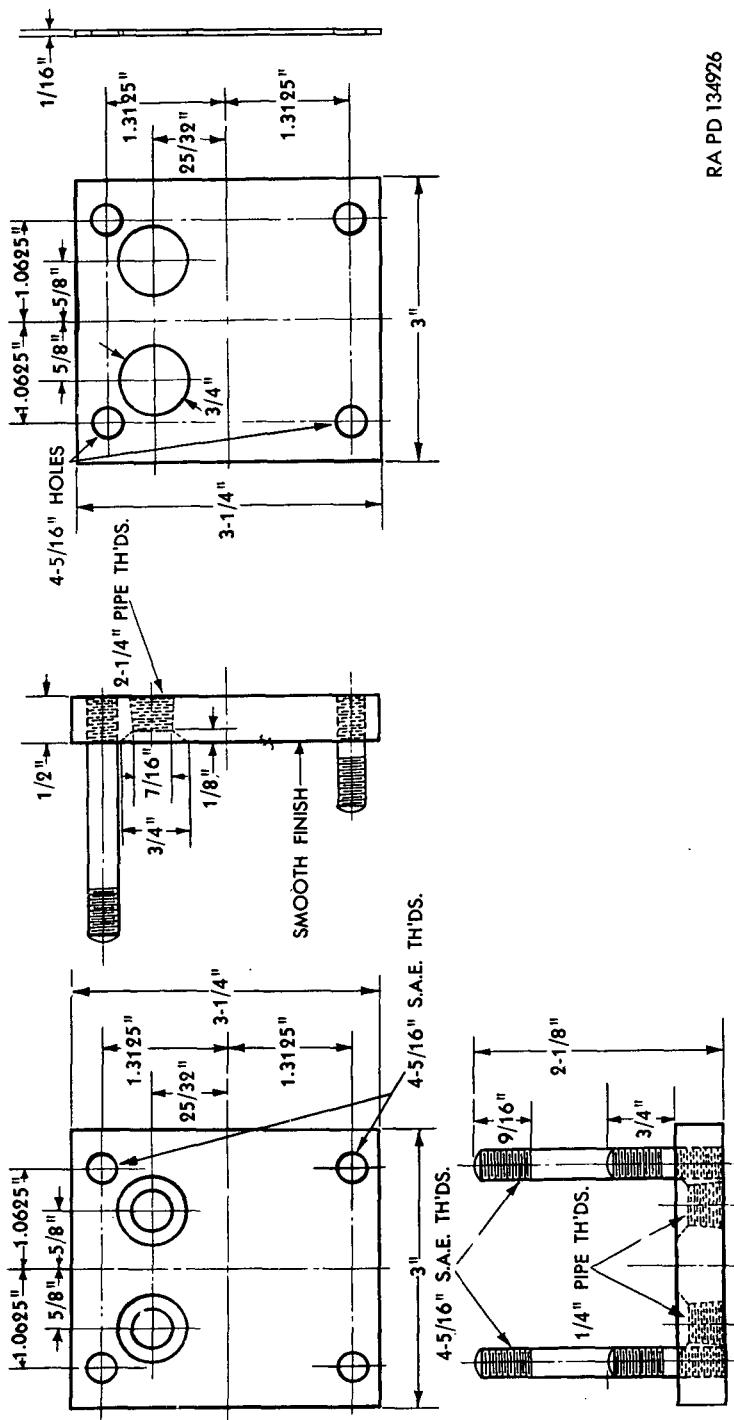


Figure 5. Fixture for testing unloading values of U-7½ compressors.

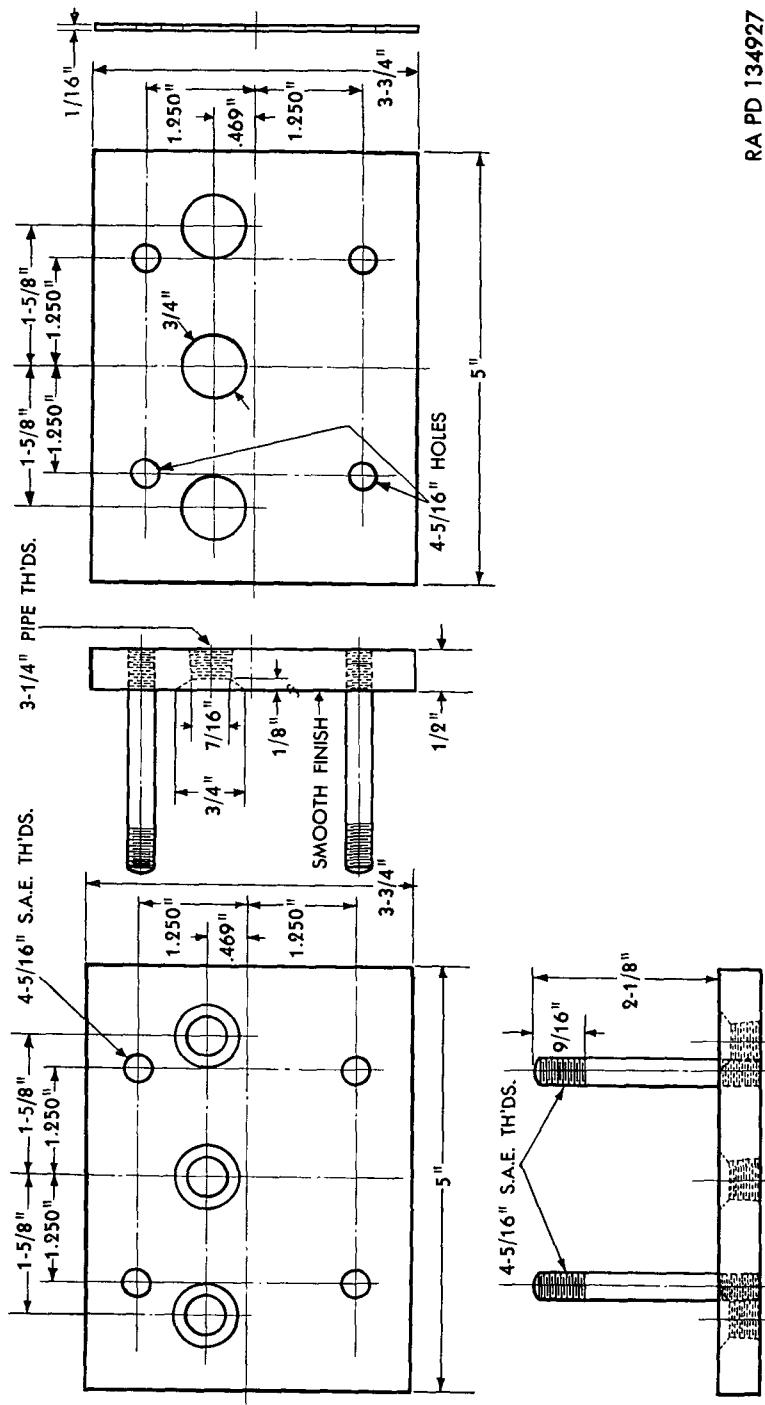


Figure 6. Fixture for testing unloading values of U-12 compressors.

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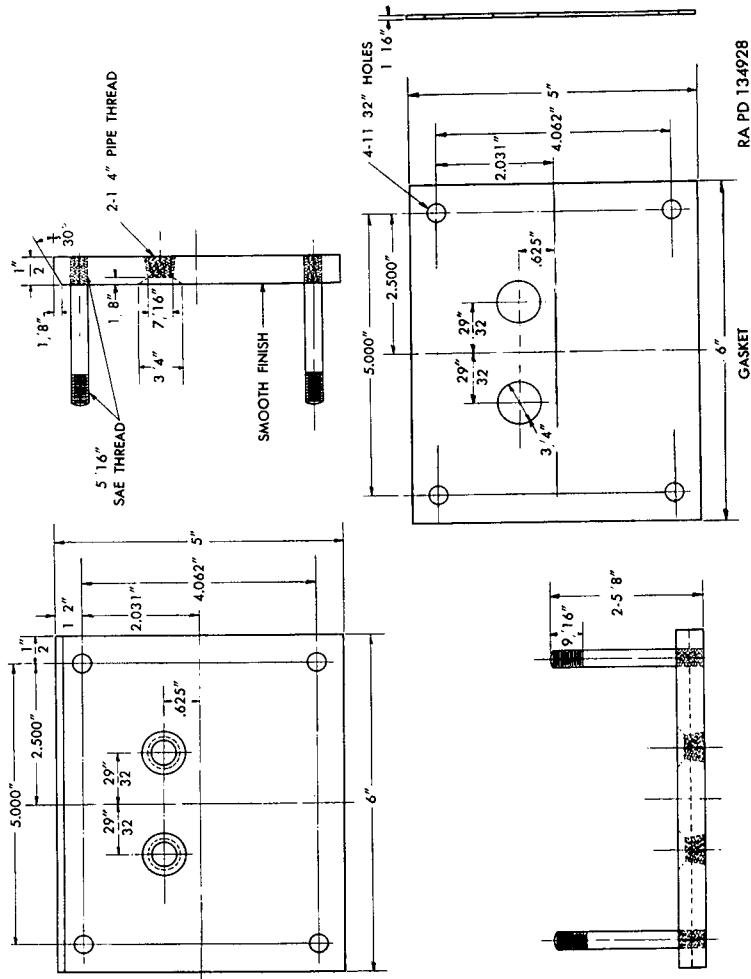


Figure 7. Fixture for testing unloading values of E and F-12 compressors.

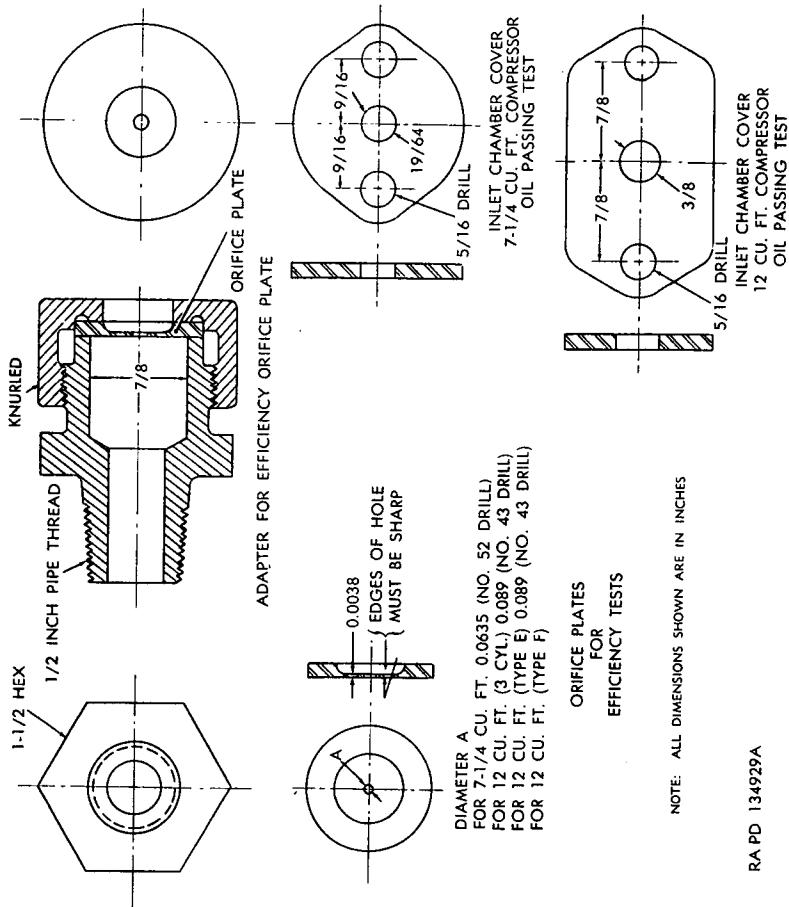


Figure 8. Orifice plates for compressor tests.

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CHAPTER 3

DESCRIPTION OF AIR BRAKE SYSTEMS

Section I. AIR-OPERATED MECHANICAL BRAKES

9. General

Air brake systems in general use are of two types—air-operated mechanical brakes and air-operated hydraulic brakes. In the first mentioned system, the actual application of the brake shoes to the brake drums is mechanical, the air pressure being applied to the mechanism which applies the brake shoes. This air-operated mechanical system includes devices for compressing air, storing it and maintaining the stored air within specified pressure limits, automatic valves which permit selective pressures to be used at option of vehicle operator, and devices which convert air pressure to mechanical leverage.

10. Trucks and Tractors

a. Six-Wheel Trucks. A typical piping diagram, showing the essential air brake devices for six-wheel trucks is shown in figure 9. The compressor delivers air to the first of two connected reservoirs. An air line from the second reservoir leads to the brake valve; a branch from this line delivers reservoir pressure to the compressor governor at all times. The function of governor is to maintain reservoir pressure within predetermined limits. At the high limit, governor admits reservoir pressure to an unloading device in compressor head, stopping compression until reservoir pressure reaches the low limit. At low limit, governor releases unloading device and compression is resumed. An air line from second reservoir leads to a relay valve near rear axles. The brake valve delivers air pressure to front brakes through a quick release valve, and to rear brakes through a relay valve. The quick release valve permits exhaust of air from front brake chambers at the valve without necessity of air travel back to brake valve. The relay valve provides quick brake action at rear wheels. When brake valve delivers pressure to relay valve, the relay valve admits the same pressure to all rear brake chambers from the reservoir. This valve also provides for quick release at the valve. A stop light switch is operated from the service line to relay valve (fig. 9).

b. Four-Wheel Tractors. The piping diaphragm in figure 10 shows a typical arrangement for four-wheel tractors, with certain auxiliary devices. The compressor, governor, brake valve, reservoirs, and brake

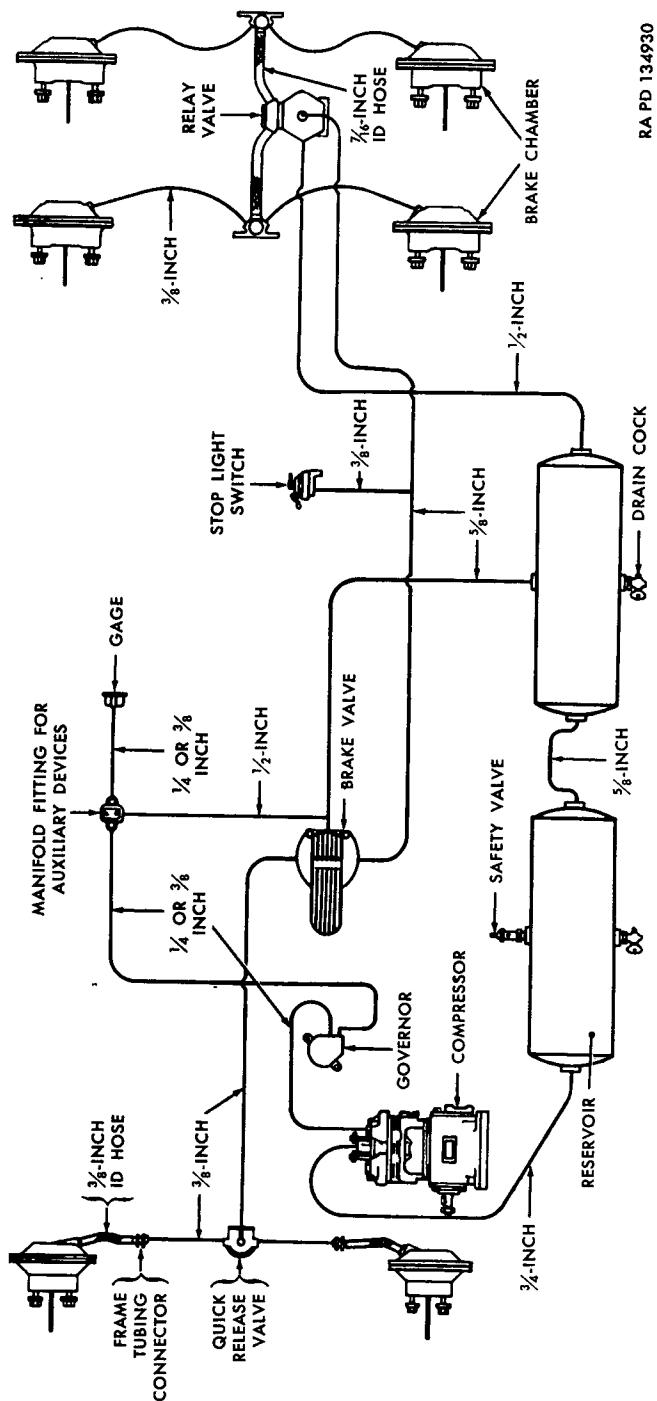


Figure 9. Typical piping diaphragm for six-wheel truck air brake system.

chambers are in similar arrangement to those for six-wheel trucks. Brake valve delivers air pressure to front brake chambers through a combined limiting and quick release valve, which, when used with a two-way valve, provides an easily operated and controlled method whereby a driver has the choice of either full brake valve delivery pressure to the front brake chambers when the two-way valve is in "DRY ROAD" position or a limited pressure equal to 50 percent of brake valve delivery pressure when in "SLIPPERY ROAD" position. The two-way valve is mounted on the dash where it can be easily reached by the driver. One air line runs direct from the brake valve to the combined limiting and quick release valve. A second line runs from the brake valve through the two-way valve to the limiting and quick release valve. Rear brake chamber pressure is delivered direct from brake valve through standard quick release valve. Service and emergency lines are provided for semitrailer connections. An independent trailer control valve enables operator to control trailer brakes. Both the brake valve and trailer control valve deliver air to trailer service line. This permits trailer brakes to be operated in conjunction with tractor brakes by brake valve or operated separately by independent control valve.

11. Trailers

a. Four-Wheel Trailers. A typical trailer brake system, shown in figure 11, consists of a relay-emergency valve, quick release valve, one reservoir, brake chambers, and the connecting lines. Air from tractor emergency line enters trailer reservoir through relay-emergency valve. Service line pressure from tractor brake valve operates relay-emergency valve and admits brake valve delivery pressure to brake chambers from the trailer reservoir and through the relay-emergency valve. In the event that trailer breaks away from tractor, the relay-emergency valve automatically delivers full trailer reservoir pressure to brake chambers.

b. Single Axle Semitrailer. The piping for a typical single axle semi-trailer shown in figure 12, is similar to that of four-wheel trailer except that the front axle devices are eliminated.

Section II. AIR-OPERATED HYDRAULIC BRAKES

12. General

(fig. 13)

In the air-operated hydraulic system, two pistons, operating with a common piston rod, are positioned in tandem cylinders. Normally, the cylinders are of different diameters, the larger being an air cylinder

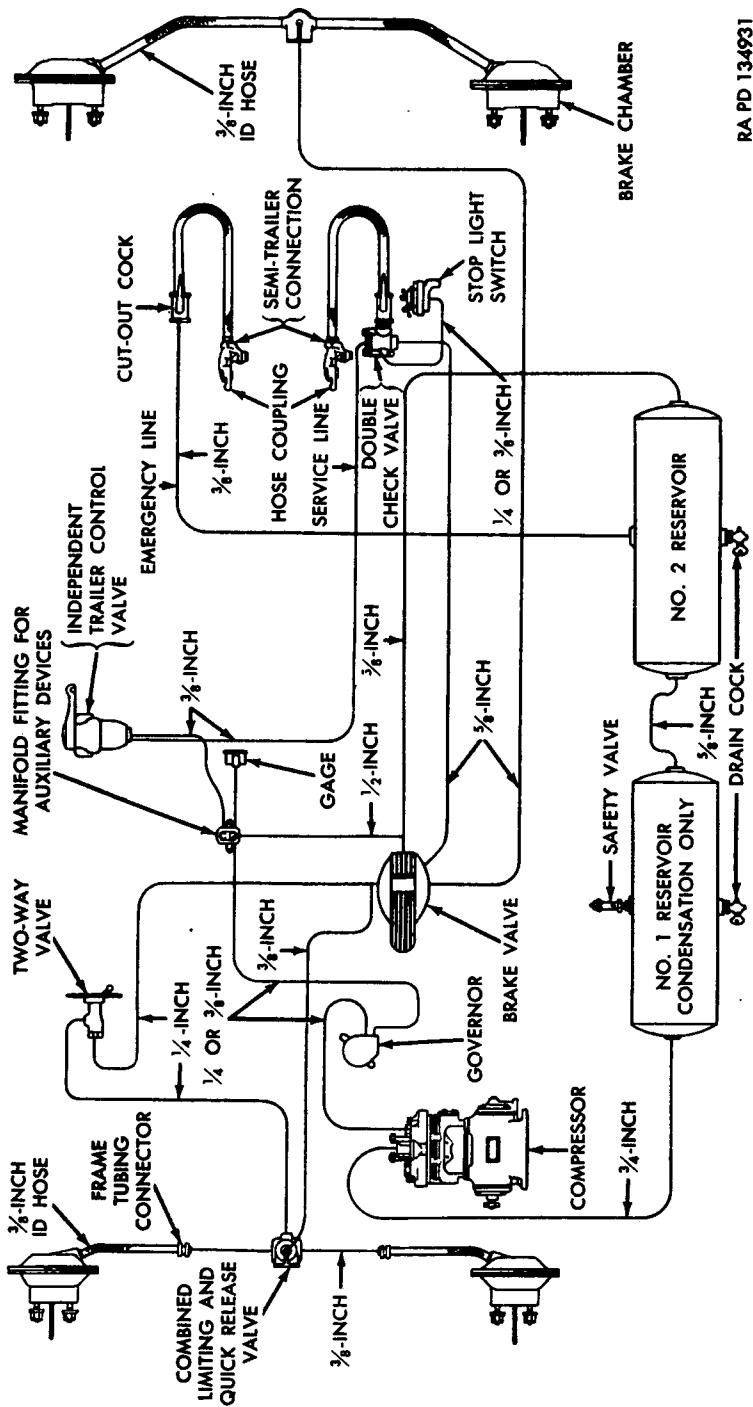


Figure 10. Typical piping diaphragm for four-wheel tractor air brake system.

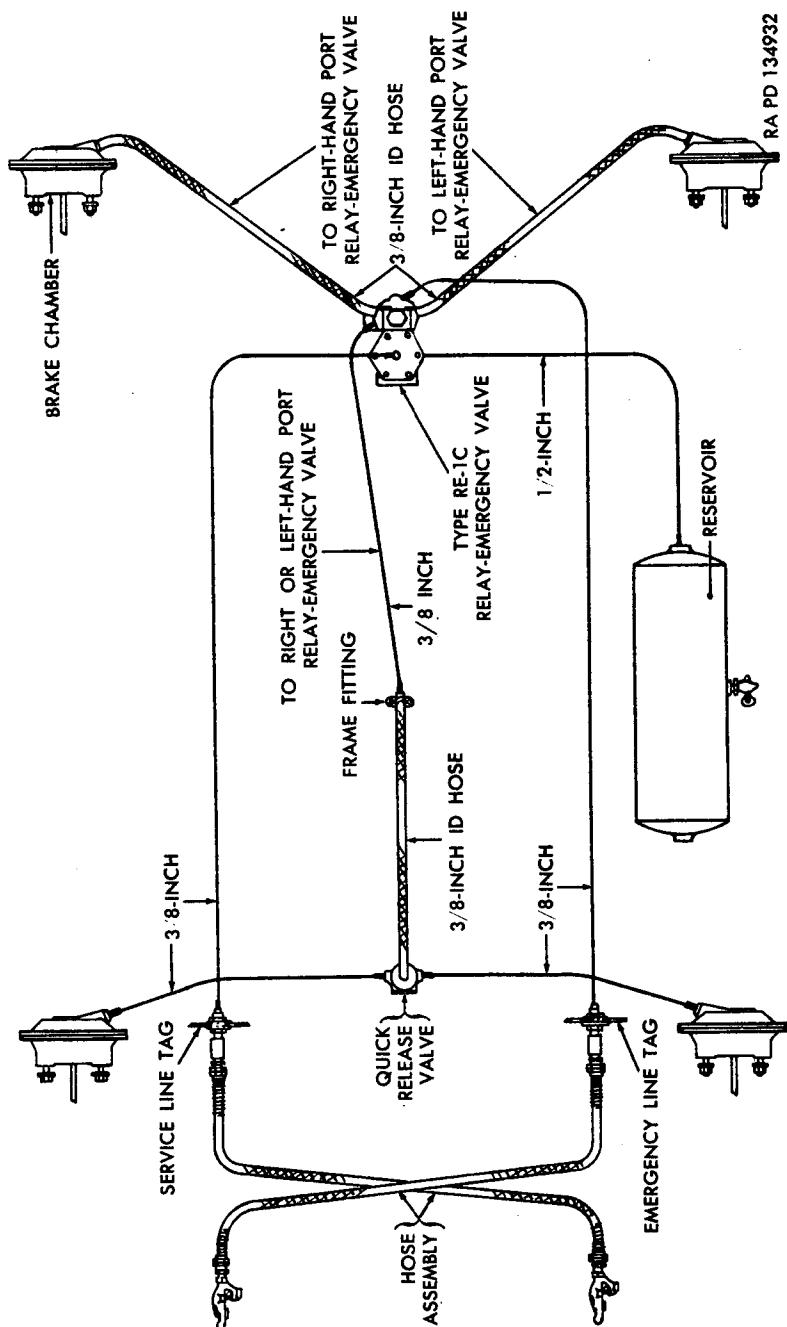


Figure 11. Typical piping diaphragm for four-wheel trailer air brake system.

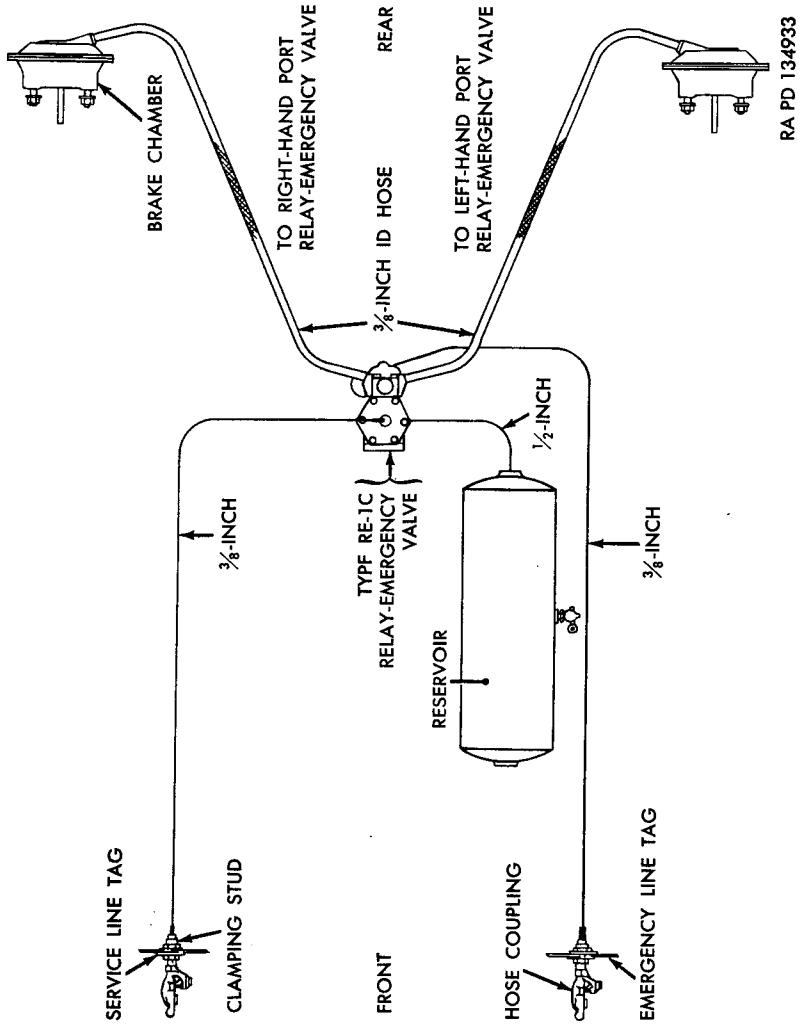


Figure 12. Typical piping diaphragm for single axle semitrailer air brake system.

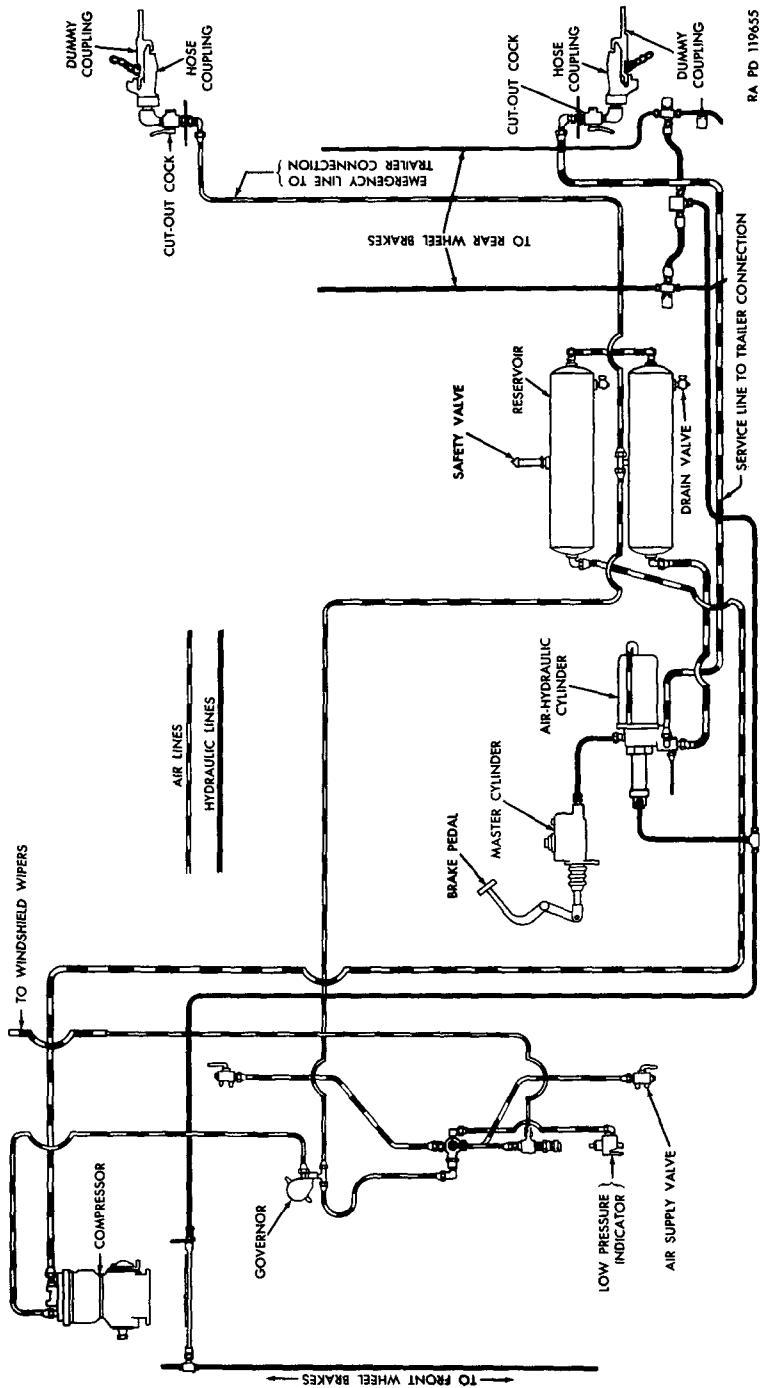


Figure 13. Typical piping diagram for six-wheel truck air-operated hydraulic brakes.

and the smaller a hydraulic cylinder. Hydraulic lines connect the hydraulic cylinder to relatively small cylinders directly connected to the brake shoes. Brakes are applied by admitting compressed air back of the air piston. As both pistons move in unison, the same total pressure is exerted on the hydraulic fluid but, owing to the smaller diameter of the hydraulic piston, the unit pressure is raised to obtain the necessary thrust on the brake shoes from the small wheel cylinders.

13. Trucks and Tractors

The compressed air devices and piping on an air-operated hydraulic system are not materially different from those used in air-operated mechanical systems. A typical piping diagram is shown in figure 13. The air system, from compressor to and including reservoirs and trailer service, and emergency lines are the same in both systems. In the air-hydraulic system, brake chambers are replaced by hydraulic wheel cylinders which are assembled with brake shoes and operate them directly. The necessary hydraulic pressure is obtained as described in paragraph 12.

CHAPTER 4

COMPRESSORS

Section I. TYPES

14. Type Variations

(figs. 14-19)

All Bendix-Westinghouse air compressors are single-acting, reciprocating design, and are classified under three general types, U, E, and F-12. Type U compressors are furnished in both $7\frac{1}{4}$ and 12 cubic feet displacement. The $7\frac{1}{4}$ cubic foot compressors have two cylinders, while the 12 cubic foot compressors have three and the cylinder blocks are air-cooled. The E and F-12 compressors have two cylinders and 12 cubic feet displacement and differ only in construction details. Type E cylinder blocks are fitted with sleeves and are water cooled. Type F-12 blocks are air-cooled and are without sleeves. All types are furnished in a variety of designs to meet different mounting requirements and for either engine or self lubrication. Cylinder heads for type U compressors may be either air-cooled or water-cooled. Type E compressors have water-cooled cylinder blocks and cylinder heads. Type F-12 compressors have water-cooled heads and air-cooled cylinder blocks. All $7\frac{1}{4}$ cubic foot compressors may be made waterproof for deep-water fording by an addition of a waterproof cover over the unloading mechanism.

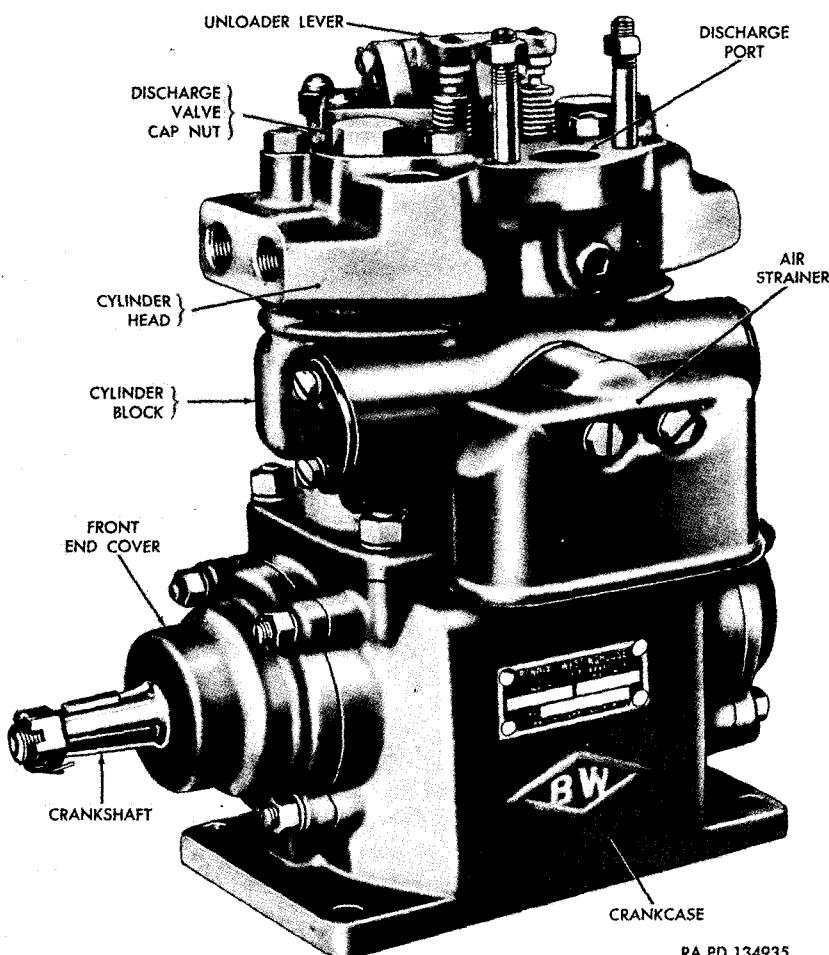
15. Identification

a. All "U" type compressors are identified by the piece number stamped on the name plate riveted to the front side of crankcase. This piece number will be used for all identification purposes. Name plates show serial number and type of compressor but compressors cannot be identified by serial number or type designation. Type designation shown on name plate is in accordance with the following:

Number of cylinders	2 or 3
Type of compressor	U
Lubrication—engine or self	E or S
Displacement cfm	$7\frac{1}{4}$ or 12
Style of mounting—flange, horizontal or vertical	F, H or V
Cooling—air or water	A or W

Thus a 2-UE- $7\frac{1}{4}$ -VW compressor is a two-cylinder, type U, engine-lubricated, displacement $7\frac{1}{4}$ cfm at 1,250 rpm, vertical mounting, and cylinder heads are water-cooled.

b. All type E and F-12 compressors are identified by the piece number stamped on the name plate riveted to the front side of crankcase. This piece number will be used for all identification purposes. Name plates show serial number and type of compressor but compressors cannot be identified by serial number or type designation. Type designation shown on the name plate will be only the letter E or F-12 for the type E or F-12 compressors respectively. All type E and F-12 compressors are two cylinders and are either engine- or self-lubricated. Their displacement is 12 cubic feet per minute when running at a speed of



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Figure 14. Type 2-UE-7 1/4-VW compressor.

1,250 rpm. Type E and F-12 compressors are made only in the vertical and flange type mountings.

Section II. DESCRIPTION AND OPERATION

16. Description

a. *General.* All Bendix-Westinghouse air compressors are identical in basic design. All are single acting, with reciprocating pistons driven by

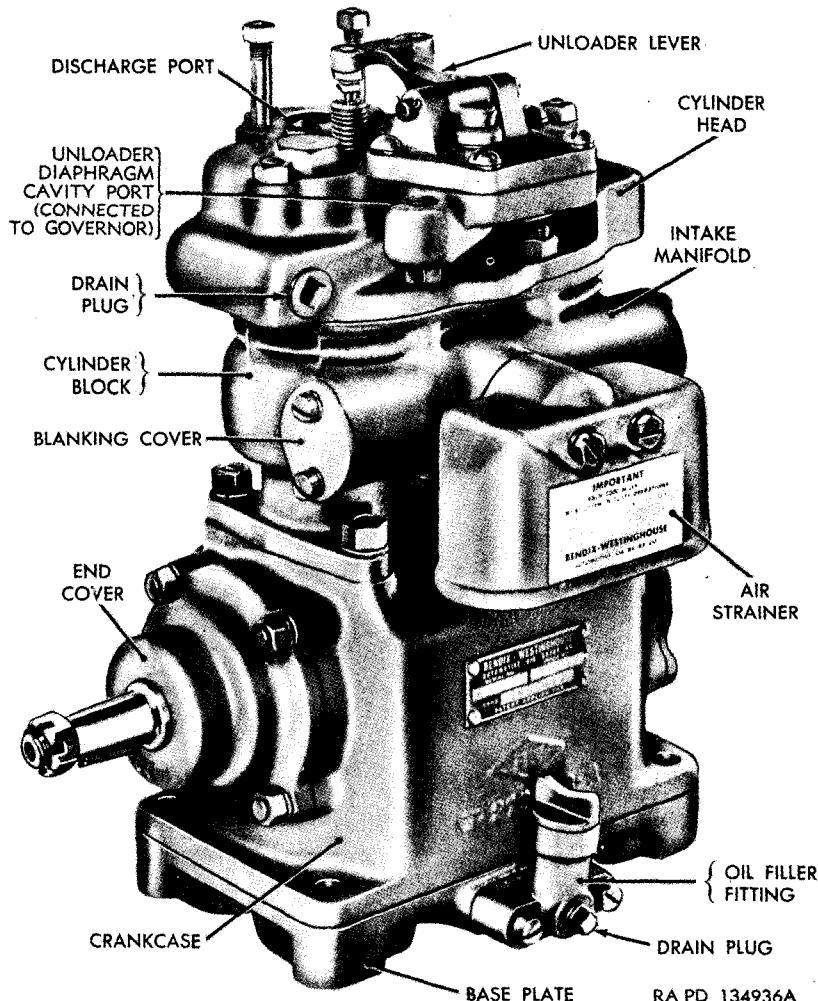


Figure 15. Type 2-US-7½-VW compressor.

a crankshaft through conventional type connecting rods. Rated capacity is based on piston displacement in cubic feet per minute at 1,250 rpm. A compressor consists of three general sections—head, cylinder block, and crankcase.

b. *Lubrication.* All compressors are pressure-lubricated.

(1) *Engine-lubricated.* With engine-lubricated compressors, oil pressure from the vehicle engine enters the compressor through a passage in the crankcase and end cover, and is conducted to connecting rod bearings through drilled holes in crankshaft and to wrist pin bearings through drilled holes in connecting rods. Main bearings are ball type and are splash-lubricated.

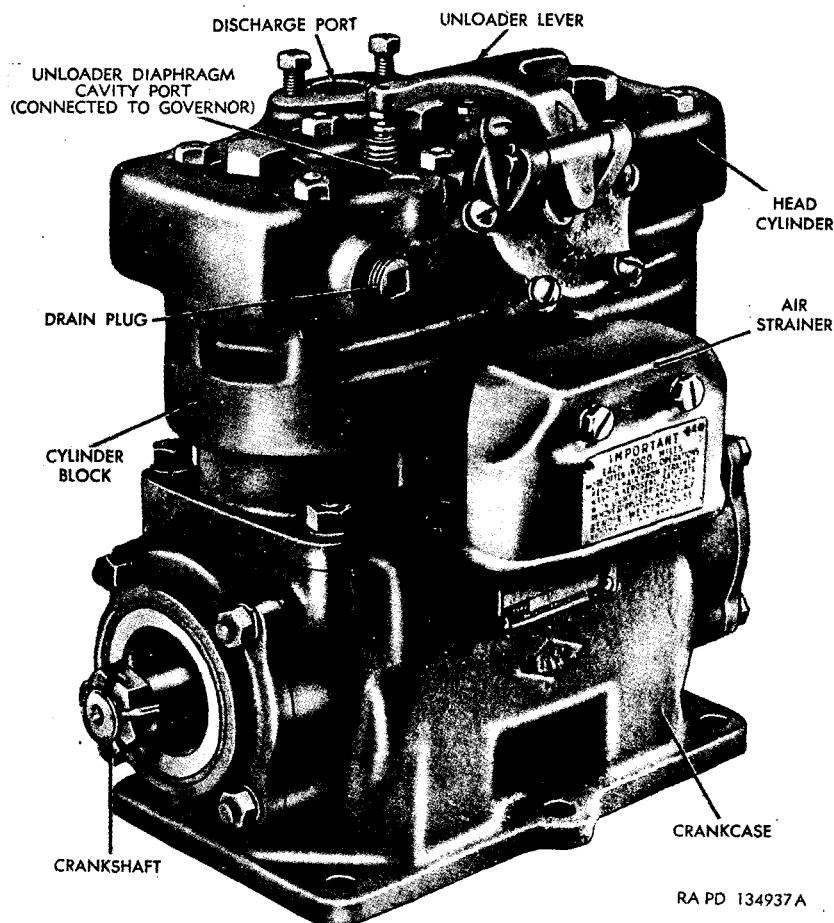


Figure 16. Type 3-UE-12-VW compressor.

~~SECRET~~ [REDACTED] Information

Oil returns to engine through open base of compressor (figs. 14 and 43).

(2) *Self-lubricated.* Self-lubricated compressors have a crankcase base which forms an oil reservoir. A piston type oil pump, mounted in the base and driven by the crankshaft, forces oil to the various parts of compressor through passages similar to those in engine-lubricated compressors. Oil pressure is controlled by a relief valve adjacent to pump. Surplus oil returns to reservoir in base (figs. 15 and 44).

c. *Cylinder Heads.* Type U cylinder heads are made for either air-cooling or water-cooling. Types E and F-12 heads are water-cooled. All cylinder heads are fitted with a discharge valve, and unloading valve for each cylinder, and a lever mechanism, under control of a diaphragm,

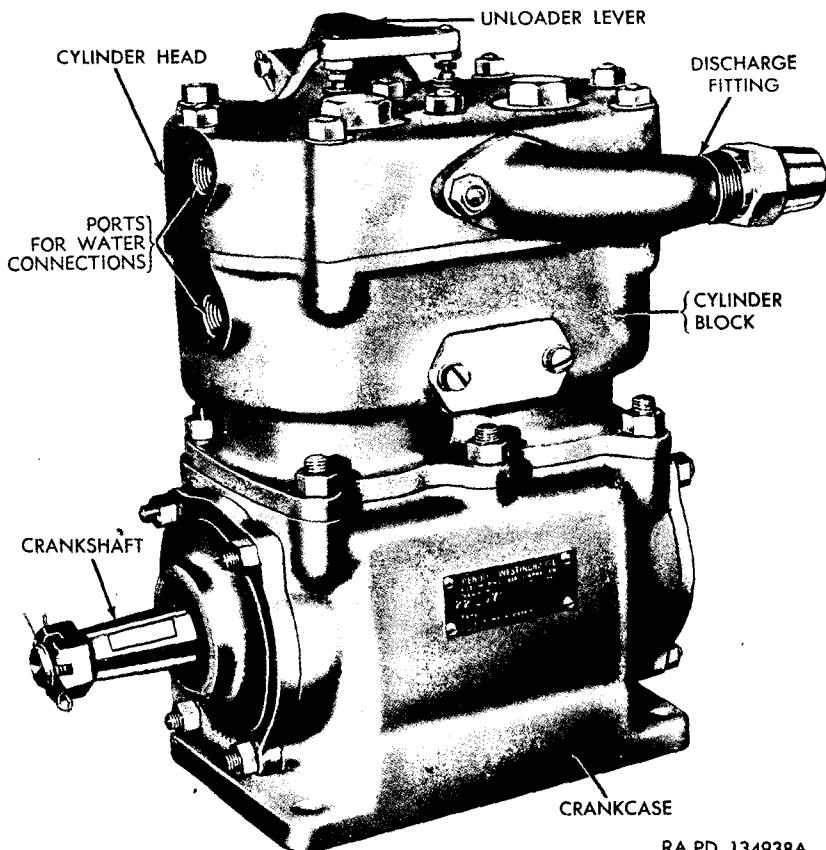


Figure 17. Type E, 12 cu ft compressor, engine-lubricated.

for operating unloading valves. Some U-7 $\frac{1}{4}$, all U-12, E, and F-12 cylinder heads are fitted with replaceable discharge valve seat inserts.

d. Cylinder Blocks.

- (1) *Type U-7 $\frac{1}{4}$ cubic foot.* All blocks are two-cylinder, cast iron, and air-cooled. They are not fitted with replaceable sleeves and have an air inlet passage along one side of block. Openings are provided in the center and in each end of air passage for optional location of air intake strainer.
- (2) *Type U-12 cubic foot.* All blocks are three-cylinder, cast iron, and air-cooled. The bores are fitted with replaceable sleeves. An air intake passage surrounds the cylinders. Openings into

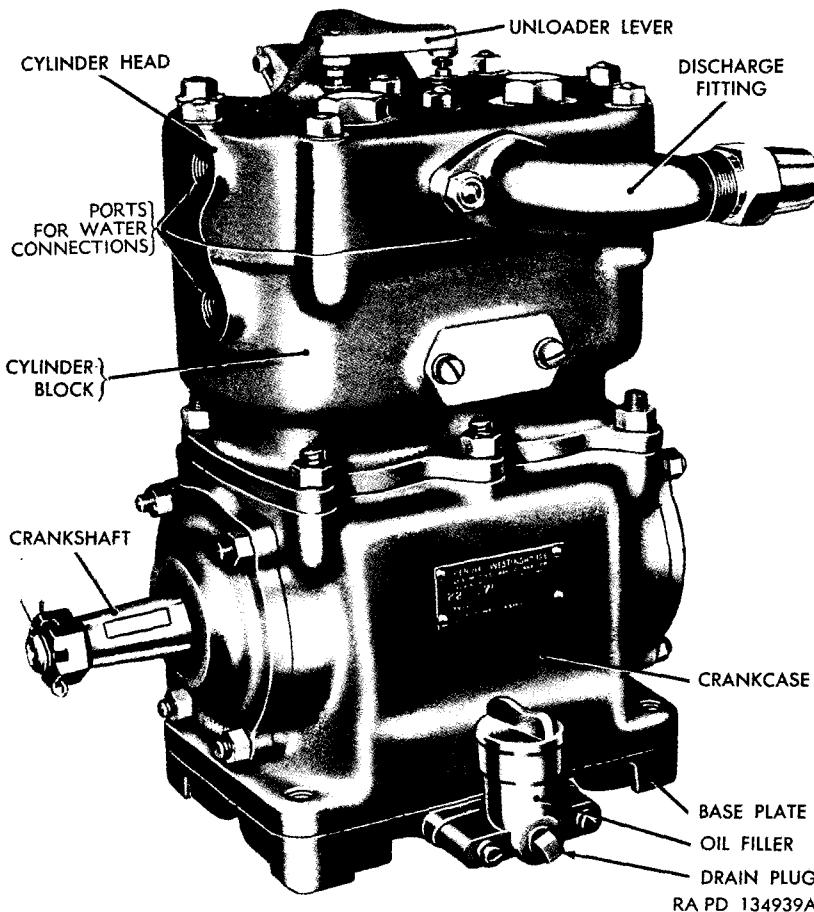


Figure 18. Type E, 12 cu ft compressor, self-lubricated.

this passage, at both sides of block, provide optional location of air intake strainer.

- (3) *Type E.* All blocks are aluminum two-cylinder with sleeves, and water-cooled. Water jacket openings connect with water passages in cylinder head. Optional mountings, for air intake strainer, are provided on each side of block.
- (4) *Type F-12.* Type F-12 blocks are two-cylinder, cast iron, air-cooled and are not fitted with sleeves; otherwise, they are similar to type E blocks.

e. *Crankcase.* Crankcase design is similar for all compressors. Ends are machined for ball bearings to support crankshaft. Dust, oiltight, end covers inclose the bearings. Crankcases for engine-lubricated compressors have open bases. Crankcase bases for self-lubricated compres-

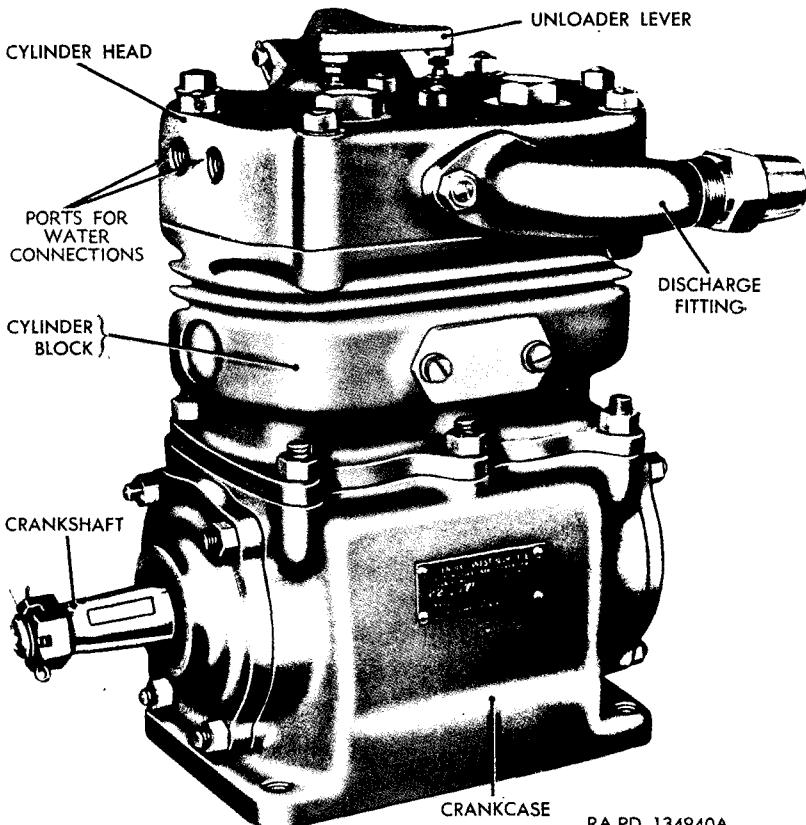


Figure 19. Type F-12 compressor, engine-lubricated.

sors are closed by an attached base, forming an oil reservoir, and containing a piston-type oil pump driven from crankshaft and a pressure relief valve. A check valve prevents oil return during the upstroke of the oil pump piston. The oil passages of these compressors are the same as for the engine-lubricated type.

f. Crankshaft. All crankshafts are forged steel and have two main bearings of the ball type. Crank throws are 180° apart except for three cylinder U-12 which are 120° apart. All shafts are drilled for oil passage to the crank pins.

g. Pistons and Connecting Rods.

- (1) All pistons are cast iron. The U-7 $\frac{1}{4}$, and U-12 pistons are fitted with four rings. Types E and F-12 have five rings (fig. 51). Replacement pistons, 0.010 inch, 0.020 inch, and 0.030 inch oversize, are furnished for all compressors. All pistons are bored for standard diameter piston pins.
- (2) Connecting rods are forged steel with replaceable piston pin bearings. Until recently, the crank pin bearings were babbitted. Since 1948, all rods are fitted with replaceable half-bearings. Rods with replaceable bearings are interchangeable with the earlier babbitted types. However, replaceable half-bearings cannot be fitted to the babbitted rods. Replacement bearings, 0.010 inch, 0.020 inch, and 0.030 inch undersize, are available for reground crank pins. All rods are drilled longitudinally for lubrication.

17. Operation

a. General. All compressors run continuously, while the engine is running, and deliver compressed air to the system at all times when the system air supply is below a predetermined minimum pressure. When system's air supply reaches a predetermined maximum, an unloading device, actuated by a governor, opens an air passage between cylinders and air is bypassed between cylinders until system pressure falls to the desired minimum. The unloading device is released at desired minimum pressure and compression is resumed.

b. Compression. During the down stroke of each piston, a partial vacuum is created above the piston. As the piston nears the bottom of its stroke it uncovers intake ports in the cylinder wall. Air then enters the cylinder above the piston through the air-intake strainer, the intake manifold, and intake ports in cylinder wall. As each piston begins its upstroke, it covers the intake ports, and air, which has entered the cylinder, is trapped above the piston. As the piston continues its upstroke, the trapped air is compressed until the pressure lifts a discharge valve

[REDACTED]
and the compressed air is discharged into the line to reservoir and discharge valve returns to its seat.

c. *Noncompression (Unloaded)*. When air pressure in reservoir reaches the maximum setting of governor, the governor valve admits this pressure into cavity below an unloading diaphragm in compressor head. This pressure lifts unloading diaphragm and one end of unloading lever. The opposite end of lever pushes unloading valves off their seats, opening an unloading cavity above the pistons. With unloading valves open, air merely passes back and forth between cylinders during reciprocation of pistons. When air pressure in reservoir drops to minimum setting of governor, the air pressure under unloading diaphragms is exhausted, unloading valves return to their seats, and compression is resumed.

Section III. TROUBLE SHOOTING

18. Purpose

Note. Information in this section is for use of ordnance maintenance personnel in conjunction with and as a supplement to the trouble shooting section in the pertinent operator's manuals. It provides the continuation of instructions where a remedy in the operator's manuals refers to ordnance maintenance personnel for corrective action.

Operation of a deadlined unit without a preliminary examination can cause further damage to a disabled component and possible injury to personnel. By careful inspection and trouble shooting, such damage and injury can be avoided and, in addition, the causes of faulty operation of a unit or component often can be determined without extensive disassembly.

19. General Instructions and Procedures

a. The inspections made while the component is mounted in the unit are, for the most part, visual and are to be performed before attempting to operate the unit. The object of these inspections is to avoid possible damage or injury and also to determine the condition of and, when possible, what is wrong with the defective component.

b. The trouble shooting performed while the component is mounted in the unit is that which is beyond the normal scope of organizational maintenance. Check the trouble shooting section of the pertinent operator's manual to be sure the trouble is not a defect normally corrected by using organization, then proceed as outlined below. These trouble shooting operations are used to determine if the fault can be remedied without removing the component from the unit and also, when subsequent removal is necessary, to indicate if repair can be made without complete disassembly of the component.

c. Inspection, after the component is removed from the unit, is performed to verify the diagnosis made when the component was in the unit, to uncover further defects, or to determine faults if the component alone is received by the ordnance establishment. This inspection is particularly important in the last case because it is often the only means of determining the trouble without completely disassembling the component.

20. Preliminary Examination

Visually examine the compressor for apparent damage or defects, such as cracked or broken castings. Turn the compressor by hand, at least one revolution, to determine possible mechanical seizure of parts. Broken or defective castings must be replaced. If compressor cannot be turned by hand, complete disassembly and rebuild is necessary. If preliminary examination discloses no defects, and if the condition of the compressor is unknown, it should be subjected to a series of tests under operating conditions.

21. Test Set-up

a. *General.* In order to test compressors under operating conditions, a certain amount of equipment is necessary for mounting, lubricating, and driving the compressor during test. A schematic arrangement of a test bench is shown in figure 20. Descriptions of all the valves, gages, reservoirs, fittings, etc required for the tests are included in this manual. These parts are readily available to any depot maintenance shop. For engine-lubricated compressors, a flat mounting plate, capable of holding compressor securely and with provision for oil return, must be provided. For self-lubricated compressors, a secure mounting only is necessary. Compressor drive may be direct-connected, as shown in figure 20, or the usual belt and pulley drive. For direct drive, a variable speed, 1,750 rpm motor is used. With belt and pulley drive, the correct compressor speed is obtained by pulley ratio. To test compressors with a rated displacement of $7\frac{1}{4}$ cfm at 1,250 rpm use a motor no smaller than 2 hp and for the 12 cfm compressors use a motor no smaller than 3 hp. Cooling water requirement is a minimum flow of 2.5 gpm. A lubrication system must be provided which can deliver oil under pressure of 30 psi. For self-lubricating compressors, oil pressure must register between 15 and 25 psi. The oil collector must be mounted at an angle as shown in diagram so that oil drain is at lowest point of oil collector (fig. 20).

b. *Preparation for Test.*

- (1) Remove air strainer; it is not necessary to uncover any other inlet ports.

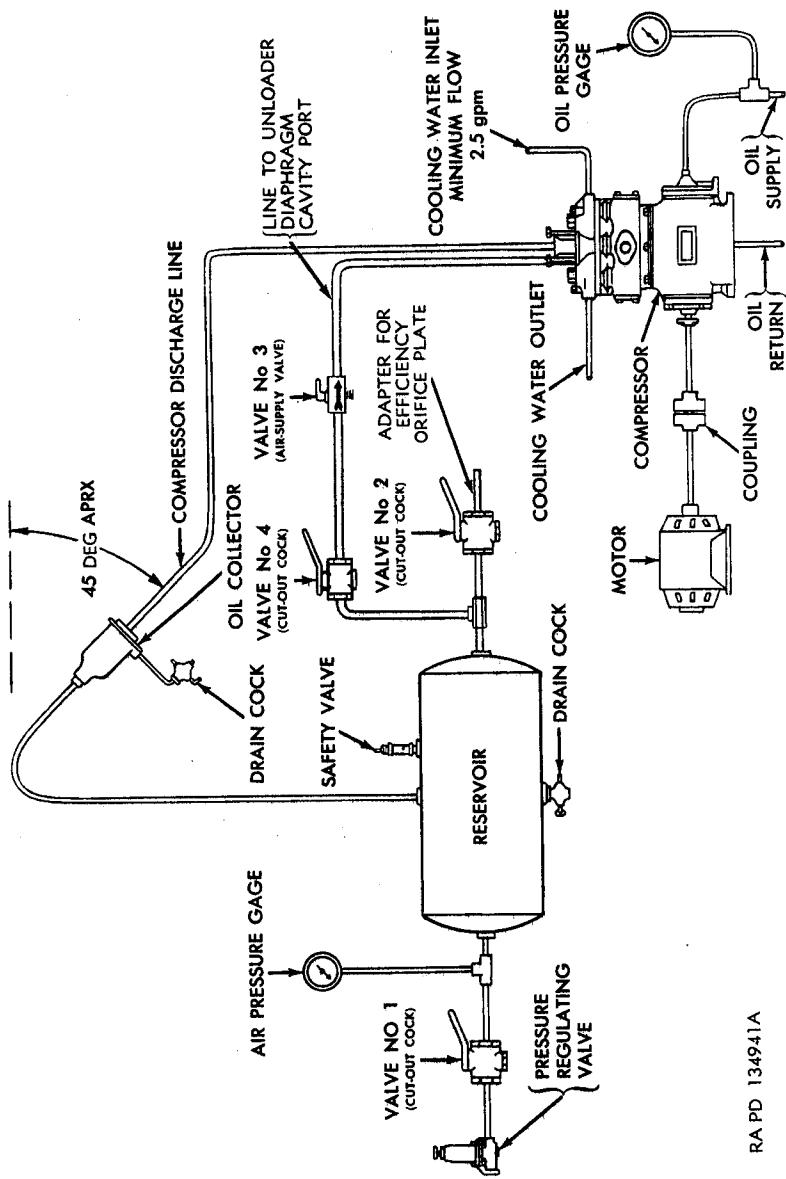


Figure 20. Schematic diagram of test bench for compressors.

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- (2) If engine-lubricated compressor is being tested, connect oil supply lines. If self-lubricating compressor is being tested, see that crankcase is filled with oil to proper level.
- (3) Connect cooling water system. For all type U and type F-12 compressors, inlet and outlet water connections are in cylinder head. For type E compressors, coolant water inlet is in cylinder block, water outlet is in cylinder head.

22. Scope of Tests

Since tests to determine necessity for complete disassembly and rebuild and tests to determine serviceability of a rebuilt compressor are similar and require the same equipment, the complete test procedures are given in this section.

23. Wear-in Test

This is a trial run test for rebuilt compressors.

- a. Prepare compressor and make test connections (par. 21b and fig. 20). Referring to figure 20, open valve No. 1 and close valves Nos. 2, 3, and 4.

Note. The (cut-out cocks) valves Nos. 1, 2, and 4 (fig. 20) are open when the handle is at right angles to the valve body and closed when the handle is parallel to the body (par. 155). Valve No. 3 (fig. 20) (air supply valve) is open when the handle is parallel to valve body and closed when the handle is at right angles to the body (par. 197). Refer to paragraph 26 for description of functioning of valve port.

- b. Run compressor at 1,750 rpm for $\frac{1}{2}$ hour.

Caution: Avoid running compressor without proper oil pressure. For engine-lubricated compressors, oil pressure should be 30 psi. For self-lubricated compressors, oil pressure should be 15 to 25 psi.

- c. While compressor is running, check frequently for overheated bearings, noisy operation, and oil leaks.

24. Oil-Passing Test

- a. Prepare compressor and make test connections (par 21b and fig. 20).
- b. Install proper inlet chamber cover (fig. 8). Restricting the air intake shortens time required for test.
- c. Open oil drain cock in oil collector and blow out any accumulation. Close drain cock.
- d. Referring to figure 20, open valve number 1 and close valves numbers 2 and 4 (par. 23a). Run compressor at 1,750 rpm, observe air gage,

and adjust regulating valve to maintain 50 psi in reservoir. Be sure coolant supply (fig. 20) and oil pressure (par. 23b) meet requirements.

e. Continue running compressor for $\frac{1}{2}$ hour and stop compressor. Open reservoir drain cock and exhaust all pressure in reservoir.

f. When air pressure gage reads zero, open oil collector drain cock and collect oil discharge in a glass graduate or other type of measuring glass in which quantity of oil can be accurately determined. With the proper inlet chamber cover installed (fig. 8), two cubic centimeters of oil, passed in $\frac{1}{2}$ hour, is the maximum permitted at 1,750 rpm.

25. Efficiency Test

a. Efficiency of a compressor is determined by the quantity or volume of air delivered at a specified pressure while running at a specified speed. This efficiency is established by the ability of the compressor to maintain a pressure of 62 psi against a constant discharge through a specified orifice when running at 1,750 rpm. The displacement of the compressor determines size of orifice in the orifice plate used. Details of these orifice plates and of the orifice adapter in which they are used are shown in figure 8.

b. Prepare compressor and make test connections (par. 21b and fig. 20).

c. Referring to figure 20, install adapter with correct orifice plate (fig. 8) in open end of valve number 2, close valve numbers 1, 3, and 4, and open valve number 2 (par. 23a).

d. Start compressor and be sure that coolant supply (fig. 20) and oil pressure (par. 23b) meet requirements. Run compressor for $\frac{1}{2}$ hour at 1,750 rpm. Pressure maintained in reservoir must be 62 psi or over.

e. If compressor is tested at a speed other than 1,750 rpm, the condemning and recondition curve (fig. 21) will give the minimum allowable pressure required to be maintained by the compressor.

26. Unloading Test

Set valves 1 and 2 (fig. 20) closed, and valve 4 (fig. 20) and (air supply) valve 3 (fig. 20) open (par. 23a), start compressor and watch air gage. When pressure reaches 105 psi, unloader valves should open and stop compression.

Caution: If air pressure rises above 105 psi, stop compressor immediately and investigate trouble.

If unloader valves function properly and stop compression, close (air supply) valve 3 (fig. 20). Compression should start immediately.

Note. When the (air supply) valve 3 (fig. 20) is closed (i. e., valve handle turned perpendicular to body), it is in its air supply position and air from the reservoir

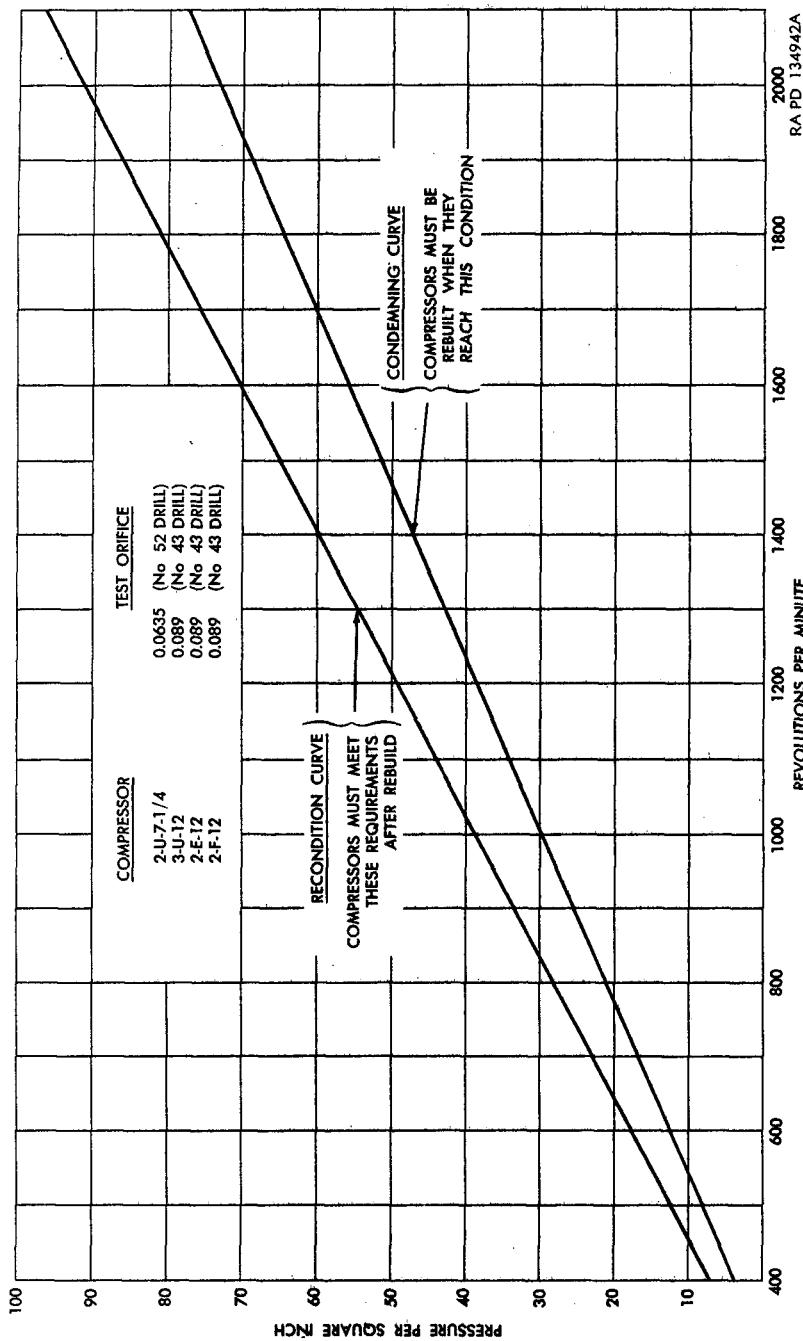


Figure 21. Condemning and recondition curves.

will discharge from a side connection of the valve. At the same time any air pressure in the unloader diaphragm cavity of the compressor is permitted to exhaust through a small vent port in the key of the air supply valve (par. 197).

27. Testing a Used Compressor

- a. Prepare compressor and make efficiency test (par. 25).
- b. Prepare compressor and make oil-passing test (par. 24).

Caution: While compressor is running, check frequently for overheated bearings, oil leaks, and noisy operation.

- c. If compressor exceeds the capacity shown by the condemning and recondition curve (fig. 21), meets the requirement of the oil-passing test, and the unloading mechanism functions properly, it is considered serviceable and should be returned to service.

28. Trouble Diagnosis

a. Knocking.

- (1) *Carbon deposit in cylinder head.* Remove cylinder head (par. 29c) and clean (par. 31a).
- (2) *Piston and cylinder wear.* Remove cylinder head (par. 29c) and inspect cylinder walls for scoring. Check piston clearance (par. 35b(2)). Replace worn parts.
- (3) *Piston strikes cylinder head.* On some early compressors, an occasional accumulation of tolerances would produce a condition in which the piston had insufficient cylinder head clearance. A few of these compressors may still be in service. The condition is corrected by the addition of an extra cylinder block gasket.
- (4) *Worn or burned bearings.* Check end play of crankshaft. Noticeable end play is indication of defective main bearings. Remove end covers and inspect. Inspect fit of connecting rods on crankshaft. Replace defective parts (par. 43).

b. Inadequate Capacity.

- (1) *Insufficient unloading valve clearance.* Check clearance and adjust (par. 33c(2)).
- (2) *Carbon deposit in cylinder head.* Remove cylinder head and clean (par. 31a).
- (3) *Discharge valves leaking.* Remove cylinder head and check valves (par. 31b).
- (4) *Unloading valve stuck open or leaking.* Recondition or replace valve.
- (5) *Piston and cylinder wear.* Disassemble (par. 29). Check cylinder block (par. 34b), pistons (par. 35b(2)), and piston rings (par. 39d(1)). Replace worn parts.

c. *Fails to Unload.*

- (1) *Excessive valve clearance.* Adjust clearance (par. 33c(2)).
- (2) *Defective diaphragm.* Replace (par. 31b(4)).
- (3) *Unloading lever stuck.* Free lever.
- (4) *Unloading valve stuck.* Recondition or replace.
- (5) *Unloading cavity plugged.* Clean (par. 31a).

d. *Excessive Oil Passage.*

- (1) *Piston and cylinder wear.* Disassemble (par. 29). Check cylinder block (par. 34b), pistons (par. 35b(2)) and piston rings (par. 39d(1)). Replace worn parts.
- (2) *Oil rings improperly installed.* Check installation (fig. 51).

Section IV. REBUILD OF COMPRESSOR

29. Disassembly Into Subassemblies

(figs. 22, 23, and 24)

a. *General.* Before attempting any repair or rebuild operations, the compressor must be thoroughly cleaned. Be certain that all openings are securely plugged or covered before cleaning. Use water under pressure to remove as much mud and dirt as possible. Use a stiff brush and dry-cleaning solvent or volatile mineral spirits to remove remaining grease and dirt.

b. *Assembly Identification.* The cylinder head, cylinder block, air strainer, and crankshaft of many compressors are designed so the compressor can be assembled in several different ways to meet installation requirements. In order to insure correct assembly, such parts must be marked before disassembly to show their correct position in relation to each other. This can be done best by making center punch marks in the related parts to act as guides during assembly. The following parts, in all cases, must be marked:

- (1) Position of cylinder head in relation to cylinder block.
- (2) Position of air strainer in relation to cylinder block.
- (3) Position of cylinder block in relation to crankcase.
- (4) Position of front end cover (drive end of crankshaft) in relation to the crankcase. (Make one punch mark on each.)
- (5) Position of rear end cover in relation to the crankcase. (Make two punch marks on each.)
- (6) Position of oil filler fitting in relation to base plate (self-lubricated compressors only).

c. *Remove Cylinder Head.* Remove nuts from all studs in cylinder head and lift off cylinder head (fig. 22). Tap head with soft hammer, if necessary, to break gasket joint. Discard gasket.

d. Remove Base Plates (Self-Lubricated Compressors Only). Drain compressor and remove screws holding base plate to crankcase. Remove base plate and discard gasket. In some three-cylinder, self-lubricated compressors, the oil pump is located in rear end-cover, which must be removed before removing base plate.

e. Remove Pistons and Connecting Rods. Remove cotter pins and nuts from connecting rod bolts and lift out connecting rod caps (fig. 23). An extension socket (fig. 23) will be found helpful. If rod is fitted with replaceable bearings, guard against dropping them as they are easily damaged. Push pistons and rods out of cylinders, again using care not to drop bearings. Rods, caps, and bearings should be reassembled in original positions, as shown by markings, and kept together. The method of marking also identifies the original installation positions. Marks consist of short lines stamped on the milled sides of both rods and caps. Rods from number 1 cylinders have one mark on both rod and cap; two marks for number 2 cylinder, and three marks for number 3 cylinder. Number 1 cylinder, in all cases, is the cylinder next to the end of crankshaft that receives power to drive compressor. If compressor is self-lubricated, remove the oil pump piston rod from crankshaft and assemble cap and rod. Keep together. Do not remove oil pump piston from rod unless it is to be replaced.

f. Remove Crankshaft.

- (1) Remove nuts and lock washers securing front- and rear-end covers to crankcase, remove covers, and discard gaskets (fig. 40).
- (2) Some crankcases are machined with a shoulder to position crankshaft. In such cases, the crankshaft can be removed through one end only. Press crankshaft and bearings out of crankcase (fig. 40).

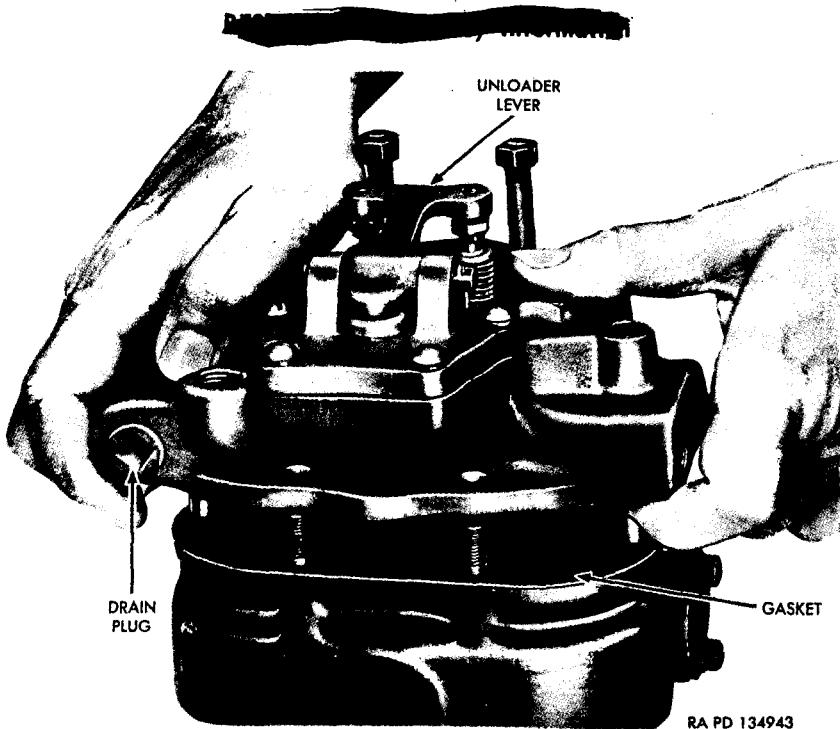
g. Remove Cylinder Blocks. Remove nuts and lock washers securing block to crankcase, remove cylinder block, and discard gasket (fig. 39). Remove air strainer from cylinder block.

30. Disassembly of Cylinder Head

a. Remove cotter pins from lever pin, drive out lever pin, and remove unloader lever, unloader lever spring, and dust cover (figs. 24, 25, and 26).

Note. Waterproof heads have an unloader cover (fig. 28) which is removed before proceeding with a.

b. Remove machine screws attaching unloader box to cylinder head, lift off box cover, and remove unloader diaphragm follower and two unloader diaphragms (figs. 24, 25, and 26).



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Figure 22. Removing cylinder head

c. Remove discharge valve cap nuts and lift out discharge valve springs and discharge valves (figs. 24, 25, and 26).

d. By hand, compress unloader valve springs (fig. 33) and remove spring retaining rings (figs. 24, 25, and 26). Then remove unloader valve stops and unloader valve springs (figs. 24, 25, and 26).

Remove unloader valves by pushing them out of the bottom of the cylinder head (figs. 24, 25, and 26). Remove pipe plug (figs. 24 and 25).

31. Cleaning, Inspection, and Repair

a. Cleaning. Clean all parts with dry-cleaning solvent or volatile mineral spirits to remove all traces of dirt, oil, or grease. Immerse cylinder head body in carbon-remover solvent to remove deposits from cylinder head cavities. If necessary, remove unloader valve bushings (c(3) below) to facilitate cleaning unloader valve cavity. Flush out coolant passages with water and use air pressure to blow dirt from all cavities.

b. Inspection (figs. 27 and 28).

(1) Cylinder head body. Inspect cylinder head body for cracks or breaks. Replace, if any are found. Check condition of un-

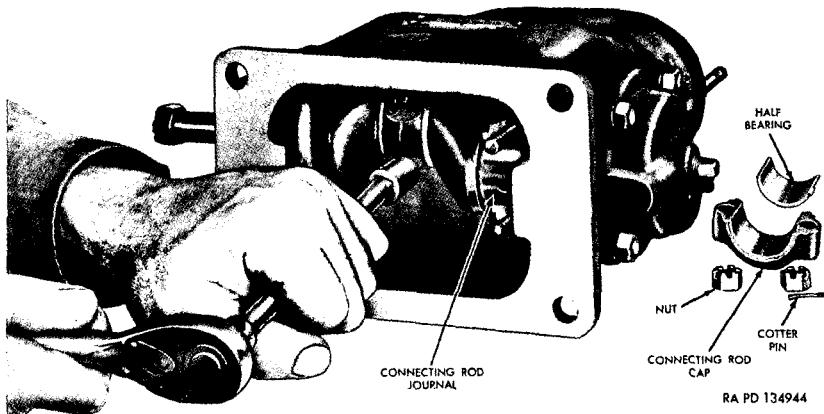


Figure 23. Removing connecting rod caps (all compressors).

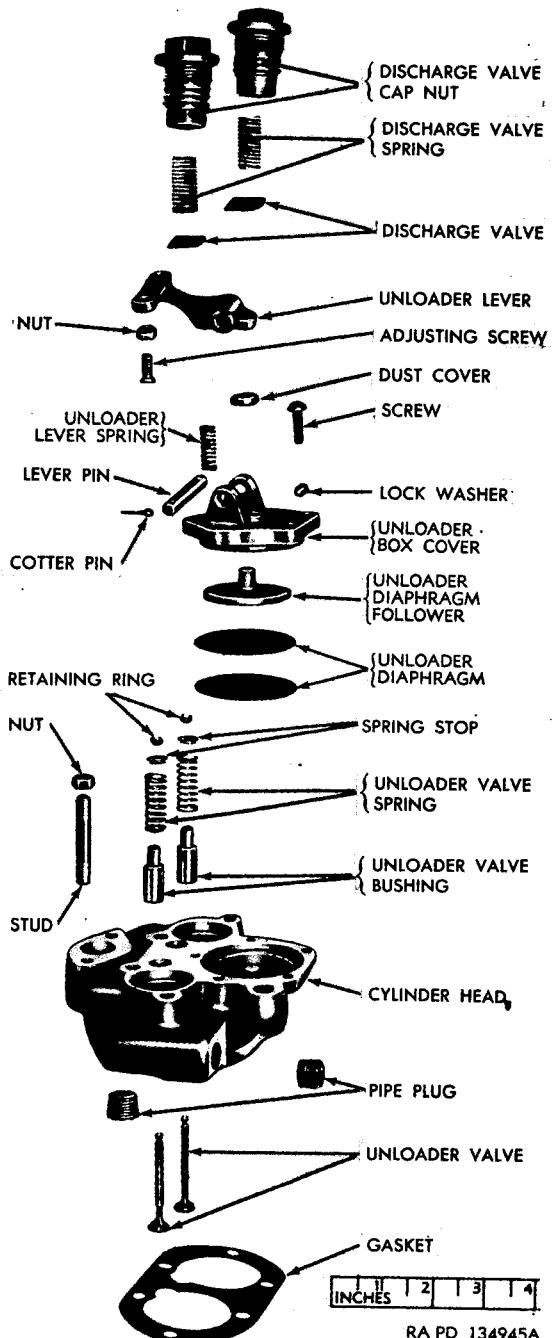
loader diaphragm seat in unloader diaphragm cavity in cylinder head. Replace cylinder head body, if seat is pitted or damaged in any way. Examine threads in tapped holes. If badly damaged, replace head.

- (2) *Test water jacket.* Test water jacket for leakage after cleaning, by applying 15 pounds air pressure to any water connection opening in the cylinder head and plugging other water outlets. With air pressure applied, immerse the cylinder head in water and check for leakage. No leakage is permissible.

Note. Cylinder blocks of type E compressors also have water jackets and are tested in the same manner.

If any leakage is found, the cylinder head body (or cylinder block) must be replaced.

- (3) *Unloader lever pin.* Check fit of unloader lever pin in unloader lever. If pin or lever shows sign of wear, either or both should be replaced.
- (4) *Unloader diaphragms and box cover.* Check unloader diaphragms and replace, if any signs of wear or cracking are present. Check diaphragm seat on bottom of unloader box cover. Smooth seat or replace cover, if necessary.
- (5) *Unloader valve stems and bushings.* Check condition of slot in unloader valve stems where the retaining washers contact the valve stems. Check fit of unloader valve stems in unloader valve bushings in accordance with limits given in serviceability



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Figure 24. Type U-7 1/4 cu ft cylinder head—exploded view.

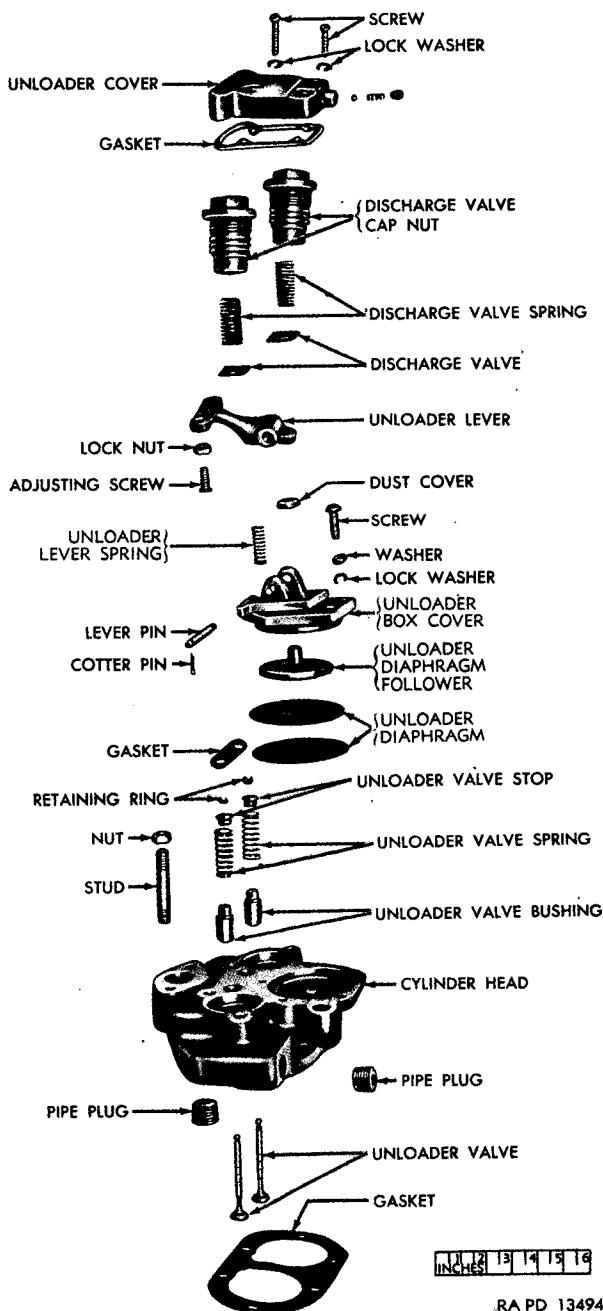


Figure 25. Type U-7 1/4 cu ft waterproof cylinder head—exploded view.

standards (par. 47). Replace the unloader valves and unloader valve bushings if necessary.

(6) *Discharge valves.* Examine discharge valves carefully for evidence of pitting or grooving. Valves showing such defects must be replaced.

(7) *Discharge valve seats.*

(a) *U-7 $\frac{1}{4}$ cylinder heads.* Some U-7 $\frac{1}{4}$ cylinder heads are machined with discharge valve seats integral with the heads. Inspect the condition of the seats. If they are pitted, grooved, or worn so badly that they cannot be reclaimed by reaming, the head must be replaced. Some cylinder heads are fitted with replaceable valve seat inserts. Damaged inserts are replaced.

(b) *U-12, E, and F-12 cylinder heads.* All of these cylinder heads have replaceable discharge valve seat inserts. Damaged inserts are replaced.

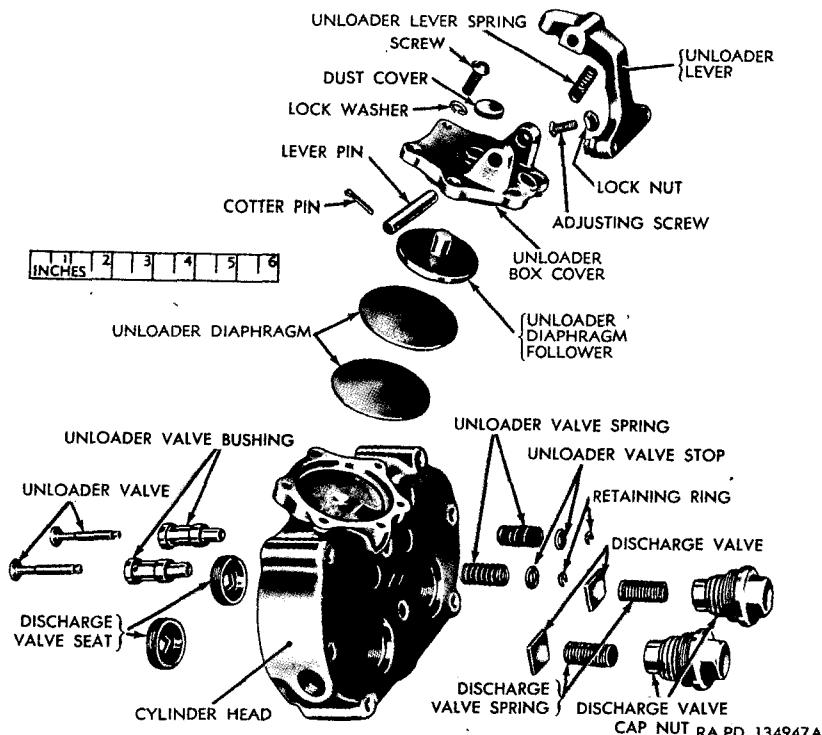
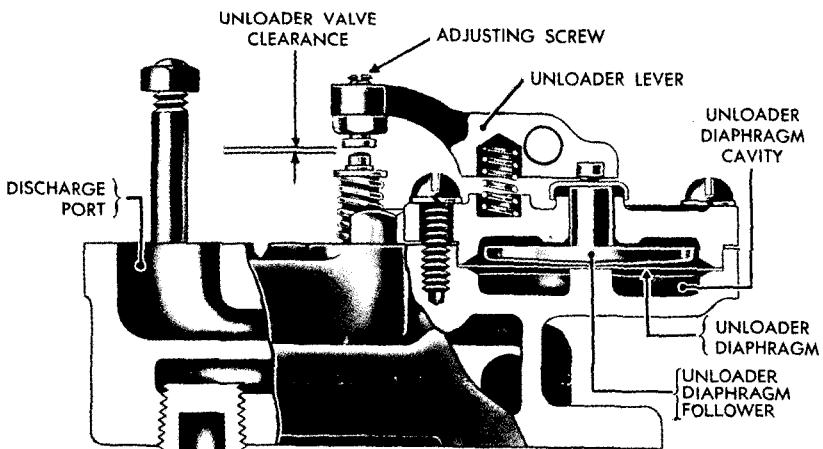
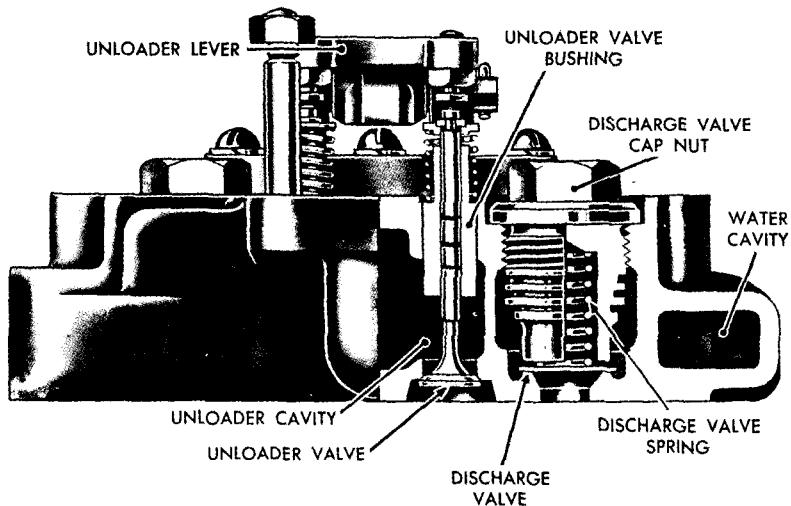


Figure 26. Type E cylinder head—exploded view.

c. *Repair.*

- (1) *Cylinder head body.* Clean out threads in all tapped holes. Use standard taps to correct minor damage. Replace loose, bent, or damaged studs. Remove any raised metal adjacent to dents or scratches on finished surfaces with a fine mill file.
- (2) *Unloader valves (all cylinder heads).*
 - (a) Grind (lap) unloader valves to their seats, using a fine valve



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Figure 27. Two-cylinder, type U, water-cooled cylinder head—sectional view.

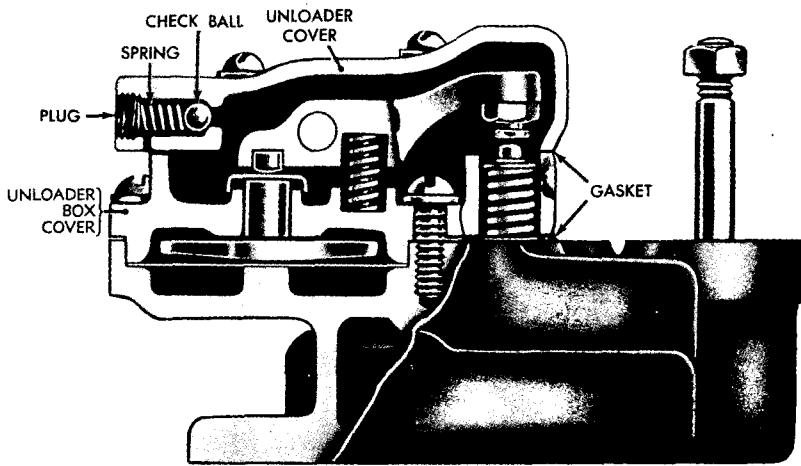


Figure 28. Two-cylinder, type U, waterproof cylinder head—
sectional view.

grinding compound and reciprocating valve grinding tool 41-T-3381-15 with valve grinding bit 41-B-660 (figs. 1 and 29). Clean valves and seats thoroughly to remove all trace of grinding compound.

(b) If valve seats are pitted, ream them before grinding the valves. Use unloading valve seat reamer 41-R-2309 (fig. 1) for U-7 $\frac{1}{4}$ heads (fig. 30), unloading valve seat reamer 41-R-2309-25 (fig. 1) for U-12 heads, and hand reamer 7950050 (fig. 1) for E and F-12 heads. If valve faces are pitted, replace valves. Grind (lap) valve to seats after reaming.

(3) *Unloader valve bushings.*

(a) *U-7 $\frac{1}{4}$ cylinder heads.* To replace unloader valve bushings, press or drive out old bushing from bottom of head. Replacement bushings are pressed or driven into place from top of head. Distance from top of bushing to bottom of head must be 2.293 inches to 2.295 inches. Drive bushing carefully and check the dimension. Ream bushings after installation (c(2) above).

(b) *U-12, E, and F-12 cylinder heads.* Unloader valve bushings in these heads are inserted from bottom of head and seated against a shoulder. To replace, press or drive out from top of head. Heat head to 300° F., chill replacement bushing, and

insert from bottom. Drive bushing to seat against shoulder. Ream bushings after installation (c(2) above).

(4) *Discharge valve seats and valves.*

(a) *Integral seats.* Some U-7 $\frac{1}{4}$ cylinder heads are made with discharge valve seats integral with the head. Examine seat carefully for scratches or pitting. Seats showing slight scratches are reclaimed by using valve seat lapping disk

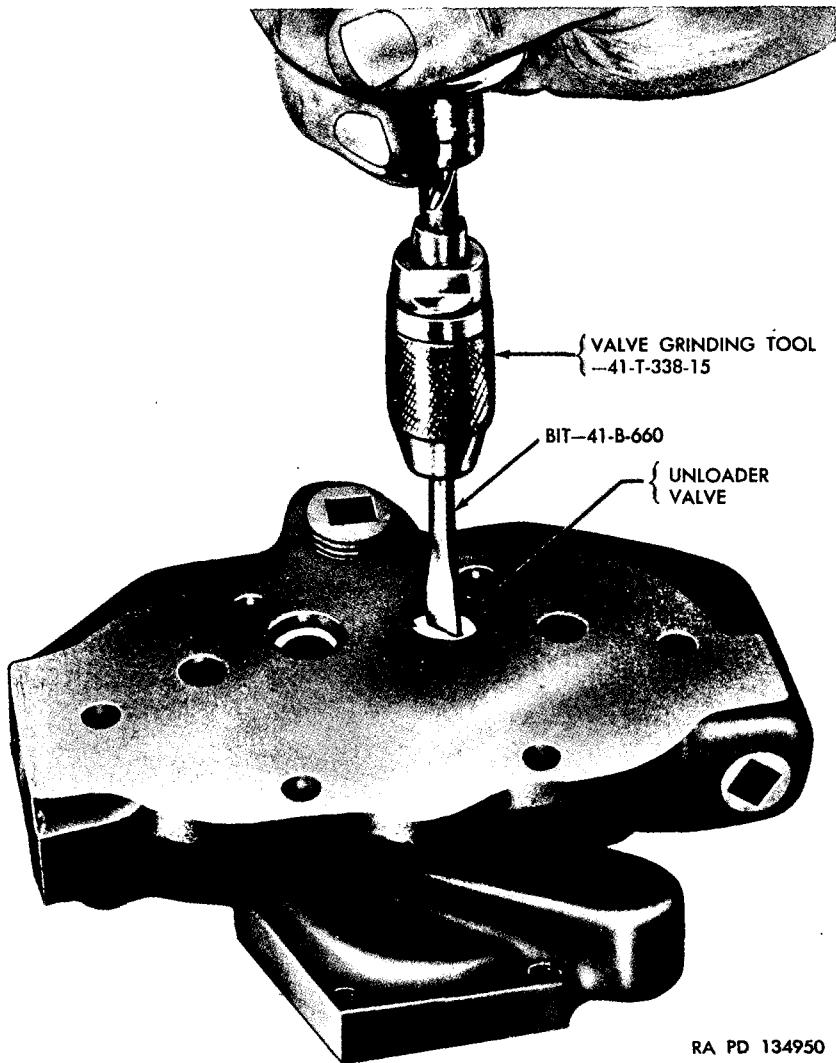


Figure 29. Grinding (lapping) unloader valves.

41-D-1261-500 (fig. 1) with valve grinding compound (fine). Drive lapping disk with reciprocating valve grinding tool 41-T-3381-15 and valve grinding bit 41-B-660 (fig. 1). If seats are pitted, use valve seat lapping tool 41-T-3224 (fig. 1) first, and finish with lapping disk and valve grinding compound (fine). Badly damaged seats must be reamed before lapping to a finish. Use valve seat reamer 41-R-1396 (fig. 1). Insert reamer and screw knurled sleeve in threaded hole until sleeve seats on cylinder head. Loosen set screw in collar on reamer shank and seat end of reamer against valve seat. Insert a 0.001-inch feeler gage between knurled sleeve and collar, tighten collar against feeler gage, and remove gage. Ream valve seat (fig. 31) until collar engages knurled sleeve. Remove reamer, examine seat, and repeat reaming, if necessary. If seats are damaged beyond repair by reaming, the cylinder head must be replaced. Seats must be lapped after reaming.

(b) *Replaceable seats.* Some U-7 $\frac{1}{4}$ cylinder heads and all U, E, and F-12 heads are fitted with valve seat inserts which are threaded into place. Seats are removed from U-7 $\frac{1}{4}$ and U-12

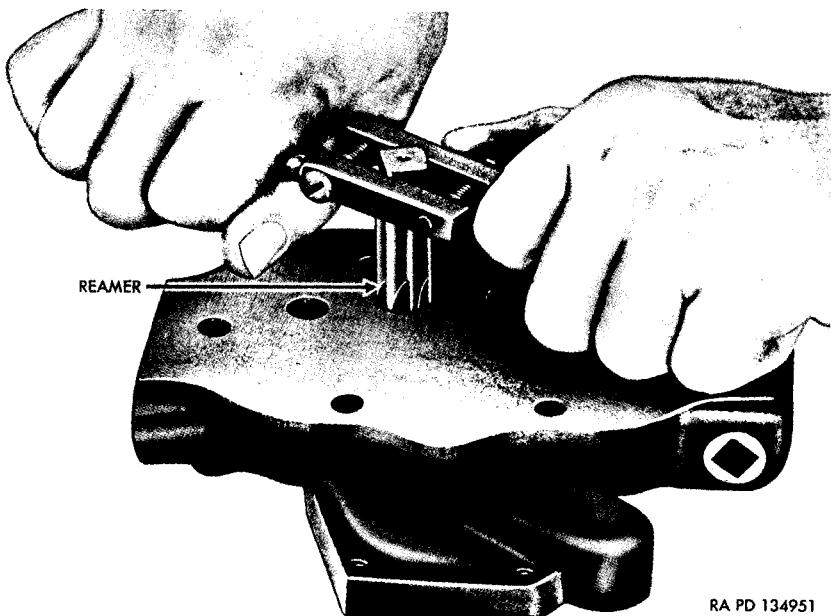


Figure 30. Reaming unloader valve seats with reamer 41-R-2909.

heads with wrench and piece of square stock inserted in seat; inserts in E and F-12 heads are removed with hex stock. It may be necessary to heat F-12 cylinder heads to about 300° F. to remove inserts. Lap seats to a finish after replacement. Use valve seat lapping disk 41-D-1261-500 (fig. 1) for U-7½ and U-12 heads. Use lapping disk 7083460 (fig. 1) for E and F-12 heads.

(c) *Discharge valves.* Discharge valves must be smooth and flat. Clean and polish valves with a piece of crocus cloth on a flat surface (fig. 32). Replace all valves showing noticeable grooving or deep scratches.

32. Assembly of Cylinder Head

a. *Unloader Valves.* Insert unloader valves into the unloader valve bushings (figs. 24, 25, and 26) from the bottom. Lay cylinder head flat, with small blocks or nuts under valves to hold them to their seats. Place unloader valve springs over valve stems and place valve stops on springs (figs. 24, 25, and 26). Compress unloader valve springs (fig. 33) by hand

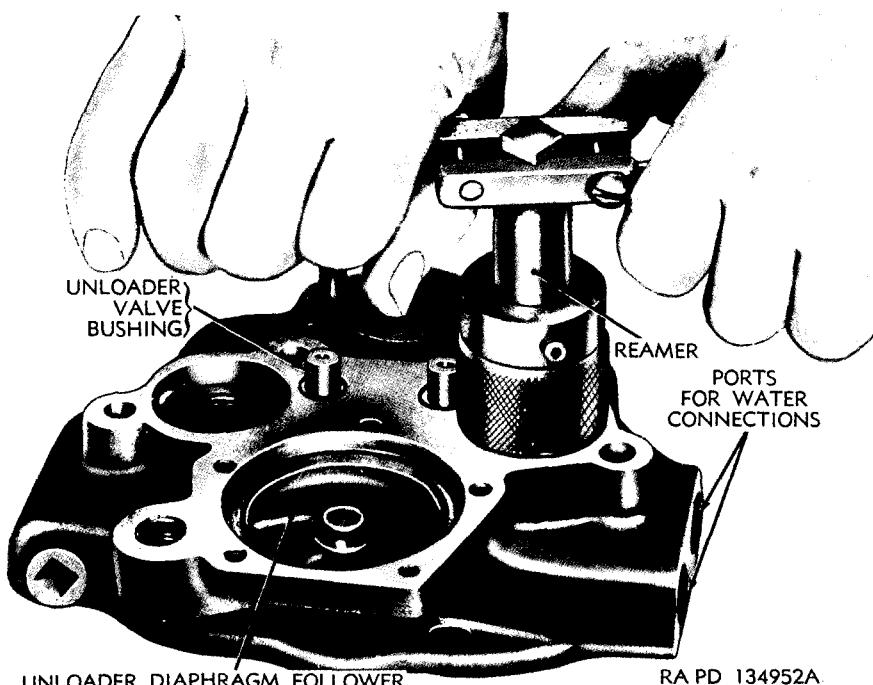


Figure 31. Reaming discharge valve seats with reamer 41-R-1896.

and insert retaining rings (figs. 24, 25, and 26). Operation is same for all type heads.

b. *Discharge Valves.* Place discharge valves on their seats through opening in top of cylinder head, insert discharge valve springs in cap nuts, and install discharge valve cap nuts (figs. 24, 25, and 26). This operation, shown in figure 34, is the same for all type heads.

c. *Unloader Diaphragms and Box Cover.* Spread a thin coat of engine oil (OE-10) over two unloader diaphragms and install them in unloader diaphragm cavity (fig. 34). Place diaphragm follower on diaphragms (figs. 24, 25, and 26), with post upward. Install box cover with a new gasket and secure with round head machine screws and lock washers (figs. 24, 25, and 26).

33. Testing Cylinder Head

a. *Unloader Diaphragms.* Connect an air line to diaphragm cavity port (fig. 34) and admit 100 psi air to diaphragm. Coat unloader box cover with soap suds and check for leakage. Leakage in excess of 1-inch soap bubble in 3 seconds is not permissible.

b. *Discharge Valves.*

(1) Connect air line to discharge port (fig. 34) and admit 100 psi air. Apply soap suds to openings of discharge valves (fig. 35). Leakage in excess of 1-inch soap bubble in 1 second is not permissible.

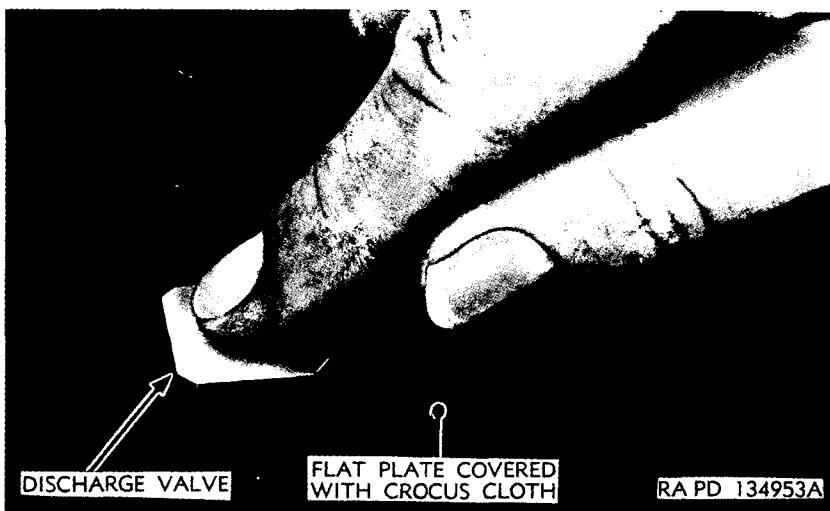


Figure 32. Polishing discharge valves.

(2) If excessive leakage is found, leave the air pressure applied and, with a fiber or hardwood dowel and light hammer, tap the discharge valves (fig. 36) off their seats several times. This will improve the seal between valve and seat and reduce leakage.

(3) With air pressure still applied, apply soap suds around top of discharge valve nut. Leakage must not exceed a 1-inch bubble in 5 seconds.

c. *Unloader Valves.* To test unloader valves a test set-up permitting air pressure to be applied below each valve, and a method of measuring leakage from that valve is necessary. Figures 5, 6, and 7 show simple fixtures which may be improvised for that purpose. These fixtures, with a gasket, are secured to cylinder heads. An air line is connected below one valve, the other valve or valves are held off their seats and leakage tested with soap suds at the remaining hole or holes. Test each valve. Figure 37 shows a more elaborate fixture for this purpose.

(1) *Install unloader lever.* Install adjusting screws and lock nuts in lever. Place dust cover over diaphragm follower port and place lever spring in position in unloader box cover. Position

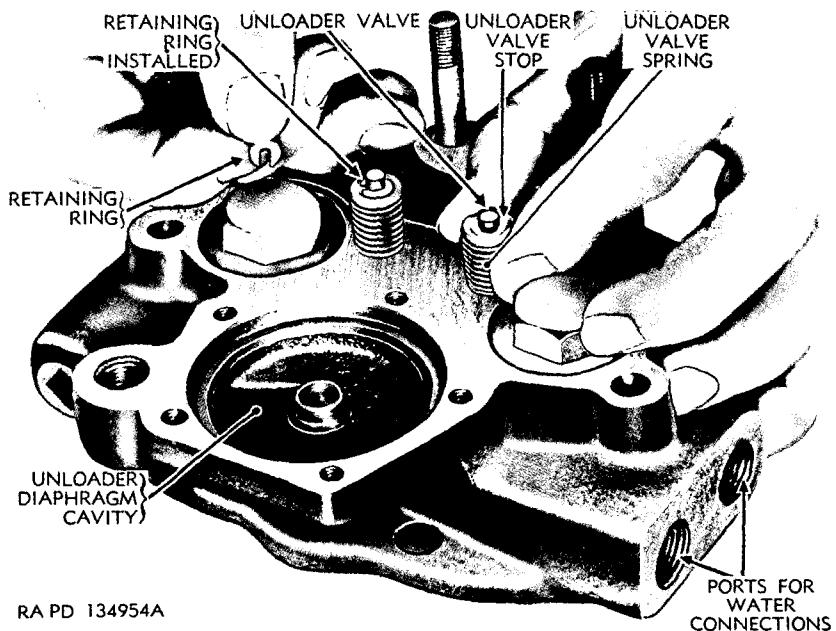


Figure 38. *Installing unloader valves.*

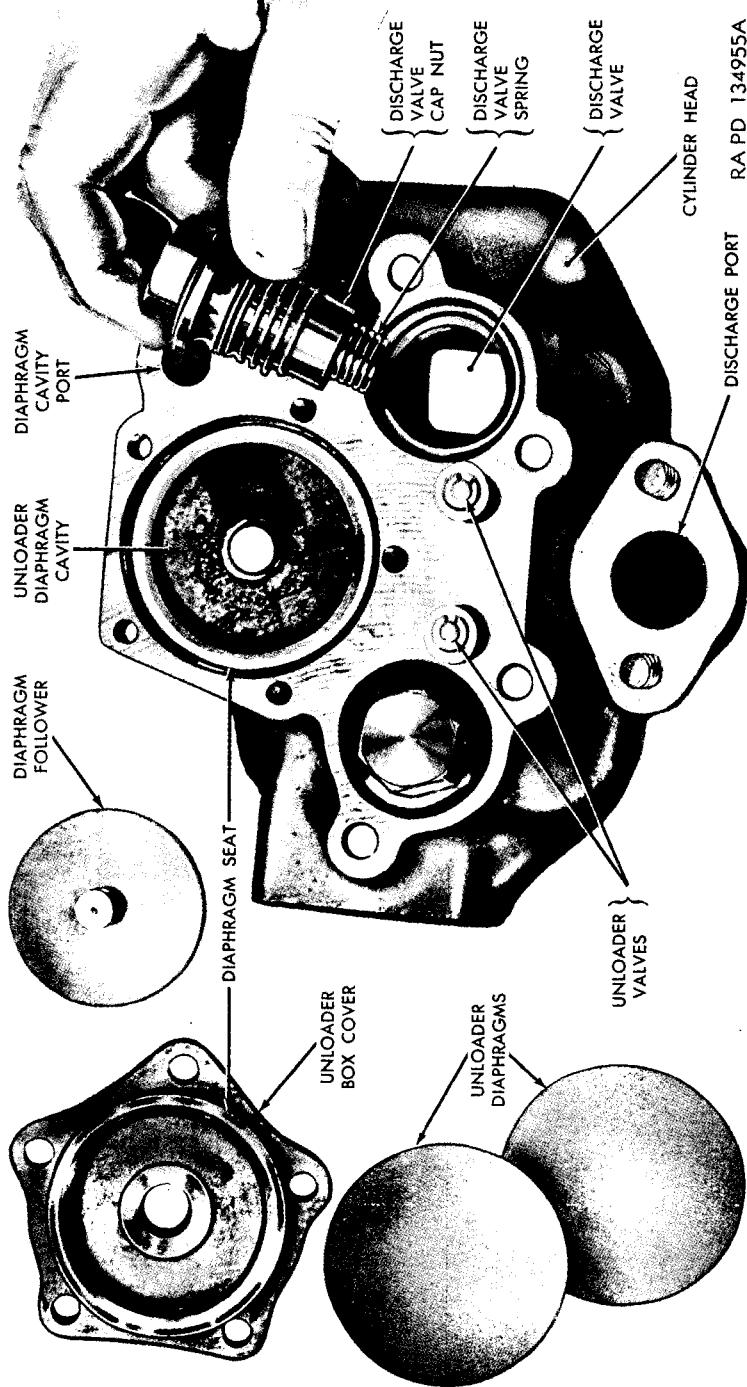


Figure 94. *Installing discharge valves.*

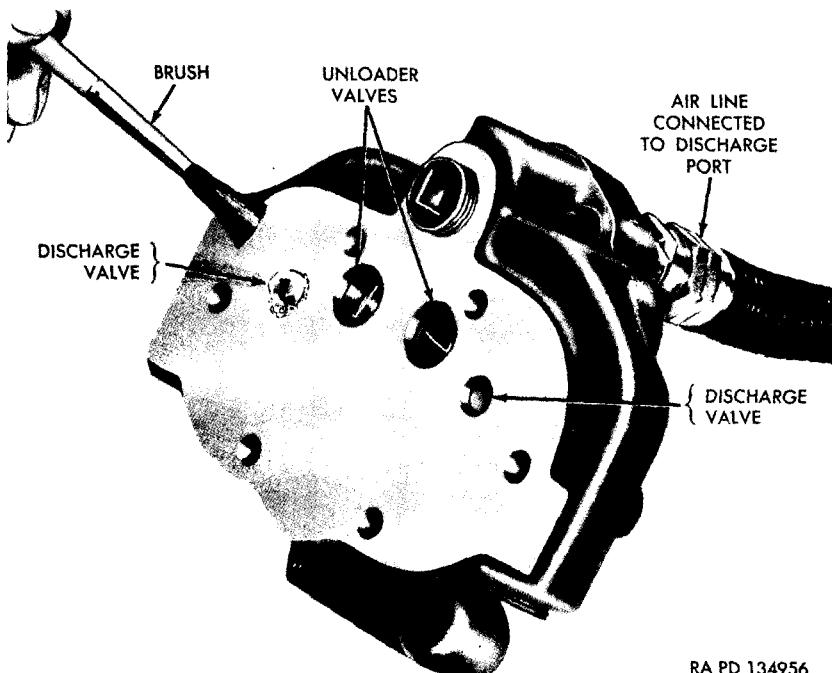
lever and insert lever pin. Secure pin with cotter pin in each end.

- (2) *Adjust unloader valve clearance* (fig. 38). Clearance between unloader lever and unloader valve stems is important. If there is too little clearance, the valves may be held open continuously and the compressor will deliver no air. If there is too much clearance, the valves may not open sufficiently to unload compressor. The desired clearance is 0.012 inch. Minimum clearance has been set at 0.010 inch and maximum at 0.015 inch. Insert a 0.012-inch feeler gage between adjusting screw and unloader valve (fig. 38) to obtain desired clearance and tighten lock nuts.
- (3) If cylinder head is waterproof type, install unloader cover with a new gasket (fig. 28) and secure.

34. Rebuild of Cylinder Block

(fig. 39)

a. *Cleaning.* Clean block thoroughly with dry-cleaning solvent or volatile mineral spirits. Flush out water jacket of a type E block to



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Figure 35. Testing discharge valves for leakage.

remove any sludge or deposit. Blow out air intake passages with compressed air.

b. Inspection.

- (1) Check blocks for broken lugs or cracks. Blocks with such defects must be replaced. Check studs. Bent or broken studs, or studs with damaged threads must be replaced.
- (2) Check cylinder bores for scuffing or scoring. Grind to standard oversize specified in paragraph 46 to restore bore to serviceable condition.
- (3) Check cylinder bores for out-of-round, taper, and diameter to limits given in serviceability standards (par. 46).

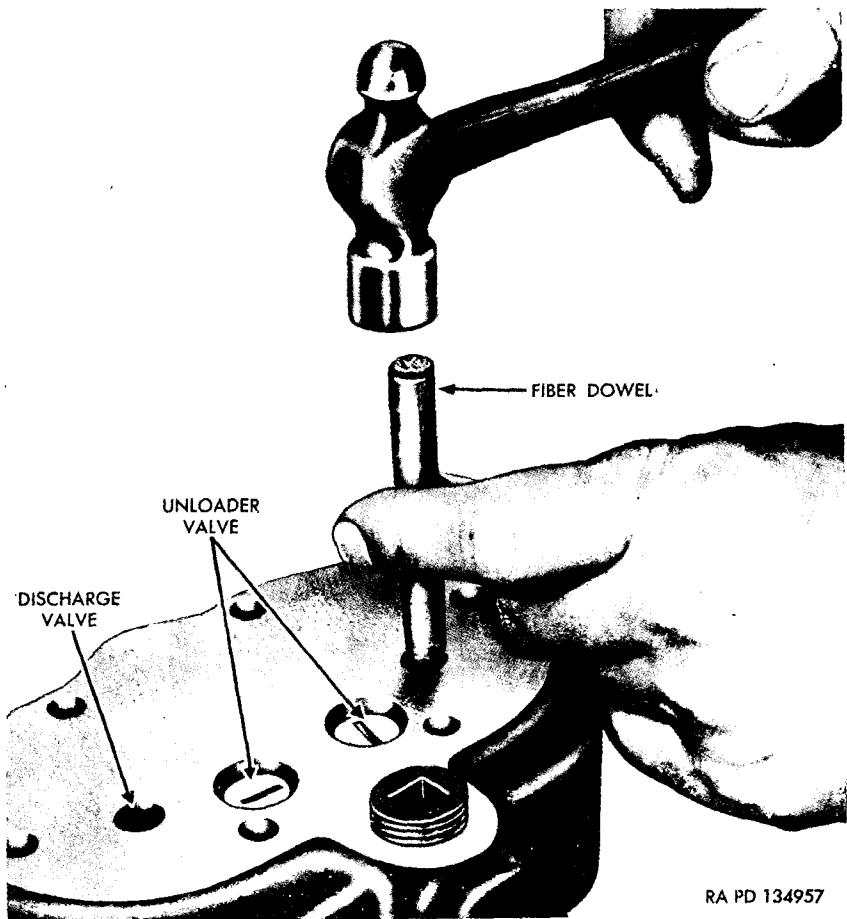


Figure 36. Seating discharge valves.

c. *Repair.*

- (1) Remove any raised metal adjacent to dents or scratches with a fine mill file.
- (2) If regrinding or honing is necessary, cylinder blocks should be bolted to crankcase during operation. Bores should be finished with a 320 grit hone. Pistons of 0.010 inch, 0.020 inch, and 0.030 inch oversize are available. See serviceability standards (par. 46) for grinding limits. U-12 blocks are fitted with cylinder sleeves which are replaced, if regrinding will result in more than 0.030 inch oversize.

35. Rebuild of Pistons and Connecting Rods

a. *Disassembly* (fig. 39).

- (1) Remove cotter pins from castellated nuts on bolts attaching connecting rod caps. Lift out of the connecting rod caps. Then push pistons, with connecting rods attached, out the top of the cylinder block. Replace connecting rod cap on each connect-

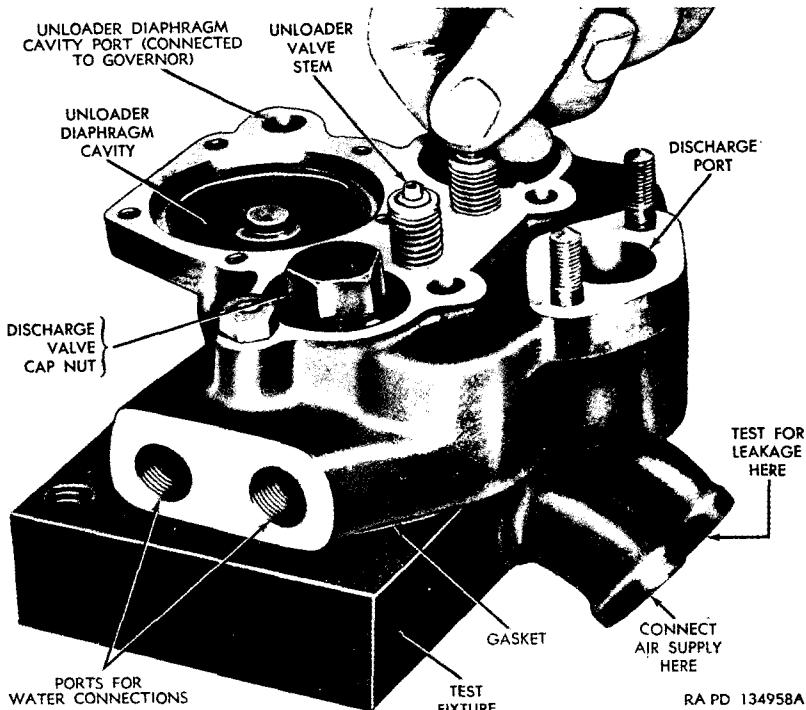


Figure 37. Testing unloader valves for leakage.

ing rod to protect bearings. Connecting rod caps and connecting rods are already marked with center punch marks to show proper position of caps (par. 29e).

(2) Remove piston rings from each piston. If pistons are to be removed from connecting rods, remove locking wire from each piston pin and press piston pins from pistons and connecting rods.

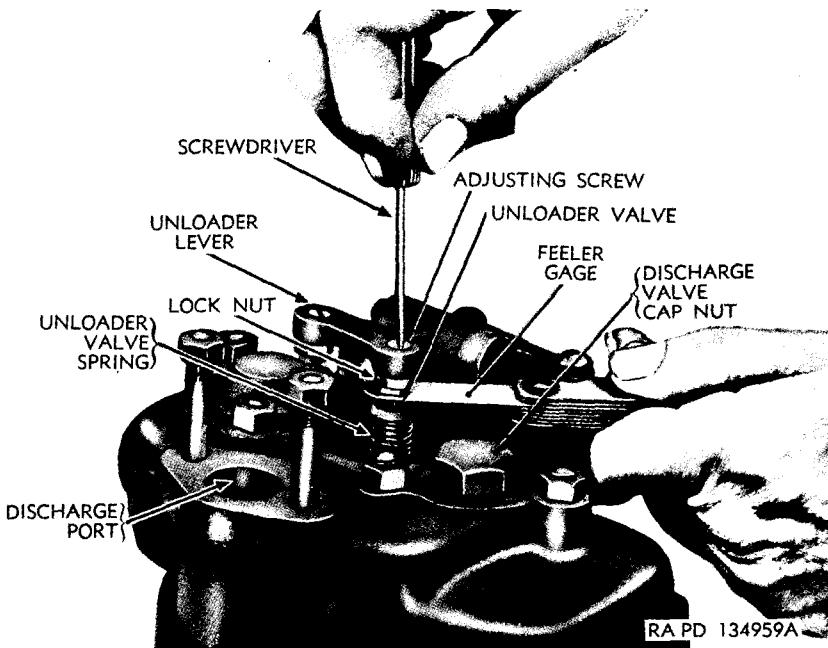


Figure 38. Adjusting unloader valve clearance.

b. Cleaning, Inspection, and Repair.

(1) *Cleaning.* Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits. Remove any carbon deposit from piston head with a scraper. A carbon or glazed varnish deposit on piston wall is removed with carbon-remover solvent.

(2) *Inspection.*

(a) *Pistons.* Inspect pistons for scores, cracks, or damage of any kind. Scored or cracked pistons must be replaced. Check each piston with micrometer to its cylinder bore. Refer to serviceability standards (par. 48) for clearance limits. Check ring groove and gap clearance (fig. 51) with new rings. If

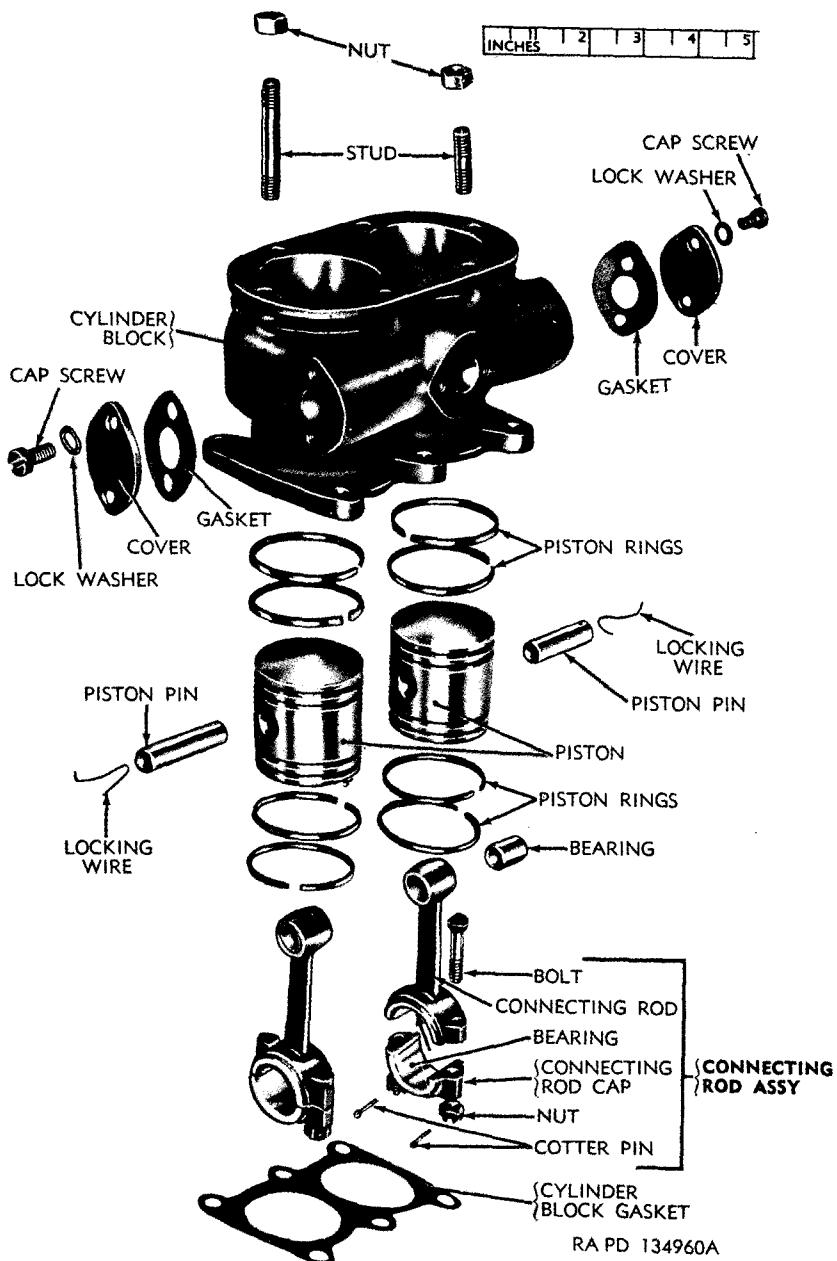


Figure 39. Cylinder block, pistons, and connecting rods—exploded view.

ring groove clearance is beyond the limits specified in figure 51, piston must be replaced.

(b) *Piston pins.* Check fit of piston pin in piston. Pins must be a light press fit in piston. Pistons and piston pins are selective fits and must be requisitioned in sets.

(c) *Connecting rods.* Check fit of piston pin in connecting rod. Pin should be a hand push fit in connecting rod bearing. If noticeable clearance is apparent, press new bearing in rod and ream to size (par. 43). Be sure to line up oil holes in bearing with oil passage in rod. Check condition of connecting rod bearings. If bearing metal is scored or shows evidence of breaking loose or flaking off, replace both halves of bearing. Formerly, connecting rod bearings were bab-bitted. If such rods are found in service, replace with rod and separate bearings. Check fit of rod on crankpin. Install half bearings and rod caps, tighten cap bolts, and check inside diameter against crankpin diameter (par. 43).

(3) *Repair.* No repair is permissible on pistons and connecting rods except replacement of parts, which is covered in (2).

c. *Assembly.* Position connecting rods in piston. Insert piston pin with retainer hole alined with hole in piston boss. Press pin in place and install new pin retainer. Do no install piston rings until ready to install assembly in cylinder block.

36. Rebuild of Crankcase

a. *Cleaning and Inspection* (fig. 40).

(1) *Cleaning.*

(a) *Engine-lubricated.* Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits.

(b) *Self-lubricated.* Clean all parts as in (a) above. Breathers must be disassembled and washed thoroughly. Be sure oil pump check valve in crankcase wall is clean and free of all deposit. See that all parts of crankcase base are clean and that oil pump screen is free of all obstructions.

(2) *Inspection.*

(a) *Engine-lubricated* (fig. 43). Check crankcase for cracks and broken lugs. Replace if such defects are found. Check oil passage in crankcase wall and be sure it is free of all obstruction. Check fit of ball bearings in bores. Bearings must be a slip fit. If bearing bores are worn or damaged to the

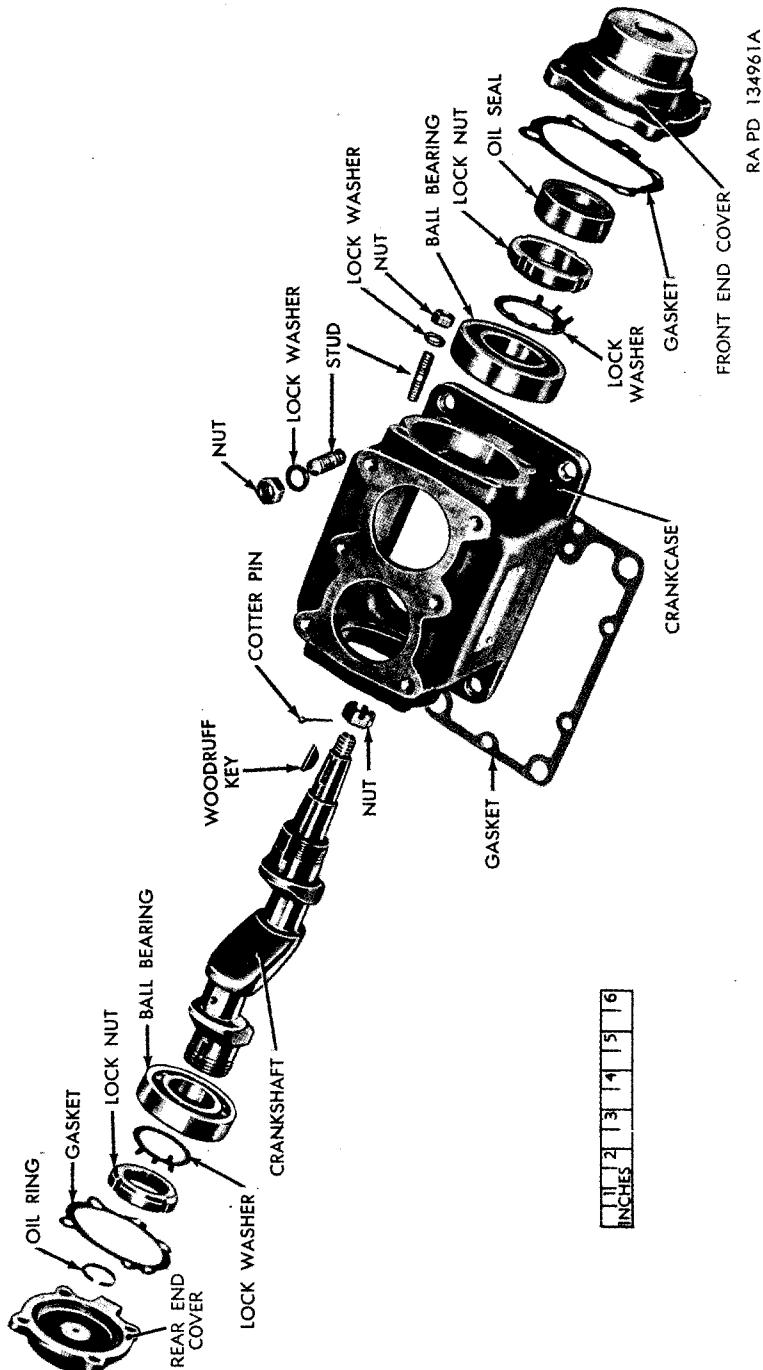


Figure 40. Crankcase section of a two-cylinder compressor—exploded view.

extent of altering the fit, crankcase must be replaced. All bent, broken, or damaged studs must be replaced.

(b) *Self-lubricated* (fig. 44). Check crankcase as in (a) above. Check condition of check valve in crankcase wall by blowing air pressure into oil passage from opening in end of crankcase. No leakage will be noticeable if valve is in good condition. Replace defective check valve. Check crankcase breather. It must be clean and unobstructed. Check crankcase base for cracks and broken lugs and replace, if defective. Examine oil pump screen and replace, if damaged in any way. Check fit of oil pump piston in its cylinder. Piston must be a sliding fit. If noticeable clearance is found, the piston, base plate, or both must be replaced. If oil pump cylinder is loose in base, the base plate assembly with cylinder must be replaced. Check oil pump relief valve (fig. 41). Unscrew check valve from base and drive out retaining pin at top of valve body (fig. 41). Lift out upper spring, piston, and lower spring (fig. 41). Piston must be a sliding fit in body, with no evidence of binding.

b. *Repair.*

(1) *Crankcase.* Replace defective studs. Remove any raised metal adjacent to scratches or dents on finished surfaces with a fine

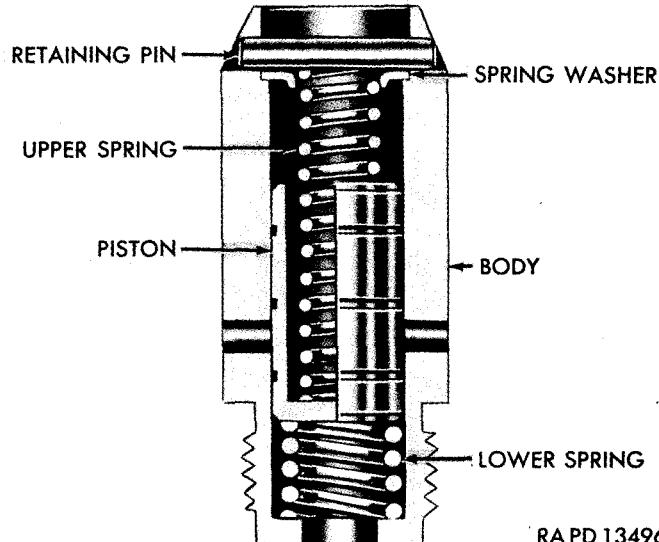


Figure 41. Oil pump relief valve—self-lubricated compressors.

mill file. If check valve in self-lubricated crankcase is defective, extract valve and install replacement and new oil seal gasket.

(2) *Crankcase base.* Remove any raised metal adjacent to scratches or dents on finished surfaces.

37. Assembly of Crankcase

a. *Engine-Lubricated Crankcase.* No assembly of engine-lubricated crankcase is required.

b. *Self-Lubricated Crankcase.*

(1) *Crankcase breather.* Breather assemblies are secured in $7\frac{1}{4}$ cubic foot crankcases with a spring retainer. Breathers for type U-12 cubic feet crankcases are secured with a protecting cover held in position with a machine screw.

(2) *Crankcase base* (fig. 44). When assembling oil pump relief valve, new springs are used. Place lower (short) spring in valve body and insert piston, with closed end on lower (short) spring (fig. 41). Insert upper (long) spring in piston, place spring washer on spring, compress spring, and insert retaining pin over spring washer (fig. 41). Test relief valve assembly with air pressure. The piston must rise sufficiently to begin to uncover ports in body when air pressure is between 14 psi and 24 psi maximum. If operation is correct, stake the retaining pin in body. Install relief valve in crankcase base and tighten securely. Position oil pump screen in base plate and install retaining ring. Install oil filler fitting (fig. 15) and blanking cover on sides of base plate, if they have been removed, being sure the oil filler fitting is positioned as marked before disassembly. Install a new oil pump check valve gasket in bottom of crankcase.

38. Reconditioning of Crankshaft

a. *Cleaning, Inspection, and Repair.*

(1) *Cleaning.* Wash crankshaft with dry-cleaning solvent or volatile mineral spirits to remove all grease and dirt. Use probe or wire if necessary to obtain oil passages. Blow passages out with compressed air.

(2) *Inspection.* Check condition of main bearing journals. Ball bearings must be a light press fit on journals. If journals are worn sufficiently to produce a loose fit in the ball bearings, discard the crankshaft. Screw threads, keyways, tapered ends, and splines must not be mutilated. Check crankpins for wear

or out-of-round. If the crankshaft is the splined type, the width of all splines must not be less than 0.170 inch for shafts with 10 splines or less than 0.246 inch for shafts with 6 splines. Splines must be in good condition and not mutilated in any way. Some crankshafts are provided with oil seal rings. Check condition of rings and their fit in crankshaft. Clearance of ring in groove must be between 0.0015 and 0.0025 inch. Check ball bearings for wear or flat spots. Replace defective bearings.

(3) *Repair.* Crankpin journals may be reground undersize to limits given in serviceability standards (par. 45). When regrinding,

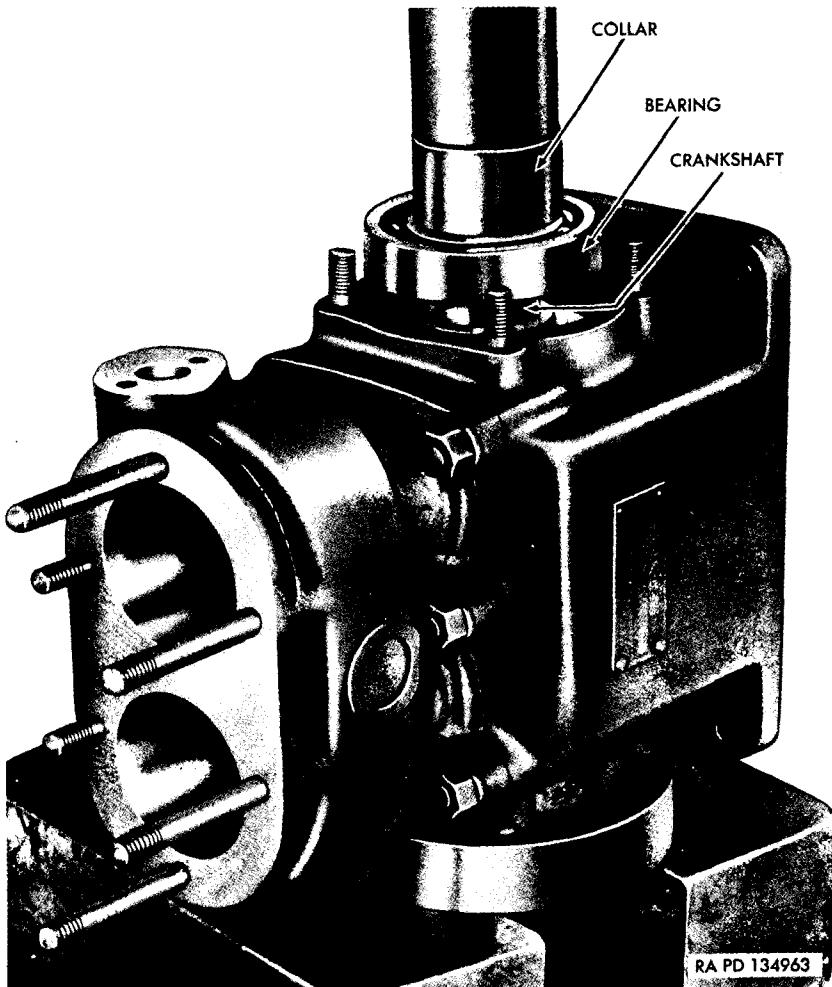


Figure 42. *Installing crankshaft and bearings with arbor press.*

fillets at ends of journals must be retained. Regrinding main bearing journals is not permitted.

39. Assembly of Compressor

(figs. 43-48)

a. *Installing Cylinder Block.* Place new cylinder block gasket (fig. 39) in position over crankcase studs. Position cylinder block on crankcase in accordance with markings made before disassembly. Install lock washers and nuts, and secure cylinder block to crankcase.

b. *Installing Crankshaft.*

- (1) Position ball bearings and crankshaft in crankcase (fig. 40), being sure the drive end of the crankshaft is positioned at the

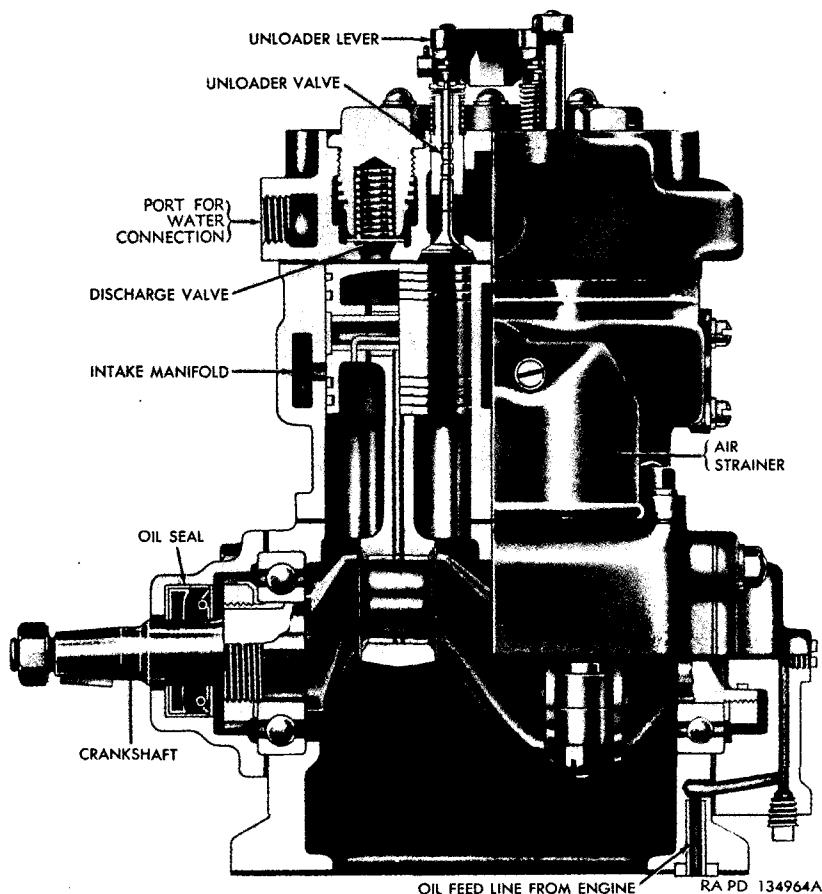


Figure 43. Sectional view of 2-UE-7 1/4-VW compressor.

end of the crankcase marked with one punch mark before disassembly. If one end of the crankcase is counterbored for holding bearing, be sure the crankshaft is entered through the correct end of the crankcase. Press crankshaft and bearings (fig. 42) into crankcase.

(2) If the crankshaft is fitted with oil seal rings, install rings. If compressor assembly includes a special lock washer and lock nut at either or both ends of the crankshaft, install lock washers and lock nuts and tighten lock nuts (fig. 40). Then bend one lug on each lock washer into one of the slots in each lock nut to prevent lock nut from becoming loose. The use of these

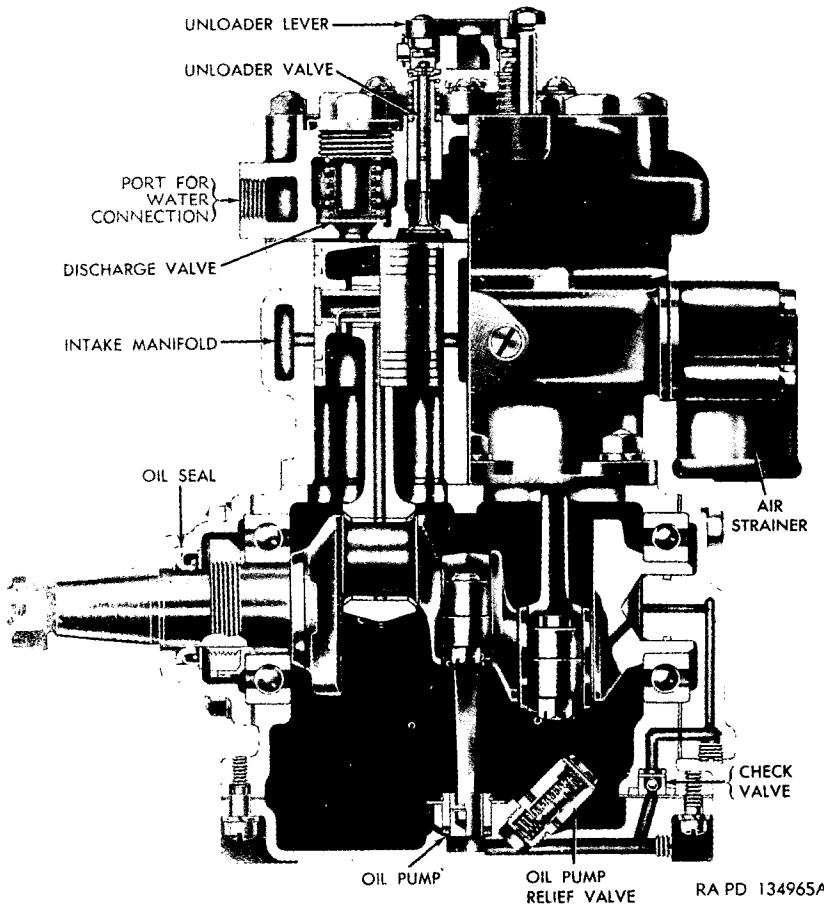


Figure 44. Sectional view of 2-US-7 1/4-VW compressor.

lock nuts and lock washers in vertical types of compressors has been discontinued and they may be omitted, if desirable.

c. *Installing End Cover.* Place a new gasket for rear end cover in position over studs on rear end of crankcase (fig. 40), making sure the oilhole in the gasket lines up with the oilhole in the crankcase. If rear end cover includes an oil ring, install oil ring (fig. 40). Then position rear end cover over studs in crankcase (fig. 40), being sure that the oilhole in the rear end cover lines up with oilhole in the gasket and crankcase. Install lock washers and nuts, and secure end cover in place. Install pipe plugs in any oil openings in end cover. If front-end cover includes an oil seal and the oil seal has been removed from the end cover, press a new oil seal into end cover (fig. 40). Install a new gasket (fig. 40). Carefully position the front-end cover so as not to damage the oil seal and install lock washers and nuts, and secure end cover in place.

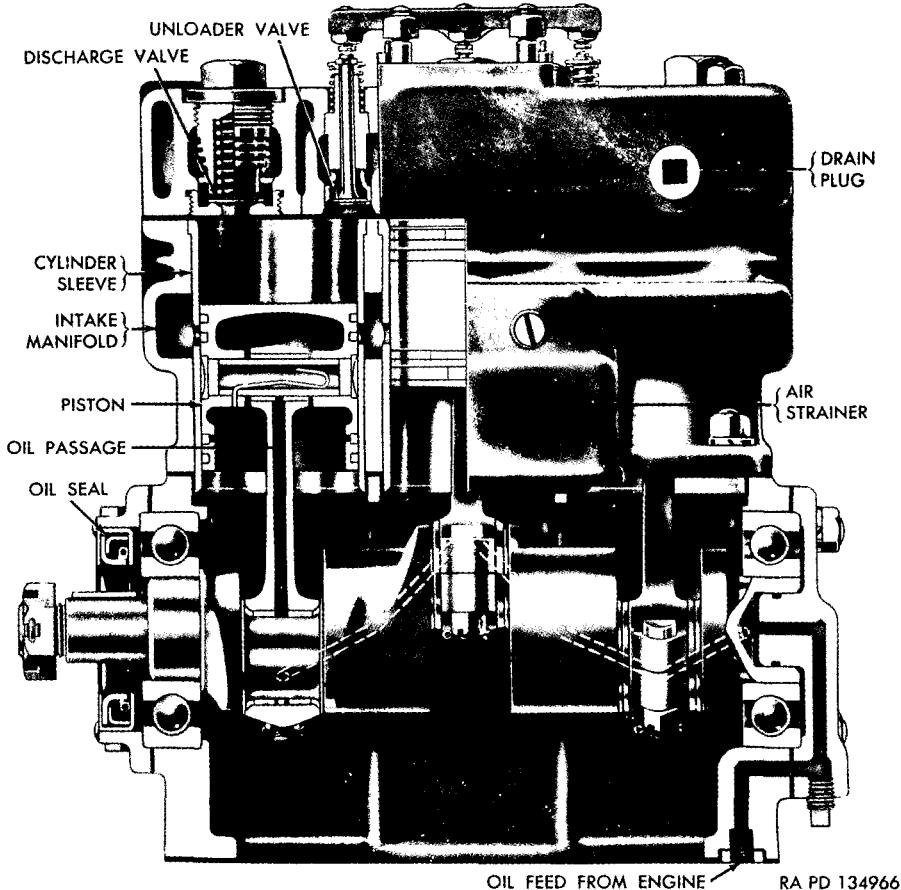


Figure 45. Sectional view of 3-UE-12-VW compressor.

d. Installing Pistons and Connecting Rods.

- (1) Check piston ring gap by placing ring in cylinder, pushing it part way in with an inverted piston, measuring gap with feeler gage (fig. 49), and checking against gap prescribed in serviceability standards given in figure 51.
- (2) Install piston rings (fig. 50) by hand. Rings must be installed in their proper locations and it is important that they be positioned correctly in the piston grooves. Figure 51 illustrates the assemblies and prescribes serviceability standards for the piston rings of types U-7½, U-12, E, and F-12 compressors.

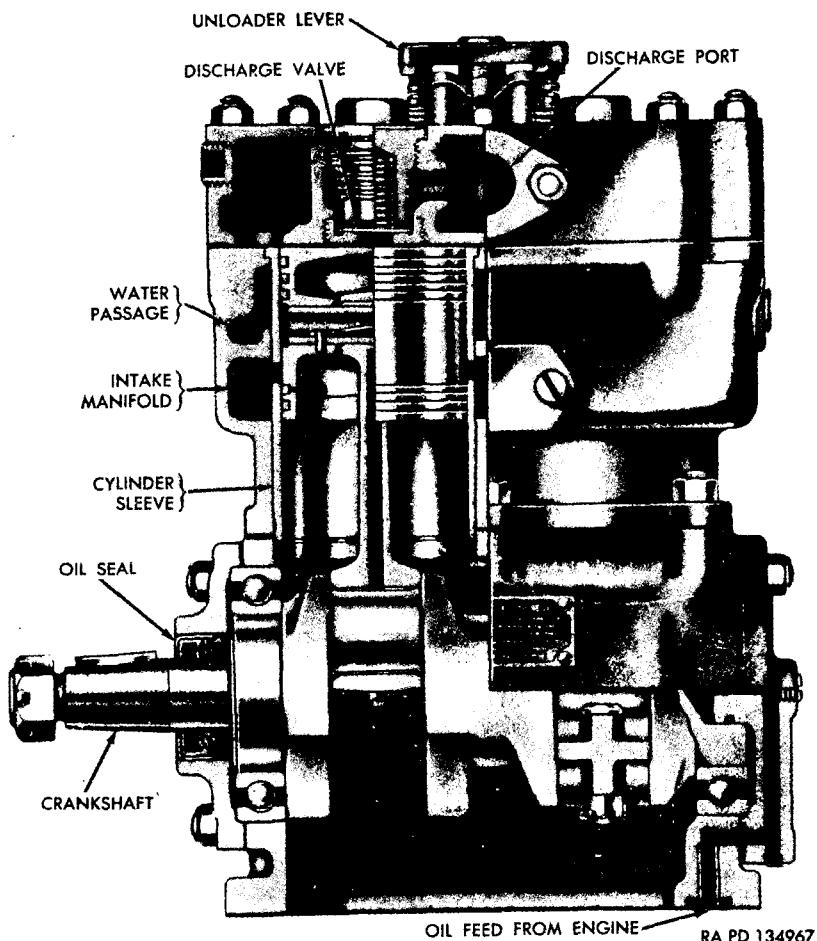


Figure 46. Sectional view of type E compressor, engine-lubricated.

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- (3) Before installing pistons and connecting rods, thoroughly lubricate pistons, piston rings, piston pin bearings, and connecting rod bearings with clean engine oil.
- (4) Turn crankshaft so as to position No. 1 crankshaft journal downward. Remove bearing cap from No. 1 connecting rod leaving connecting rod bolts in the rod.
- (5) Insert No. 1 connecting rod and piston through top of No. 1 cylinder being sure the connecting rod bearing engages in the connecting rod journal in the same position as that in which it was fitted.

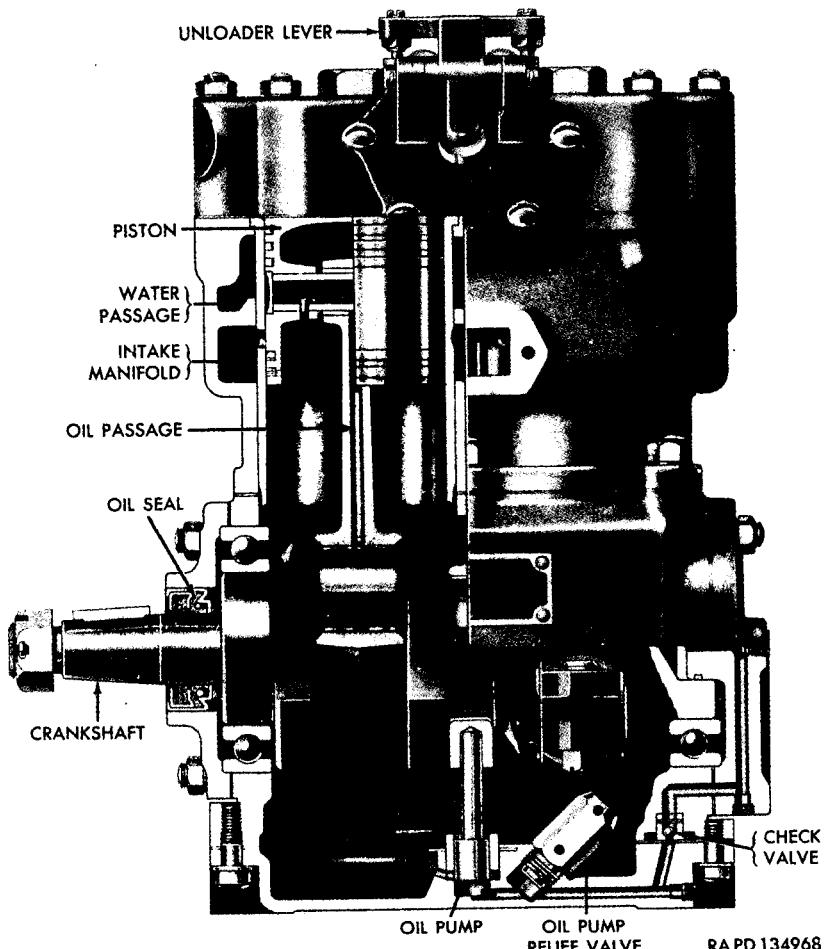


Figure 47. Sectional view of type E compressor, self-lubricated.

(6) Position and attach lower bearing cap to connecting rod and install two castellated nuts and cotter pins.

(7) Install other pistons as in (1) through (6) above.

e. *Installing Cylinder Head.* Install new gasket (fig. 22) for cylinder head. Be sure the gasket is positioned to clear unloading valves. Position cylinder head on cylinder block in accordance with marking made at disassembly (par. 29b). Install nuts and tighten securely.

f. *Installing Base Plate (Self-Lubricating Compressors Only).*

(1) Install oil pump piston and rod on crankshaft. Oil pump rod bearing fit must be the same as the serviceability standards for

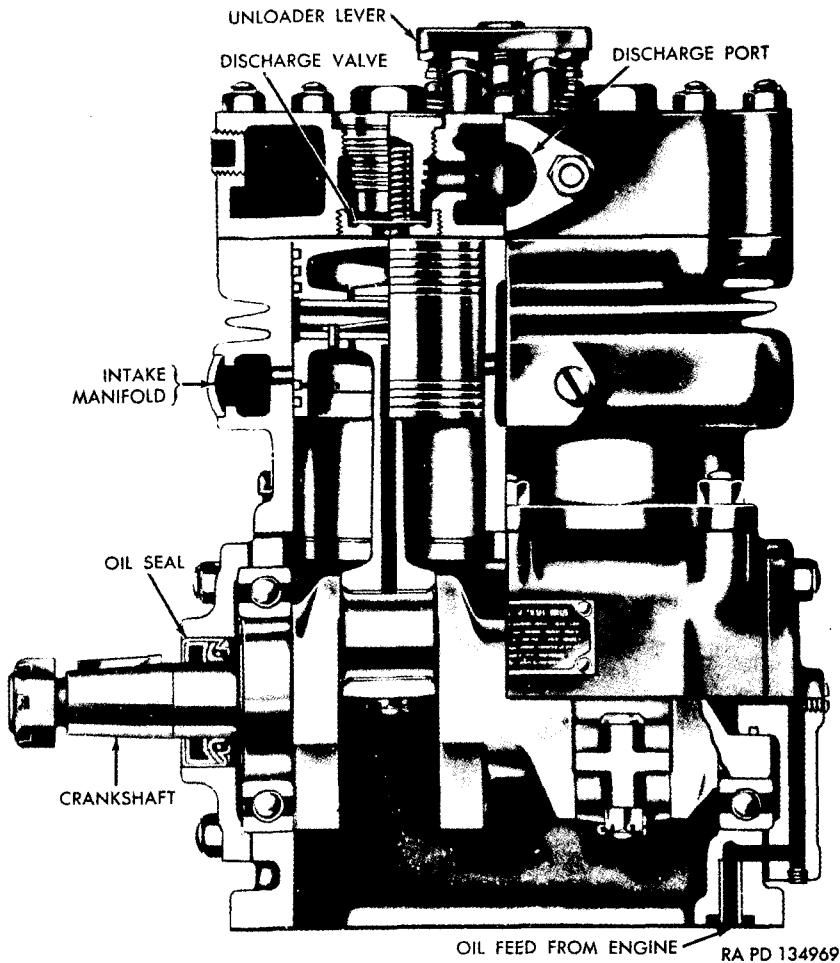


Figure 48. Sectional view of type F-12 compressor, engine-lubricated.

connecting rod bearings specified in paragraph 43. Be sure to install cotter pins in nuts securing bearing cap.

(2) Position base plate assembly on bottom of the crankcase, being sure the oil pump piston engages the oil pump piston bushing in the base plate (fig. 52), and install dowel screw at end of base plate. Install remaining attaching machine screws and tighten securely.

40. Testing Rebuilt Compressor

All rebuilt compressors must be subjected to the following tests:

- a. *Wear-In Test* (par. 23).
- b. *Oil-Passing Test* (par. 24).
- c. *Efficiency Test* (par. 25).

Note. If compressor is not to be put in service immediately, plug air connection to unloading cavity and water inlet and outlet openings. Fit a temporary cover over the discharge port.

d. *Crankshafts.* Fit the ends of all crankshafts with cotter pins, nuts, and keys when such parts are required and then protect against damage during handling by wrapping with friction tape or some other similar material.

e. *Lubrication.* The unloading lever and valve mechanism must be well lubricated with the oil prescribed for the engine in the lubrication order for the vehicle.

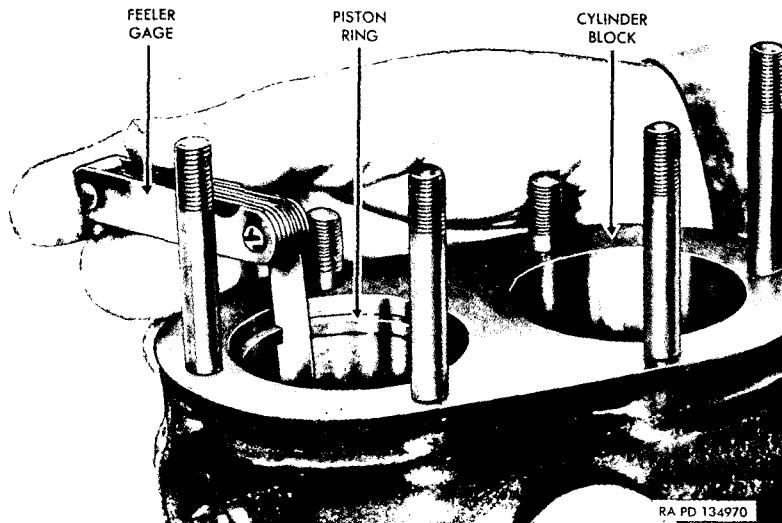


Figure 49. Checking piston ring gap.

f. Storage. Protect the open bottom of engine-lubricated compressors against the entrance of dirt during handling or storage by installing a temporary wooden cover.

41. Air Strainers

a. General. Every compressor is equipped with an air strainer to prevent suspended dirt and dust from entering the compressor. The standard air strainer (fig. 53) is used on vehicles not intended for deep fording. A waterproof strainer (fig. 54) is used when vehicle is adapted for deep fording. Both strainers are similar in construction.

b. Disassembly.

- (1) To disassemble standard air strainer, pry out retainer spring from recess in body, holding hand over outer baffle to prevent inner parts from scattering, and remove all parts, as shown in figure 53.



Figure 50. *Installing piston rings.*

**TYPE U—7 1/4 cu.-ft
COMPRESSORS**

**TYPE U—12 cu-ft
COMPRESSORS**

TYPE E, AND F-12 COMPRESSORS

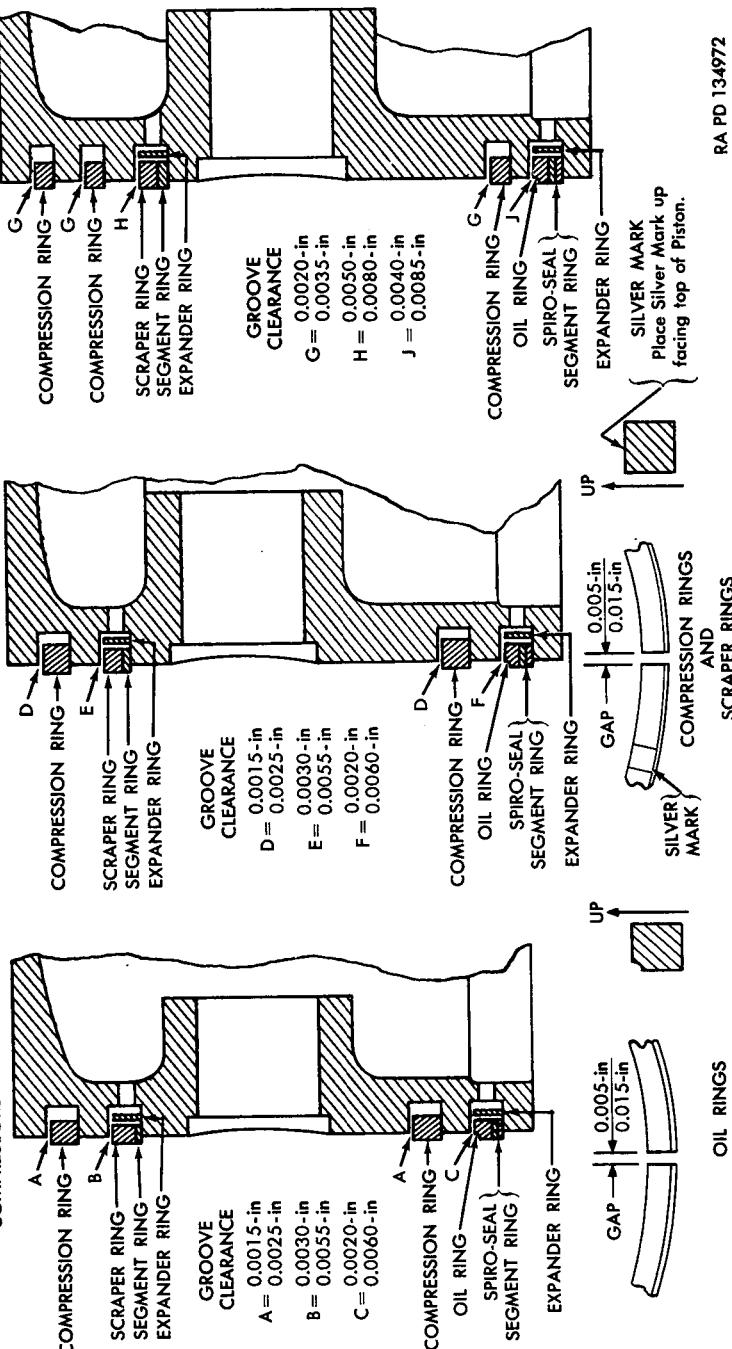


Figure 61. Piston ring arrangement and serviceability standards.

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(2) To disassemble waterproof strainer, remove screws holding cover to body and remove all parts, as shown in figure 54.

c. *Cleaning.* Clean all parts with dry-cleaning solvent or volatile mineral spirits and wash curled hair thoroughly in the solvent. Squeeze solvent from curled hair, saturate it with the oil, prescribed for lubricating the engine in the lubrication order for the vehicle, and squeeze dry.

d. *Assembly.* The internal parts of both standard and waterproof strainers are the same. Place baffle plate in body, with screen toward open side of body (figs. 53 and 54). Set spring on baffle plate and curled hair on spring (figs. 53 and 54). Place baffle plate, with screen side against the curled hair, and secure. Force the retainer spring (fig. 53) into recess in body to secure standard strainer. To secure waterproof strainer, place new gasket on body and install cover (fig. 54) with screws and washers.

e. *Installation.* Install air strainers after compressors are tested. Note that annular copper washers are used on cap screws when installing the waterproof strainer.

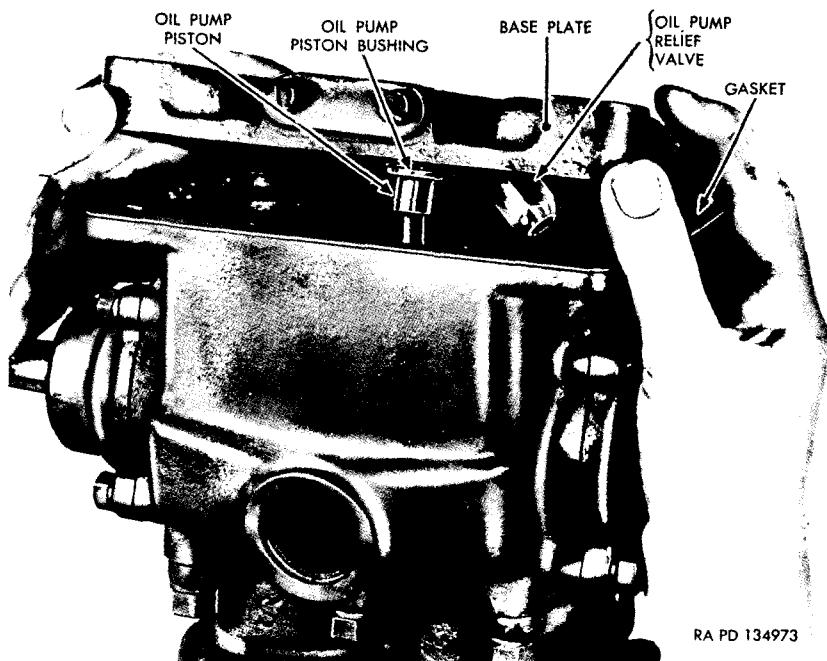


Figure 52. *Installing base plate (self-lubricating compressors only).*

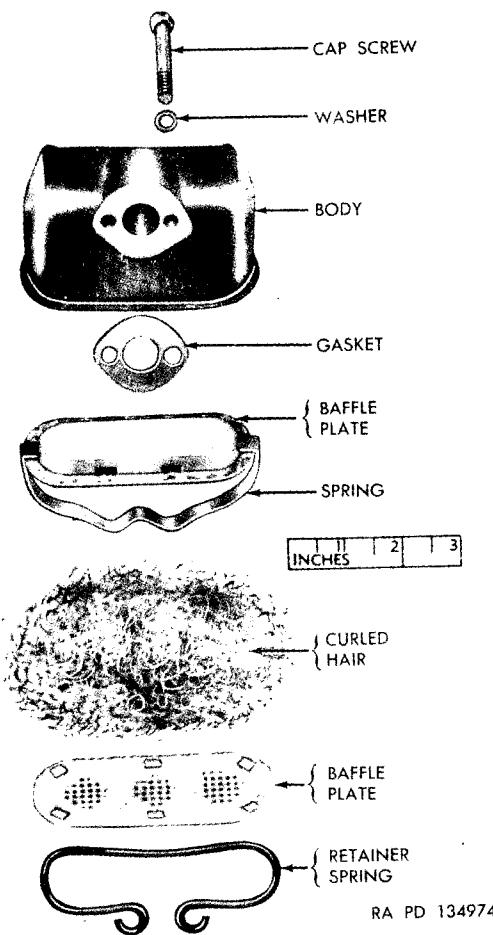


Figure 53. Standard air strainer—exploded view.

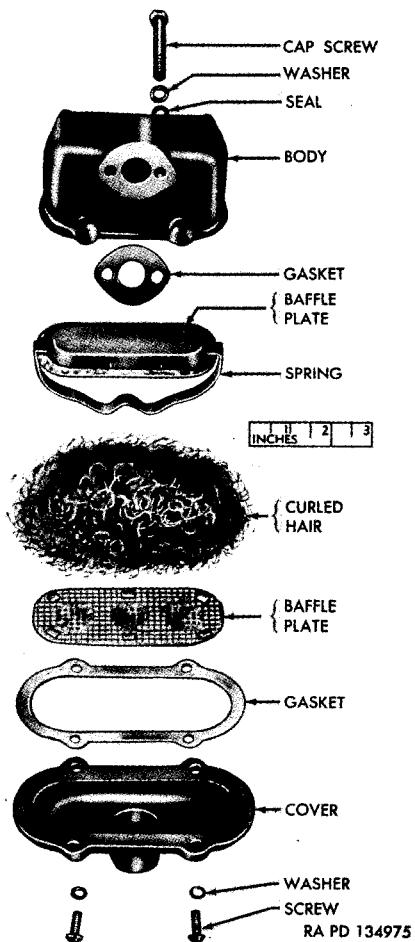


Figure 54. Waterproof air strainer—exploded view.

Section V. DATA AND SERVICEABILITY STANDARDS

42. Tabulated Data

	Type U		Type E	Type F
	Two-cylinder	Three-cylinder	Two-cylinder	Two-cylinder
Displacement in cfm at 1,250 r.p.m.	7 $\frac{1}{4}$	12	12	12
Bore (inches)	2 $\frac{1}{16}$	2 $\frac{3}{16}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$
Stroke (inches)	1 $\frac{1}{2}$	1 $\frac{1}{2}$	.....	.....
Lubrication	Engine or self	Engine or self	Engine or self	Engine or self
Cooling	Water or air	Water or air	Water or air	Water or air
Horsepower required at 1,250 rpm against 90 psi air pressure	1.6	2.6	2.4	2.4
Maximum speed recommended for water-cooled compressors..	1,800 rpm	1,800 rpm	2,000 rpm	2,000 rpm
Maximum speed recommended for air-cooled compressors	1,250 rpm	1,250 rpm	1,250 rpm	1,250 rpm
Minimum oil pressure required at engine idling speed	5 psi	5 psi	5 psi	5 psi
Minimum oil pressure required at maximum governed speed of engine	15 psi	15 psi	15 psi	15 psi

43. Serviceability Standards for Connecting Rods (par. 35)

Fig. No.	Ref. No.	Item	Standard sizes		Repair or replace after (in.)
			Min. (in.)	Max. (in.)	
56	5	Clearance			
		Bearing to crankpin	0.0003	0.0021	0.004
	1	Piston pin to bearing	0.0001	0.0006	0.0015
		Crankpin bearing undersizes	0.010	0.020	0.030

44. Serviceability Standards for Crankcase

(par. 36)

Fig. No.	Ref. No.	Item	Standard sizes		Repair or replace after (in.)
			Min. (in.)	Max. (in.)	
.....	Main bearing bores to bearings (interference). Cast iron	-0.0002	+0.0010	0.001
		Aluminum	-0.0008	-0.0020	-0.002

Note. Main bearing bores
should be checked with
cylinder block and crank-
case assembled.

45. Serviceability Standards for Crankcase

(par. 38)

Type U-7 1/4	Standard sizes		Repair or replace after (in.)
	Min. (in.)	Max. (in.)	
Diameter main journals	1.3779	1.3784	1.3779
Diameter crankpins	1.1242	1.1250	1.1237
Grind crankpins undersize	0.010	{ 0.020 0.030 }	.....
<i>Type U-12</i>			
Diameter main journals	1.3779	1.3784	1.3779
Diameter crankpins	1.1242	1.1250	1.1237
Grind crankpins undersize	0.010	{ 0.020 0.030 }	.....
<i>Type E</i>			
Diameter main journals	{ 2.1653 1.3779 }	{ 2.1658 1.3784 }	{ 2.1653 1.3779 }
Diameter crankpins	1.1242	1.1250	1.1237
Grind crankpins undersize	0.010	{ 0.020 0.030 }	.....
<i>Type F-12</i>			
Diameter main journals	{ 2.1653 1.3779 }	{ 2.1658 1.3784 }	{ 2.1653 1.3779 }
Diameter crankpins	1.1242	1.1250	1.1237
Grind crankpins undersize	0.010	{ 0.020 0.030 }	.....

Note. In some type E and F-12 compressors a combination of 2.1653 and 1.3779 main journals may be found.

46. Serviceability Standards for Cylinder Block
 (par. 34)

Fig. No.	Ref. No.	Item	Standard sizes		Repair or replace after (in.)
			Min. (in.)	Max. (in.)	
<i>Type U-7 1/4</i>					
56	4	Diameter bore	2.0630	2.0635	2.0670
		Grind oversize	0.010	0.020	0.030
		Out-of-round .....	.....	.....	0.002
		Taper .....	.....	.....	0.003
	3 to 4.	Clearance to piston	0.0015	0.0025	0.004
<i>Type U-12</i>					
56	4	Diameter bore	2.1880	2.1885	2.1920
		Grind oversize	0.010	0.020	0.030
		Out-of-round	0.002
		Taper	0.003

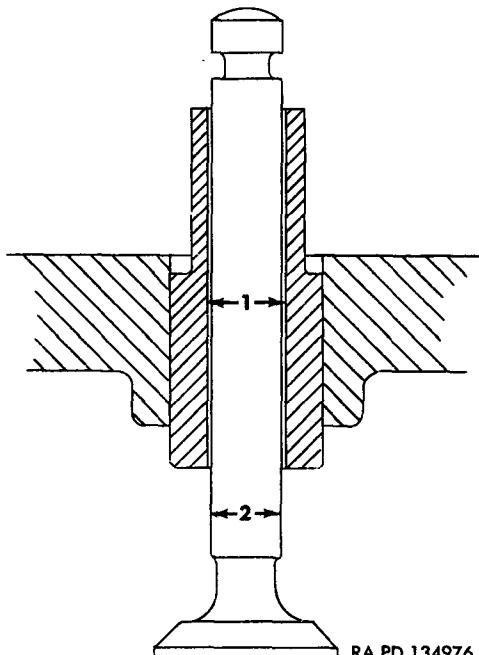


Figure 65. Unloader valve stem clearance.

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46. Serviceability Standards for Cylinder Block—Continued

Fig. No.	Ref. No.	Item	Standard sizes		Repair or replace after (in.)		
			Min. (in.)	Max. (in.)			
<i>Type E</i>							
58	4	Diameter bore	2.5000	2.5005	2.5040		
		Grind oversize	0.010	0.020	0.030		
		Out-of-round .....	.....	.....	0.002
		Taper .....	.....	.....	0.003
58	3 to 4	Clearance to piston	0.0015	0.0025	0.004		
		<i>Type F-12</i>					
		Diameter bore	2.5000	2.5005	2.5040		
		Grind oversize	0.010	0.020	0.030		
58	3 to 4	Out-of-round	0.002		
		Taper	0.003		
		Clearance to piston	0.0015	0.0025	0.004		

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47. Serviceability Standards for Cylinder Heads (par. 30)

Fig. No.	Ref. No.	Item	Standard sizes		Repair or replace after (in.)		
			Min. (in.)	Max. (in.)			
<i>Unloader valve stem</i>							
55	2	Type U-7 $\frac{1}{4}$	0.2475	0.2485	0.2485		
		Type U-12	0.187	0.188	0.186		
		Type E	0.2475	0.2485	0.2465		
		Type F-12	0.2475	0.2485	0.2465		
55	1 to 2	<i>Clearance to bushing</i>					
		Type U-7 $\frac{1}{4}$	0.001	0.003	0.005		
		Type U-12	0.001	0.003	0.005		
		Type E	0.001	0.003	0.005		
55	1	<i>Ream replacement bushing</i>					
		Type U-7 $\frac{1}{4}$	0.2495	0.2505	0.2515		
		Type U-12	0.189	0.190	0.191		
		Type E	0.2495	0.2505	0.2515		
55	.....	Clearance stem to un- loader lever adjusting screws (all types)	0.010	0.015		

48. Serviceability Standards for Piston

(par. 35)

Fig. No.	Ref. No.	Item	Standard sizes		Repair or replace after (in.)
			Min. (in.)	Max. (in.)	
56	3	<i>Diameter</i>			
		Type U-7 $\frac{1}{4}$	2.0610	2.0615	.....
		Type U-12	2.1860	2.1865	.....
		Type E	2.4980	2.4985	.....
		Type F-12	2.4980	2.4985	.....
		Oversizes (all types)	0.010	0.020	0.030
		Out-of-round (all types) .....	.....	.....	0.003
56	3 to 4..	Taper (all types) .....	.....	.....	0.003
		Clearance to cylinder wall	0.0015	0.0025	0.004

49. Serviceability Standards for Piston Pins

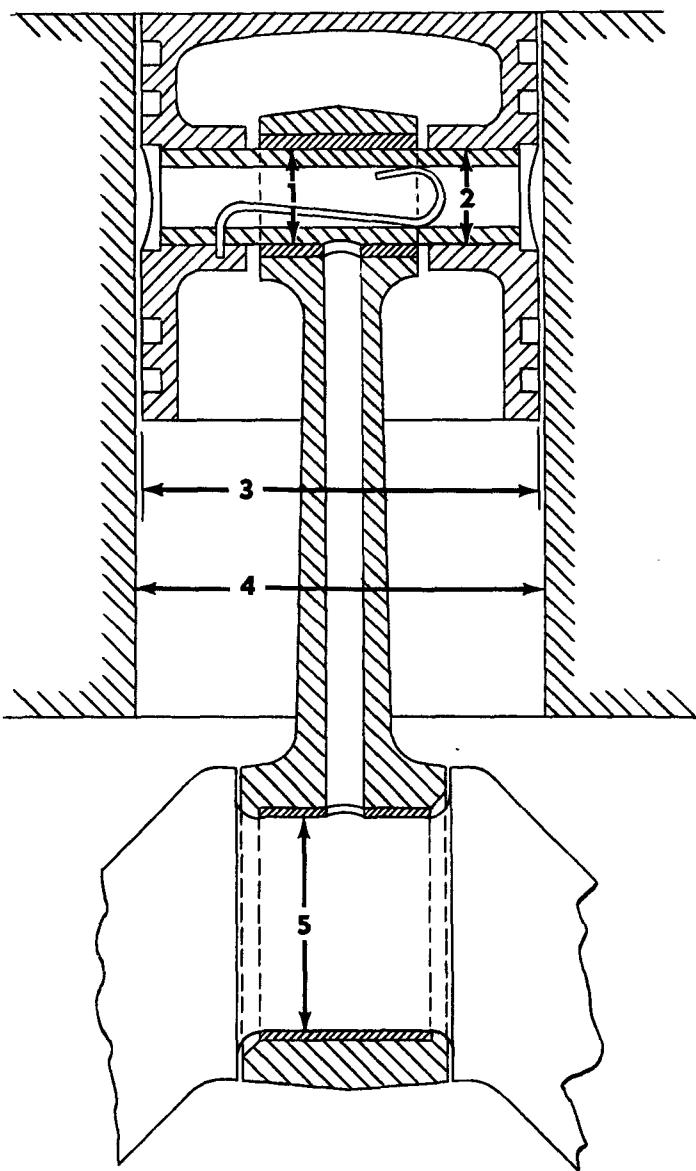
(par. 35)

Fig. No.	Ref. No.	Item	Standard sizes		Repair or replace after (in.)
			Min. (in.)	Max. (in.)	
56	2	Clearance in piston	-0.0001	+0.0003	+0.0003
	1	Clearance in connecting rod	+0.0001	0.0006	0.0015

50. Serviceability Standards for Piston Rings

(par. 39d)

See figure 51.



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Figure 56. Fits and clearances, pistons, connecting rods, and crankshafts.

CHAPTER 5 GOVERNOR

Section I. DESCRIPTION AND OPERATION

51. Description

(figs. 57 and 58)

a. The purpose of the compressor governor is to automatically control the air pressure being maintained in the reservoir of the air brake system by the compressor, between the maximum pressure desired (100-105 lb.) and the minimum pressure required for safe brake operation (80-85 lb.). To understand this function of the governor, it should be remembered that while the compressor may run continuously, actual compression of air is controlled by the governor, which, acting in conjunction with the compressor unloader mechanism, stops or starts compression when these maximum and minimum reservoir pressures are reached.

b. The design of the compressor governor is based on the principle of a Bourdon tube which is a flattened metal tube bent to a curve that tends to straighten under internal pressure. This reaction by the tube, due to changes in the air pressure in the tube, increases or decreases the spring load on the valve mechanism of the governor and makes the valve mechanism assume its "cut-in" or "cut-out" positions in accordance with the air pressure in the reservoir. Two types of governor cases will be found in service, one being a die-cast case and the other a pressed-steel case. Both types of cases are interchangeable with each other and the working parts used in both are identical.

c. Two types of governors will be found in service, the standard (fig. 57) and waterproof (fig. 58). The governing mechanism is identical for both types. Cases for standard type may be pressed steel or die-cast and cases are interchangeable. Cases for waterproof type are die-cast and a waterproof breather valve is installed in cover.

52. Operation

(fig. 59)

a. Air pressure from the reservoir enters the governor through the strainer and is always present below the lower valve and in the spring tube. As the air pressure increases, the load exerted on the lower valve by the tube, decreases because the tube tends to straighten out.

b. When the reservoir air pressure reaches the cut-out setting of the governor (100-105 lbs.), the spring load of the tube on the lower valve

has been reduced enough to permit air pressure to raise the lower valve off its seat. This movement of the lower valve raises the upper valve to its seat which closes the exhaust port. Air then flows up through the small hole in the lower valve and out the upper connection to the unloader mechanism of the compressor cylinder head. When this occurs, the unloader valves in the compressor cylinder head are opened and compression of air is stopped.

c. As the air pressure in the reservoir drops to the cut-in setting of the compressor governor (80-85 lbs.), the pressure of the tube on the upper valve increases and forces the upper valve down and off its seat. This movement also seats the lower valve, preventing reservoir air pressure from passing through the governor. With the upper valve off its seat, air pressure in the unloader diaphragm cavity in the compressor

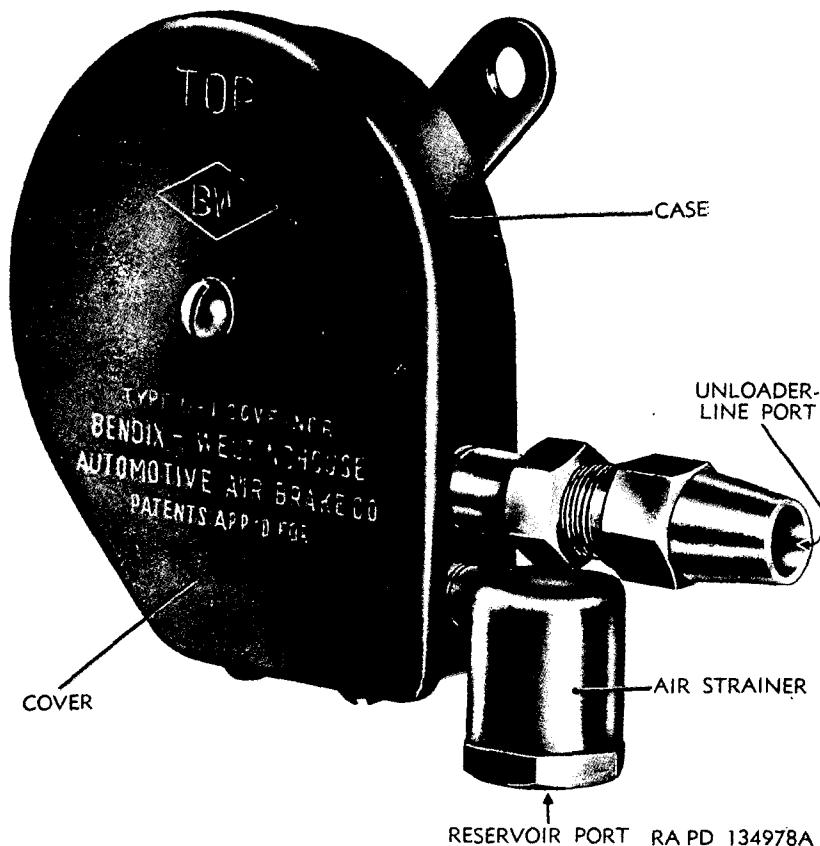


Figure 57. Type O-1 standard governor.

cylinder head escapes through the exhaust port in the governor. This permits the unloader valves in the compressor cylinder head to close. Compression is resumed until reservoir pressure again rises to the cut-out setting of the governor.

Section II. REBUILD OF GOVERNOR

53. Preliminary Inspection

Inspect case and cover for breakage or damage. Remove cover (par. 55b) and inspect tube (par. 56b(1)). Perform leakage and operation test (par. 54). No disassembly is necessary, if unit passes inspection.

Note. Unit is to be disassembled once a year or every 12,000 miles for cleaning.

54. Test

a. *General.* Although the governor may be tested by improvising the necessary connections, it is advisable to prepare a test bench at which tests may be made quickly and conveniently. A diagram of a suitable test bench is shown in figure 71.

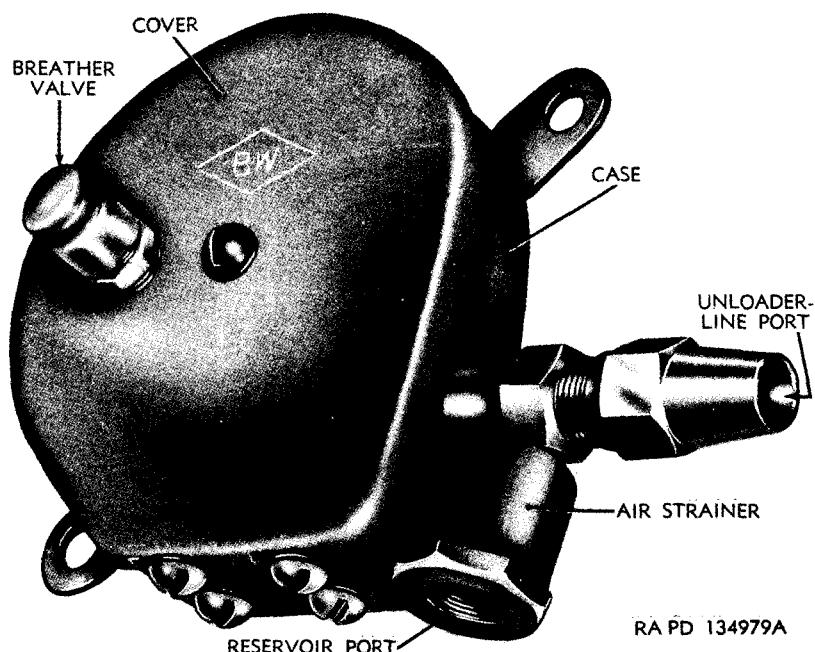


Figure 58. Type O-1 waterproof governor.

b. Test Preparation.

(1) When test bench similar to that shown in figure 71 is used, begin all tests by positioning the valves as follows:

Valve No. 1	Closed position
Valve No. 2	Closed position
Valve No. 3	Open position
Valve No. 4	Released position
Valve No. 5	Open position
Valve No. 6	Open position

(2) Note that (cut-out cocks) valves 1, 2, 5, and 6 (fig. 71) are open when handle is at right angles to valve body, and closed when handle is parallel to body (par. 155). Valve number 3 (fig. 71) (air supply valve) is open when handle is parallel to valve body, and closed when handle is at right angles to body (par. 197). Open valve No. 1 until gage No. 1 registers 105 pounds, then close valve.

Note. If at any time during a test, pressure in reservoir No. 1 as registered by gage No. 1 should drop below 100 psi, open valve No. 1 until gage reads 105 pounds, then close valve.

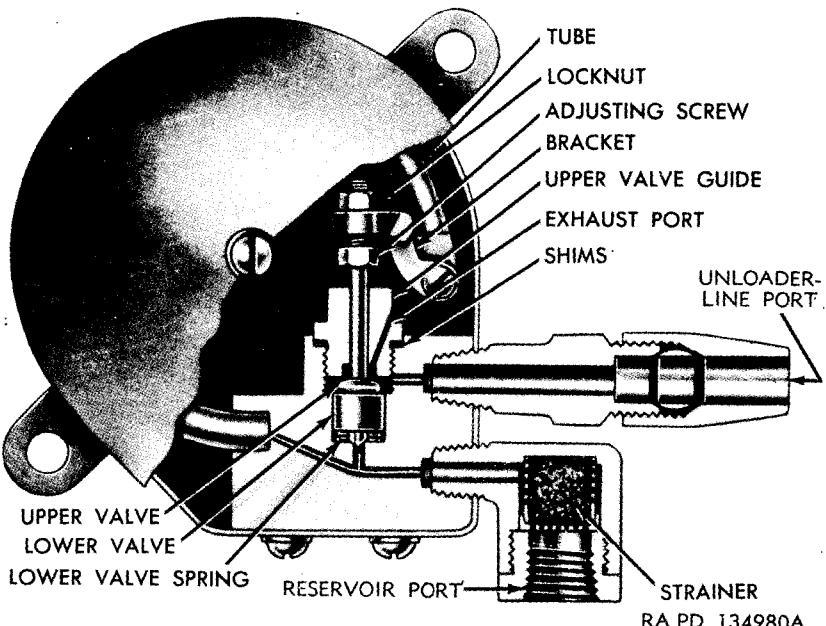


Figure 59. Sectional view of governor.

(3) If governor is still in the case, remove cover and case (par. 55).

(4) Before connecting governor to test stand, the tube must be tested for leakage. Connect an air hose to the reservoir port of the governor (fig. 59), apply approximately 50 pounds pressure and submerge governor in water. Watch for air bubbles around the soldered joint between body and tube and at end of tube. No leakage is permissible.

(5) Remove all traces of water and connect line 1 (fig. 71) of the test bench to reservoir port of governor (fig. 59).

(6) Metal tubing $\frac{3}{8}$ -inch diameter and 18 inches long, with one end sealed, is to be installed at the unloader-line port of the governor (fig. 59).

c. *Governor Cut-Out Test and Adjustment.* Place valve 4 (fig. 71) in the released position. Open valves 1, 2, and 3 (fig. 71 and b(2) above) and observe gage 1. Note at what pressure the governor cuts out. The governor must cut out between 100 and 105 pounds pressure. The governor will be in the cut-out position when the tube moves upward or when the metallic click of the upper valve seating itself is heard. Cut-out pressure is raised by loosening the lock nut and turning the adjust-

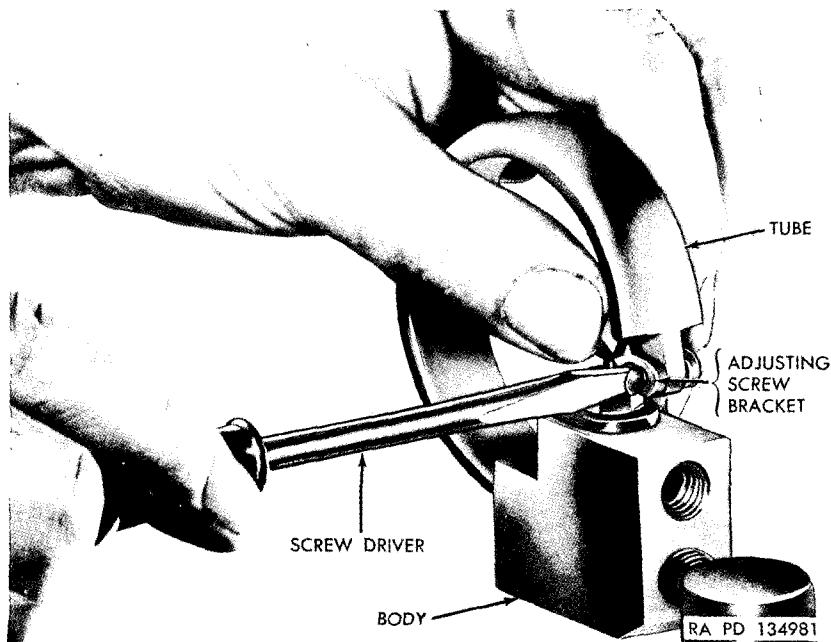


Figure 60. Removing adjusting screw bracket.

ing screw (fig. 59) clockwise. Cut-out pressure is lowered by turning the adjusting screw (fig. 59) counterclockwise. If adjustment is made, tighten lock nut (fig. 59) before again checking cut-out pressure.

d. Test Upper Valve Seat. Coat the exhaust port, located in the upper valve seat, with soap suds to detect leakage of the upper valve (fig. 59). Leakage should not exceed that required to produce a 1-inch soap bubble in 3 seconds.

e. Governor Cut-In Test and Adjustment.

- (1) Close valve 1 (fig. 71) and reduce pressure in reservoir 1 (fig. 71) by placing handle of valve 3 (fig. 71) to the extreme clockwise position.

Note. When the valve handle of the (air supply) valve No. 3 (fig. 71) is turned to its extreme clockwise position the existing reservoir pressure is applied to the governor while the reservoir is discharging through the valve.

- (2) Observe gage 1 (fig. 71) and note at what pressure the governor cuts in. The governor must cut in between 80 and 85 pounds pressure. The governor will be in the cut-in position

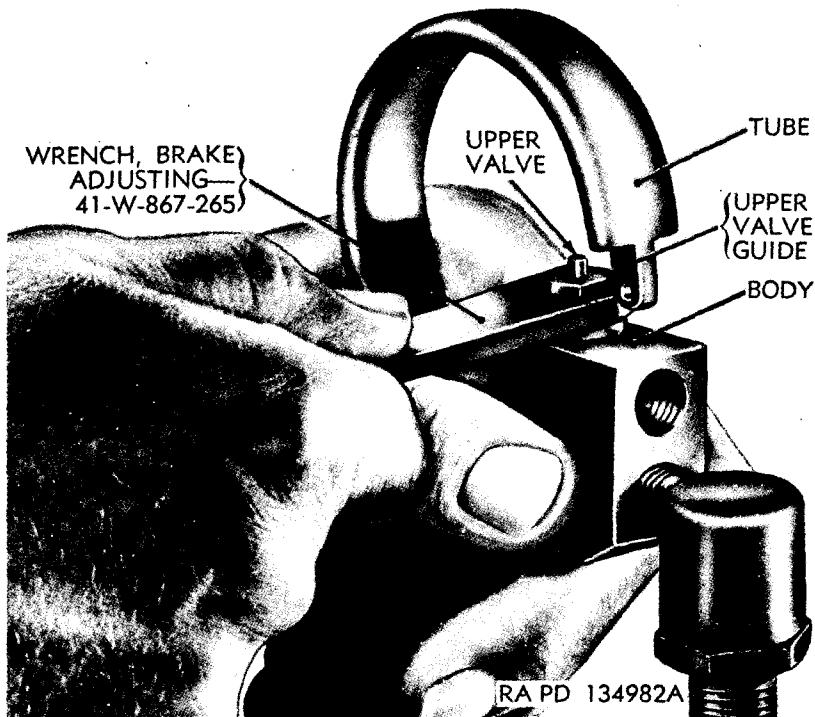


Figure 61. Removing upper valve guide, using wrench 41-W-867-265.

when air is heard escaping at the exhaust port for a brief moment. Cut-in pressure is raised or lowered by removing or adding one or more shims beneath the upper valve guide (fig. 59).

f. Test Lower Valve Seat. After the governor has cut in, open valve 3 (fig. 71). Coat the exhaust port with soap suds to detect leakage of the lower valve. Leakage should not exceed a 1-inch soap bubble in 3 seconds.

g. Progressive Adjustment. Continue tests and adjustments until governor range is between 100-105 pounds to 80-85 pounds.

h. Disconnect Governor. Turn the handle of valve 3 (fig. 71) to the extreme clockwise position and disconnect governor. Remove metal tubing from unloading port and assemble governor (par. 57).

55. Disassembly

a. Unscrew connector and remove from case (figs. 64 and 65). Unscrew strainer body from case and remove cap nut from strainer body (figs. 64 and 65). Remove strainer cup, lamb's wool, and strainer cylinder from strainer body (figs. 64 and 65).

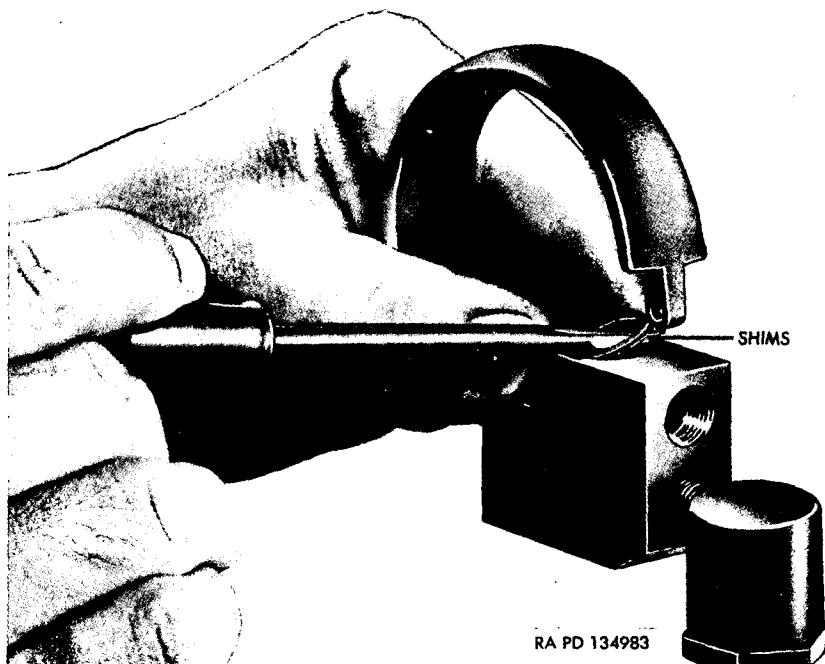


Figure 62. Removing shims.

b. Remove screw and lock washer holding cover to case and remove cover (figs. 64 and 65). In the waterproof type, remove gaskets from cover (fig. 65) and discard. Remove four screws and lock washers from bottom of case and remove body from case (figs. 64 and 65).

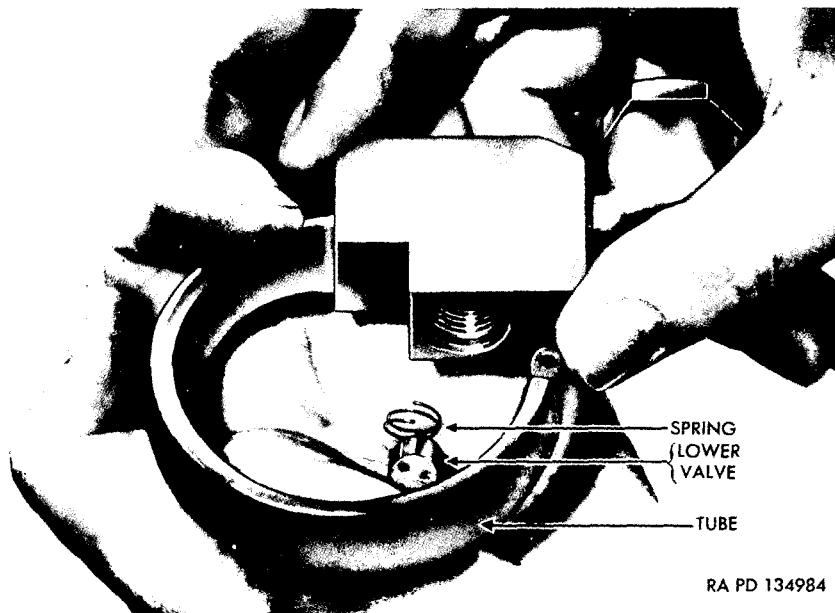
c. Remove screw which holds adjusting screw bracket (fig. 60) to the end of tube and remove bracket. Unscrew upper valve seat, using brake adjusting wrench 41-W-867-265 (fig. 2) or equivalent, and remove upper valve guide and valve (figs. 61, 64, and 65). Lift out shims from body (figs. 62, 64, and 65). Remove lower valve and lower valve spring (figs. 63, 64, and 65).

56. Cleaning, Inspection, and Repair

a. *Cleaning.* Clean all parts in dry-cleaning solvent or volatile mineral spirits. Be sure that all passages through the body are free and unobstructed in any way. Be sure small drilled passage through lower valve is clean and open. Lamb's wool in the air strainer may be used again, if it can be washed thoroughly clean; otherwise, it must be replaced.

b. *Inspection.*

(1) *Tube.* If the tube is damaged, if it leaks (par. 54b(4)), or if



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Figure 63. Removing lower valve and spring.

it is loose at the soldered joint at the body or at the end of tube, the body and tube must be replaced. Do not attempt to repair a tube.

(2) *Upper valve and upper valve guide.* Inspect seat on upper valve and upper valve guide for wear or damage. Also check fit of upper valve stem in upper valve guide. If the seat on the upper valve shows a decided groove from wear (fig. 66) or if the upper valve stem is not a sliding fit in the upper valve guide, the upper valve and upper valve guide must be replaced as an assembly.

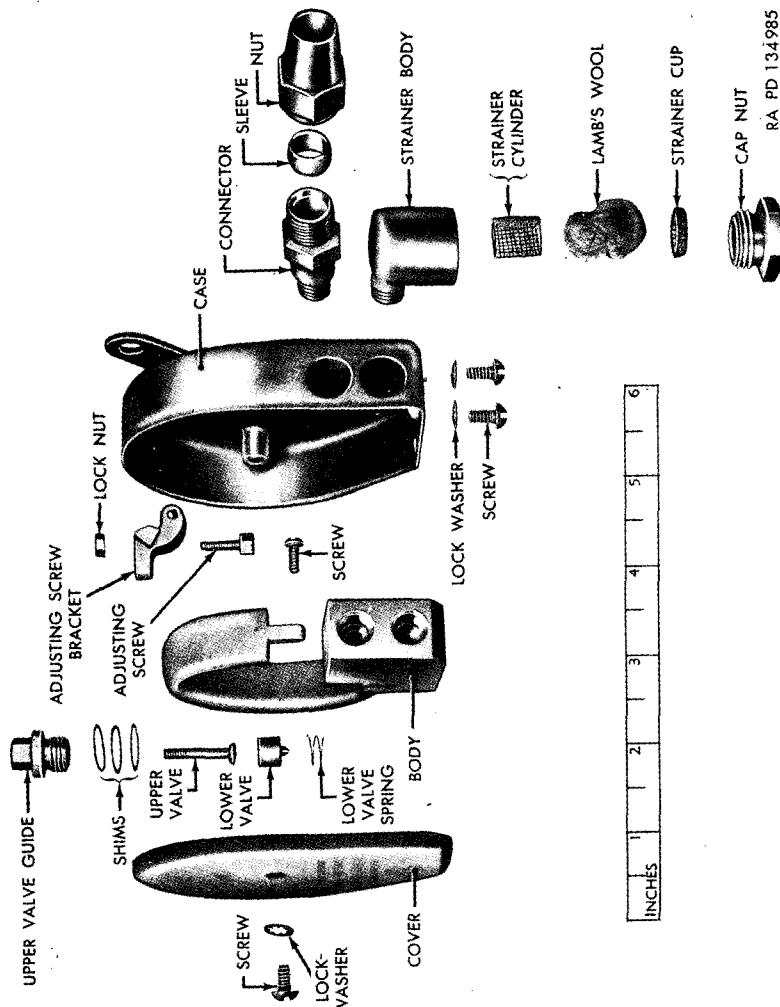


Figure 64. Standard governor—exploded view.

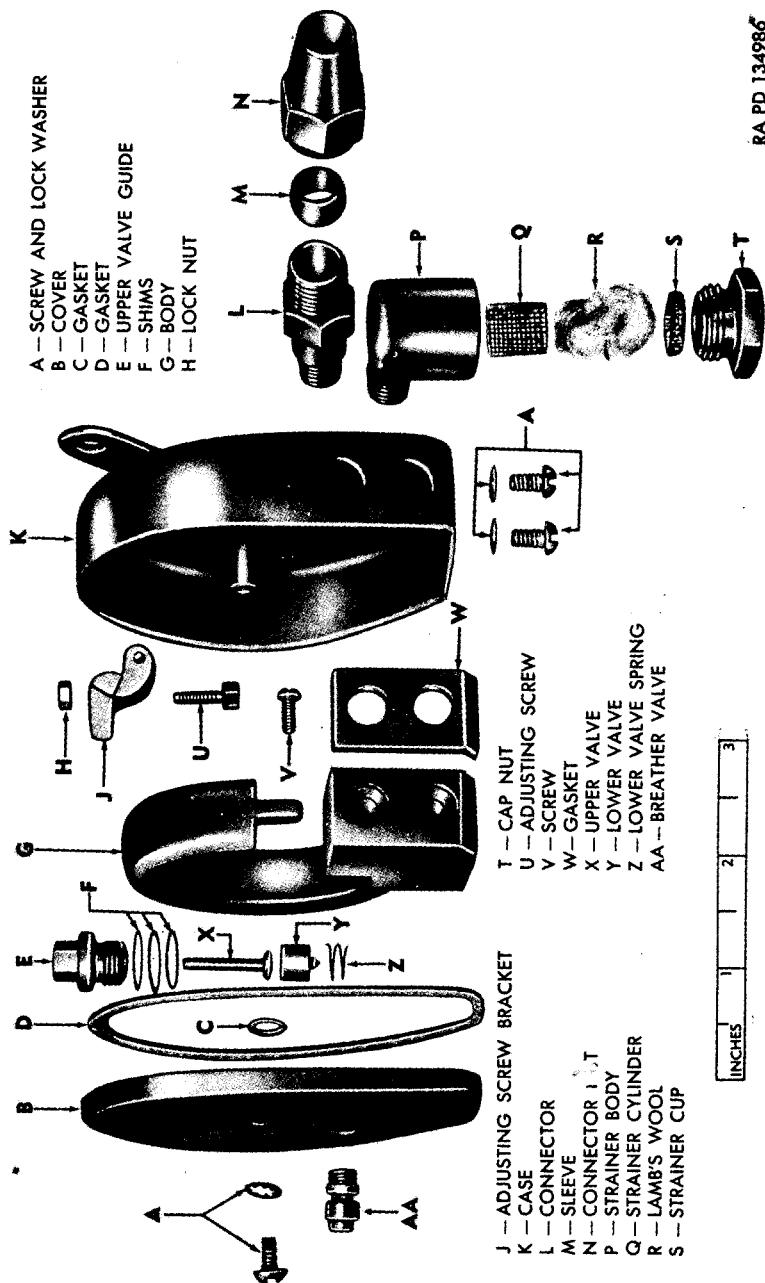


Figure 65. Waterproof governor—exploded view.

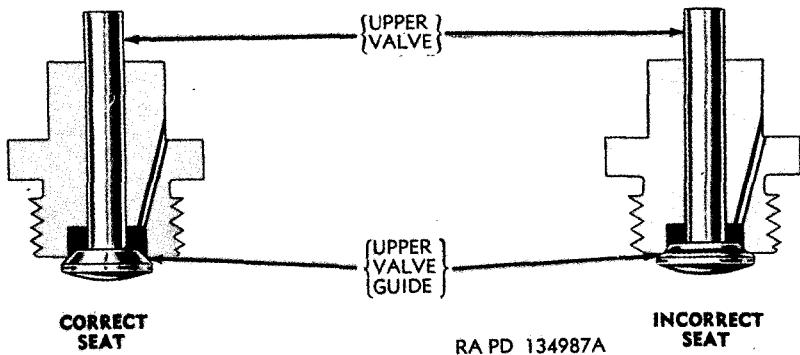


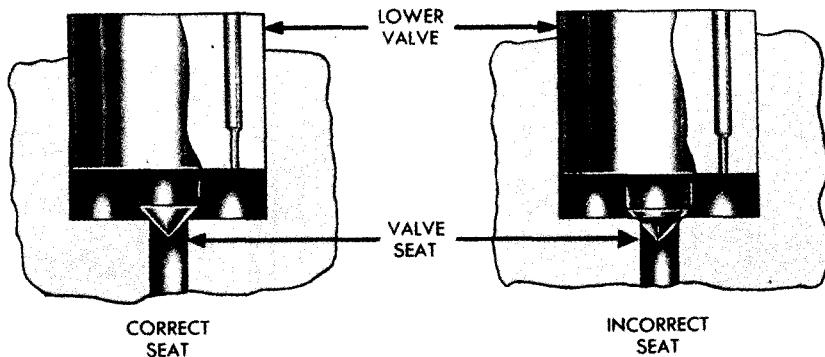
Figure 66. Correct and incorrect upper valve seats.

- (3) *Lower valve and lower valve seat.* Inspect lower valve for wear or damage. If the valve is grooved (fig. 67), it must be replaced. Check fit of lower valve in body. It must be a sliding fit. If clearance is evident, the lower valve must be replaced.
- (4) *Adjusting screw and bracket.* Inspect adjusting bracket and screw for wear or damage. Replace, if necessary.

c. *Repair.*

- (1) Upper valve and upper valve seat.

(a) If upper valve and seat are not too badly worn, they are repaired by carefully grinding (lapping) the valve to its seat, using valve grinding tool 41-T-3381-20 (fig. 2) and valve



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Figure 67. Correct and incorrect lower valve seats.

grinding compound (fine), as shown in figure 68. When grinding upper valve, temporarily screw upper valve and upper valve guide in place in body (fig. 61). The valve must be turned back and forth during the grinding operation by using a piece of cord (fig. 68). The cord should be pulled in such a manner as to keep the upper valve in contact with the upper valve guide during the grinding operation.

(b) After grinding (lapping) upper valve and guide, all traces of grinding compound must be cleaned off with dry-cleaning solvent or volatile mineral spirits.

(2) *Lower valve and seat.*

(a) If lower valve and seat are not too badly worn, they are repaired by carefully grinding (lapping) the valve to its seat, using valve grinding tool 41-T-3381-10 (fig. 2) and valve grinding compound (fine) as shown in figure 69.

(b) If a new lower valve is being installed, tapping the valve to its seat before grinding is usually helpful. To do this, put lower valve in place and install upper valve and upper valve guide. Then, using valve seating tool 41-T-3383-10 (fig. 2),

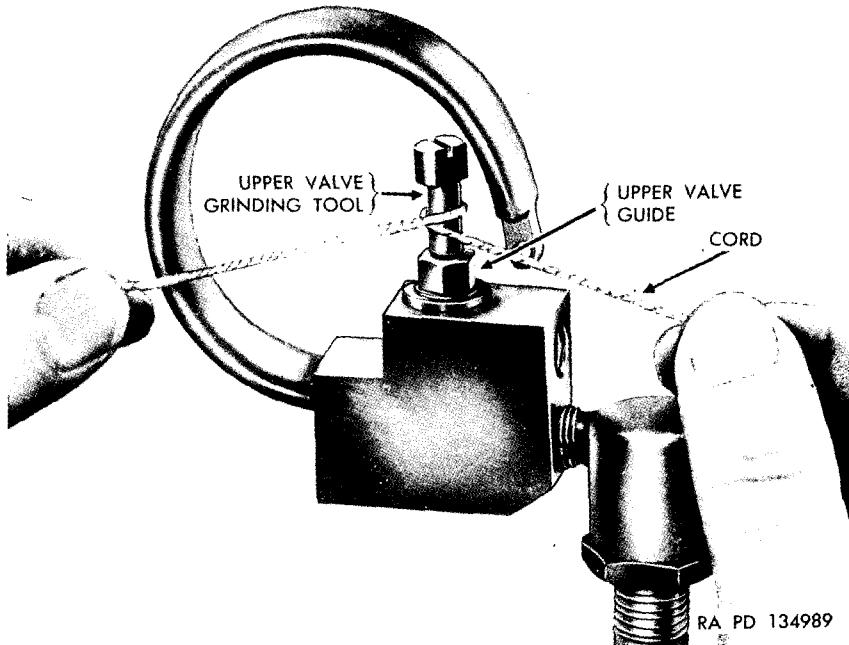


Figure 68. Grinding (lapping) upper valve, using valve grinding tool 41-T-3381-20.

lightly tap the upper valve (fig. 70) a few times to seat the lower valve.

- (c) Clean valve and governor body thoroughly, after grinding, with dry-cleaning solvent or volatile mineral spirits.
- (d) If leakage of the lower valve cannot be corrected by the above procedure, the complete governor must be replaced.

57. Assembly

- a. Position lower valve spring and lower valve in lower valve recess of body (figs. 64 and 65). Position shims in body (figs. 64 and 65). Insert upper valve stem through bottom of upper valve guide and screw upper valve and guide into body (figs. 64 and 65). Tighten securely, using brake adjusting wrench 41-W-867-265 (fig. 2) or equivalent, as shown in figure 61. Position adjusting screw bracket in place on ends of tube and install attaching screw (figs. 60, 64, and 65.)
- b. Pack strainer cylinder with new or cleaned lamb's wool and place strainer cylinder in strainer body (figs. 64 and 65). Position strainer cup over the end of cylinder strainer in strainer body, and install cap nut

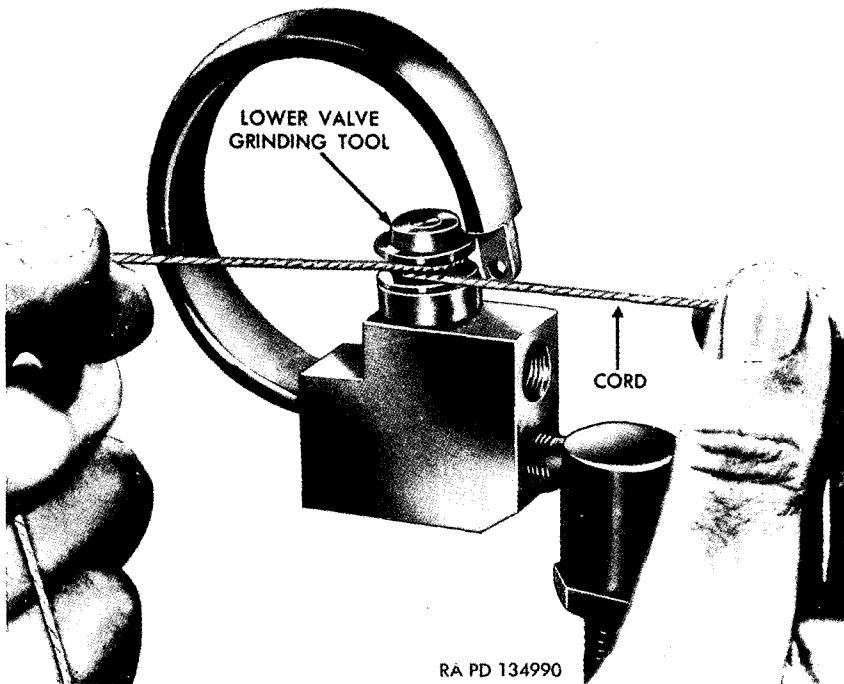


Figure 69. Grinding (lapping) lower valve, using valve grinding tool 41-T-3381-10.

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(figs. 64 and 65). Screw strainer assembly into lower connection of body (figs. 64 and 65).

c. Test and adjust governor (par. 54).

d. If governor passes all tests, remove strainer, position governor in case, and install four lockwashers and mounting screws (figs. 64 and 65). Position cover on case and install lockwasher and attaching screw (figs. 64 and 65). In the waterproof type, position gaskets on inside of cover (fig. 65) and cement to cover with gasket cement.

e. Screw air strainer into lower connection in body and position as shown in figures 57 and 58. Screw connector in top connection of body (figs. 64 and 65).

f. In the waterproof type governor, seal the screws on the outside of the case and fill space in case around fittings with joint sealing compound.

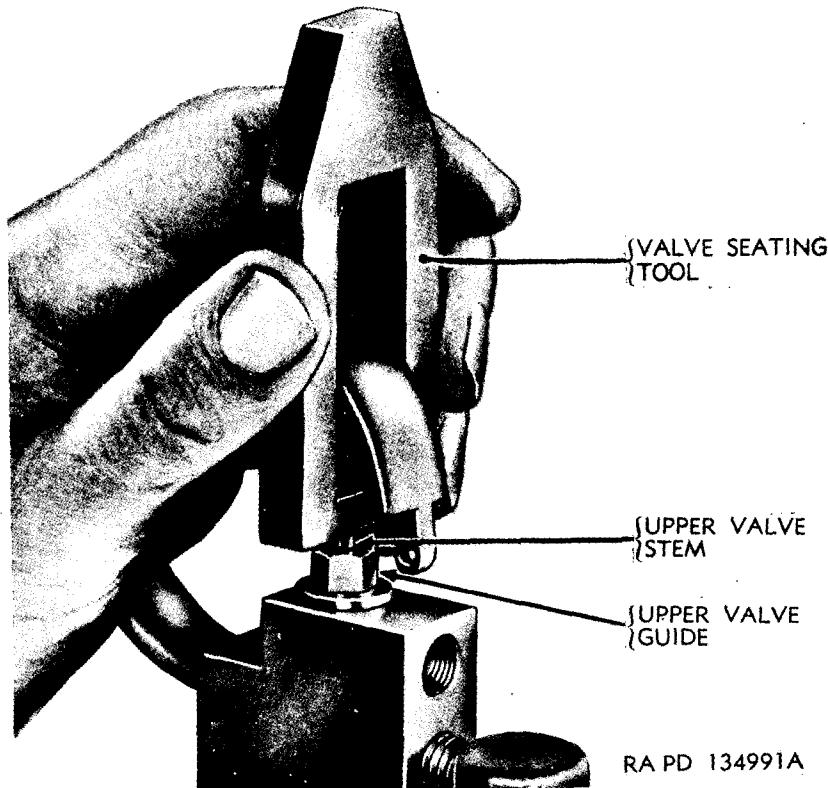


Figure 70. Seating lower valve, using valve seating tool 41-T-3383-10.

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CHAPTER 6

BRAKE VALVES

Section I. GENERAL

58. Function and Types

a. Function. Brake valves are devices by which the driver of the vehicle applies the brake. They are designed to automatically vary the air pressure, thus actuating the brakes in direct ratio to the force used by the driver in operating the valves.

b. Types. Five types of brake valves will be found in service, all having similar functions. Differences in design and characteristics are designated by type numbers. Three of the valves, type B-4-B (fig. 72), type D (fig. 87), and type D-1 (figs. 96 and 97) are used to control the brake system of trucks and tractors. Two valves, type HP (fig. 103) and type TC (fig. 107) are known as trailer control valves and are used when independent control of trailer brakes, at option of driver, is desirable.

59. Preliminary Examination and Test

a. General. When the condition of brake valves on a vehicle scheduled for rebuild or the condition of separately returned valves is unknown, a preliminary examination and test is advisable before their complete disassembly. Since the preliminary procedures are similar for all brake valves, they are given in this section. Disassembly is unnecessary, if valve passes inspection.

b. Preliminary Examination. Inspect the valve for broken or damaged parts. If any are found, disassemble and rebuild the valve as outlined in paragraphs 61 through 86. If valve appears to be in good condition, perform the tests as outlined in *c* and *d* below.

c. Operating Test Valve Mounted in Vehicle. Check delivery pressure of valve with an accurate pressure gage. On vehicles having trailer connections, the gage can be conveniently connected to the service line outlet at the rear of vehicle. On vehicles without trailer connections, disconnect an air line from any brake chamber and attach test gage to line.

- (1) *Trailer control valves HP and TC.* Move the valve handle to several different positions between fully applied and full released positions and note variations of pressure registered by gage. With the valve handle moved to the fully applied position, the HP valve must deliver at least 60 pounds pressure

and the TC valve, 85 pounds pressure. If pressure does not vary in accordance with position of handle, valve must be rebuilt.

(2) *B-4-B, D, and D-1 valves.* With brake pedal or treadle fully depressed against its stop, the valve must deliver approximately full reservoir pressure as registered by instrument panel air gage. Depress the brake pedal or treadle to several positions between fully released and fully applied and check to be sure the delivered air pressure registered by the test gage varies in accordance with the position in which the pedal or treadle is held.

Note. On some vehicles the treadle stop or pedal linkage is arranged to prevent delivery of full reservoir pressure. Such arrangement should not be altered unless it is necessary to correct delivery pressure. Increasing travel of brake pedal or treadle will increase delivery pressure.

d. Leakage Tests.

- (1) Coat exhaust port with soap suds. With valve in fully released position, leakage must not exceed a 1-inch soap bubble in 1 second.
- (2) Coat exhaust port with soap suds. With valve fully applied, leakage must not exceed a 1-inch soap bubble in 1 second.
- (3) No leakage is permissible in any other part of valve.
- (4) Valves showing excessive leakage must be rebuilt.

60. Testing Rebuilt Brake Valves

a. General. All rebuilt brake valves must be tested before being returned to service. Although such tests can be made by improvising necessary connections, it is advisable to prepare a test bench at which all specified tests may be made quickly and conveniently. A piping diagram of a suitable test bench is shown in figure 71.

b. Test Preparation (fig. 71). When a test bench similar to that shown in figure 71 is used, begin all tests by positioning the valves as follows:

Valve No. 1	Closed position
Valve No. 2	Closed position
Valve No. 3	Open position
Valve No. 4	Released position
Valve No. 5	Open position
Valve No. 6	Open position

Note that (cut-out cocks) valves 1, 2, 5 and 6 are open when handle is at right angles to valve body and closed when handle is parallel to body

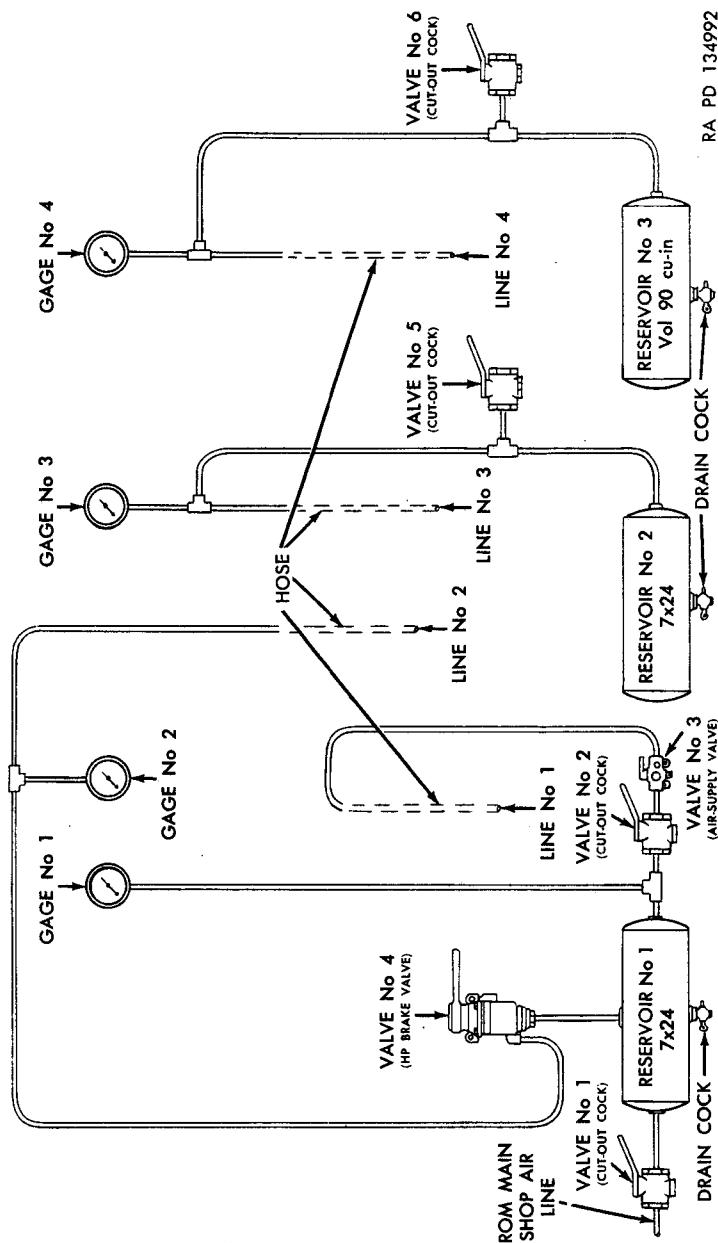


Figure 71. Piping diagram of test bench.

(par. 155). Valve number 3 (air supply valve) is open when handle is parallel to valve body and closed when handle is at right angles to body (par. 197). Open valve No. 1 until gage No. 1 registers 105 pounds, then close valve.

Note. If at any time during a test, pressure in reservoir No. 1 as registered by gage No. 1 should drop below 100 psi, open valve No. 1 until gage reads 105 pounds, then close valve.

c. Test Procedure.

- (1) Connect line 1 (fig. 71) to reservoir port (of brake valve) and line 4 (fig. 71) to one brake chamber port of brake valve being tested (figs. 72, 87, 96, 103, and 107). If the brake valve has multiple ports, install plugs in other brake chamber ports. Place valve 4 (fig. 71) in released position and close valve 6.
- (2) With normal pressure in reservoir No. 1 (fig. 71), apply and release brake valve several times to insure proper seating of inlet and exhaust valve.
- (3) With brake valve in released position, coat exhaust port with soap suds to detect inlet valve leakage.
- (4) With brake valve half-way between released and fully applied position, coat exhaust port with soap suds to detect exhaust valve leakage.
- (5) With brake valve in fully applied position, coat exhaust port with soap suds to detect exhaust valve leakage.
- (6) Leakage in (3), (4), and (5) above must not produce a soap bubble larger than 1-inch within 1 second.
- (7) Coat entire valve with soap suds and place in fully applied position to detect casting leakage. No leakage is permissible.
- (8) Observe gage 4 (fig. 71) and note that the first movement of brake valve lever or treadle, after slack is taken up, toward applied position causes brake to deliver 4 to 6 pounds pressure.
- (9) Observe gage 4 (fig. 71) and operate valve from the released to the fully applied position in steps. Note if with each step a corresponding increase of pressure is obtained.
- (10) Operate the valve in steps from the applied position. Observe gage 4 (fig. 71) and note if pressure decreases in corresponding steps.
- (11) With brake valve fully applied, gages 1 and 4 (fig. 71) should read the same. With brake valve in released position, gage 4 should read zero.

Note. If the brake valve fails to meet any of the above requirements, it is not in serviceable condition.

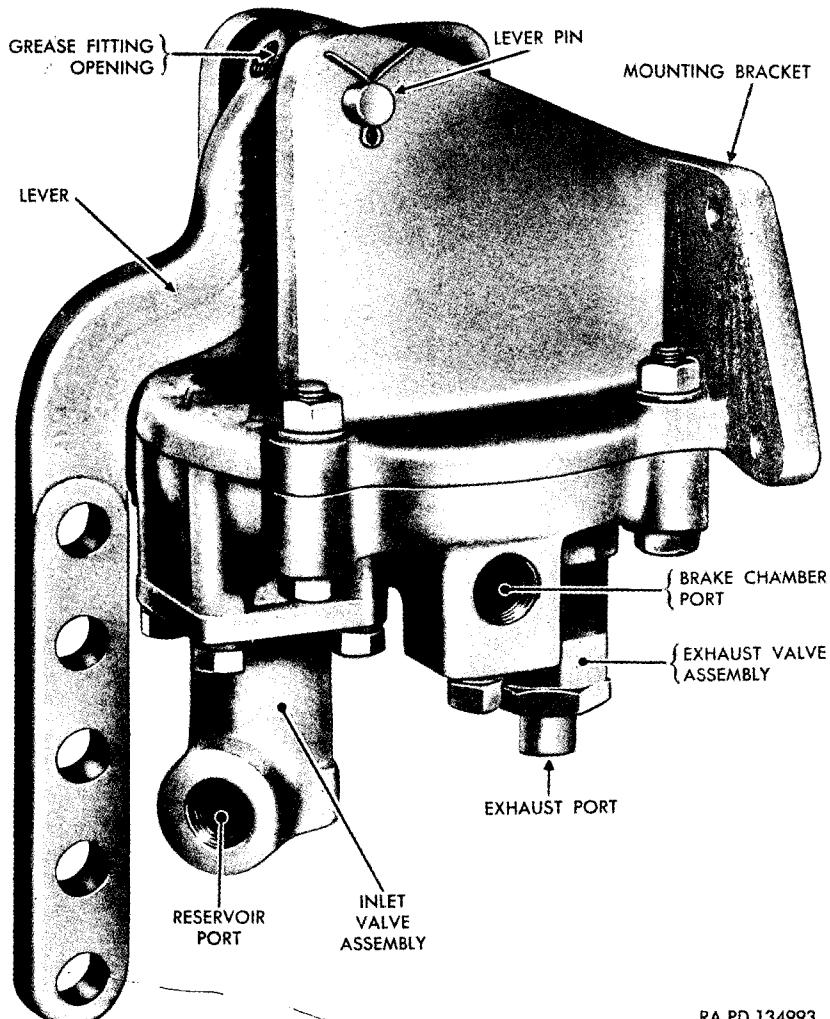
(12) Close valves 2 and 3 (fig. 71) and disconnect brake valve from test bench.

Section II. TYPE B-4-B BRAKE VALVE

61. Description and Operation

a. Description.

(1) Standard B-4-B valves (figs. 72 and 73). B-4-B brake valves are fitted with a lever which is connected to and operated by a

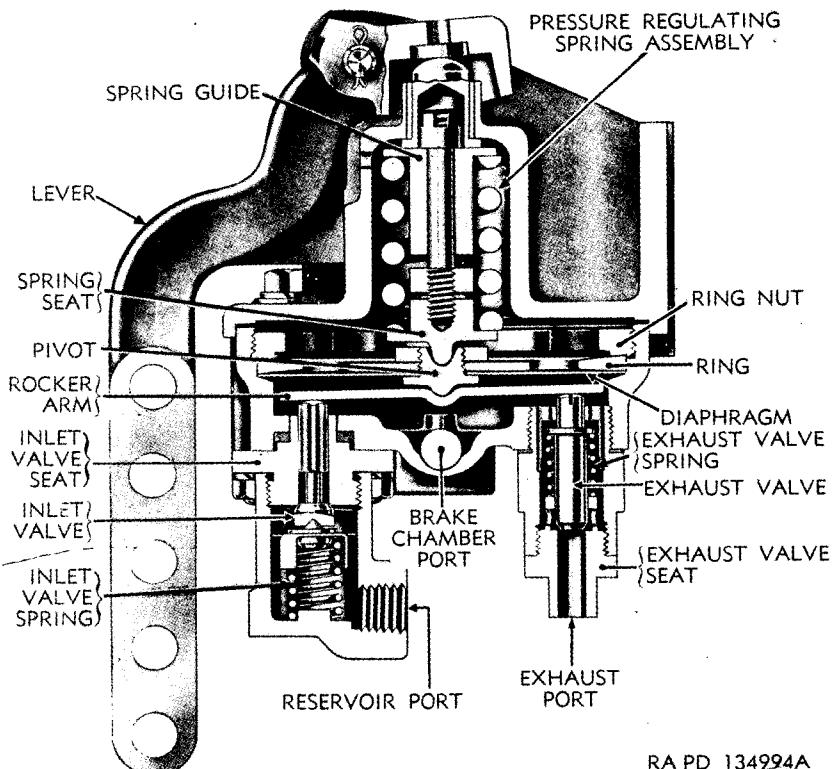


RA PD 134993

Figure 72. Standard B-4-B brake valve.

foot pedal. Movement of the lever by brake pedal linkage operates air inlet and an exhaust valve within the B-4-B valve which control the air delivered to or released from the brake chambers. Air pressure delivered to brake chambers is controlled automatically in proportion to the distance the brake pedal is depressed.

(2) *Special B-4-B brake valves* (fig. 74). The special B-4-B brake valves (fig. 74) are exactly the same in outward appearance as the standard type. The only difference is that the special type has a steel sleeve to depress the diaphragm instead of a pressure-regulating spring assembly. The use of a sleeve instead of a spring is desirable because this type of brake valve is only intended to be operated by a hand grip control such as is used on the steering levers of some track-laying tractors.



RA PD 134994A

Figure 73. Sectional view of B-4-B brake valve.

b. Operation.

(1) *Standard valves* (fig. 73). As the lever moves toward its fully applied position, mechanical force is applied to the top of the diaphragm in the brake valve. This occurs through the action of the plunger and pressure-regulating spring assembly, located in the upper chamber above the diaphragm. As the diaphragm moves downward, a force is exerted on the middle of the rocker arm. Because the exhaust valve spring is weaker than the inlet valve spring, the exhaust valve is forced downward to its seat before the inlet valve is forced downward to open. When the inlet valve opens, air pressure is permitted to flow from the reservoir through the brake valve to the brake chambers, applying the brakes. When the air pressure being delivered to the brake chambers from the cavity below the diaphragm overcomes the mechanical force being exerted on

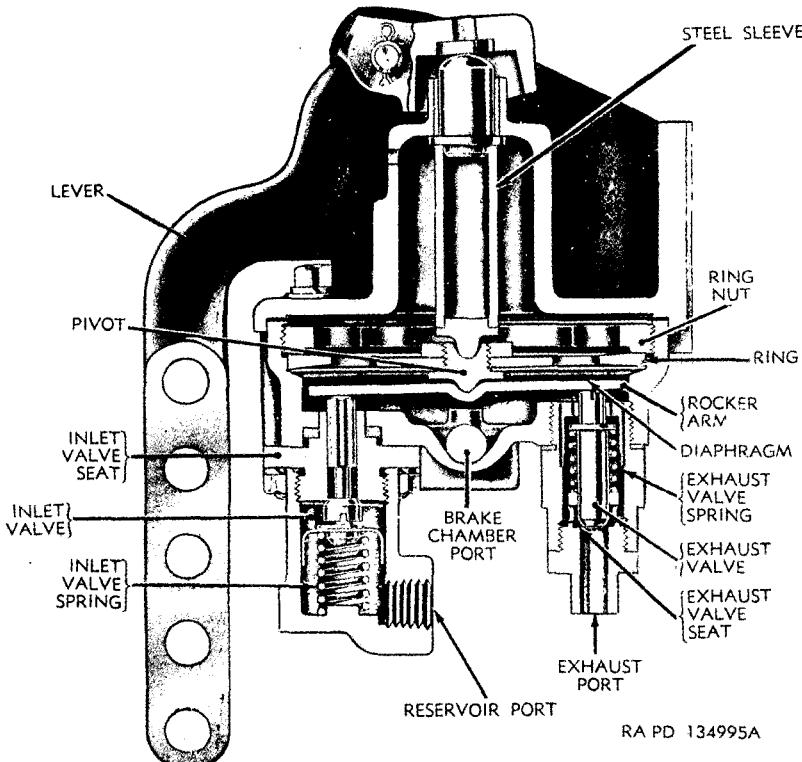


Figure 74. Sectional view of special B-4-B brake valve.

top of the diaphragm, the diaphragm lifts and the inlet valve closes, preventing any further rise of air pressure in the brake chambers, while the exhaust valve remains closed, preventing any escape of air pressure. Should the driver depress the foot pedal further and put additional mechanical force on top of the diaphragm, the air pressure being delivered to the brake chambers is correspondingly increased. If the driver permits the foot pedal to partially return toward its full released position, thus reducing the force on top of the diaphragm, air pressure below the diaphragm overcomes the mechanical force on top of it and the diaphragm lifts slightly. Under these conditions, the inlet valve remains closed and the exhaust valve opens to exhaust air pressure from the brake chambers until the air pressure below the diaphragm again balances the mechanical force on top of it. If the driver permits the foot pedal to return to fully released position, the exhaust valve remains open, all pressure from the brake chambers is exhausted, and the brakes on the vehicle are fully released. If the driver depresses the foot pedal to fully applied position, the pressure-regulating spring is compressed until the spring guide strikes the spring seat to actuate the rocker arm. Under these conditions, the inlet valve is held open and full reservoir pressure is permitted to pass through the brake valve to the brake chambers.

(2) *Special valves* (fig. 74). Operation of the special type brake valve is very similar to that of the standard type, except this type of valve is operated by a hand grip control. It has a steel sleeve above the diaphragm instead of a pressure-regulating spring assembly. Reaction of the valve mechanism is totally controlled and cushioned by the driver's hand grip rather than by the pressure-regulating spring.

c. *Preparation for Rebuild.*

- (1) When condition of brake valve is unknown, it should be subjected to operating tests (par. 60) before disassembly. If valve meets requirements, it will be returned to service.
- (2) Each year or after each 50,000 miles, brake valves will be completely disassembled and rebuilt.

62. Disassembly of Type B-4-B Brake Valve

- a. *Marking Before Disassembly.* The inlet valve assembly may be installed on the body of the brake valve in several different positions to meet installation requirements. Before disassembly, the location of the

inlet opening in relation to the body of the brake valve is marked with a center punch to facilitate assembly. Also mark the cover and body in relation to one another before disassembly.

b. Remove and Disassemble Lever. Remove cotter pins from ends of lever pin and drive out lever pin (fig. 85). If lever pin bushings are to be replaced, they are pressed or driven out of the cover (fig. 85). The button must not be removed from lever (fig. 85) unless replacement is necessary (par. 63c(1)).

c. Remove and Disassemble Inlet Valve Assembly. Remove four nuts and lock washers (fig. 85), and remove inlet valve assembly (fig. 75) from brake valve body. Remove inlet valve gasket (fig. 85). Unscrew inlet valve body from inlet valve seat and remove shim from top of valve body (fig. 85). Remove inlet valve from inlet valve seat (fig. 85). Remove dampener and spring from inlet valve body (fig. 85).

d. Remove and Disassemble Exhaust Valve Assembly. Unscrew exhaust valve assembly and remove shims (fig. 76). Unscrew exhaust valve seat from exhaust valve body and lift out exhaust valve spring and exhaust valve (fig. 85).

e. Remove and Disassemble Cover. Remove four bolts, lockwashers, and nuts that attach the cover to the body (fig. 85). Lift off cover (fig.

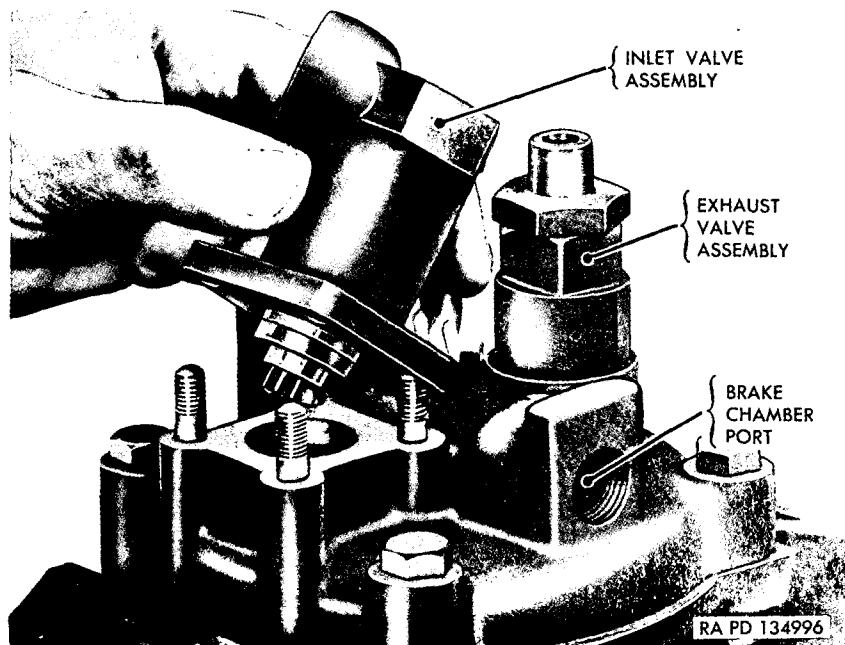


Figure 75. Removing inlet valve assembly.

77). Lift out pressure-regulating spring assembly and plunger from cover (figs. 77 and 85). Do not disassemble pressure-regulating spring assembly (par. 63b(5)).

f. Remove Diaphragm Assembly. The diaphragm ring nut (figs. 78 and 85) may best be removed by using a wrench, such as shown in figure 4. If such a wrench is not available, the ring nut can be removed with a piece of stock and an adjustable wrench. Lift diaphragm ring and diaphragm assembly out of body (fig. 79). Unscrew nut from pivot and lift off washer and diaphragms (fig. 85). Remove rocker arm from body (figs. 79 and 85).

g. Special B-4-B Brake Valve. Disassembly of the special type B-4-B brake valve is the same as for the standard valve.

63. Cleaning, Inspection, and Repair

a. Cleaning. Wash all parts with dry-cleaning solvent or volatile mineral spirits.

b. Inspection.

(1) *Diaphragms.* Carefully inspect both diaphragms to be sure they are not bent or distorted in any way. If ridges or cracks are found, the diaphragms must be replaced.

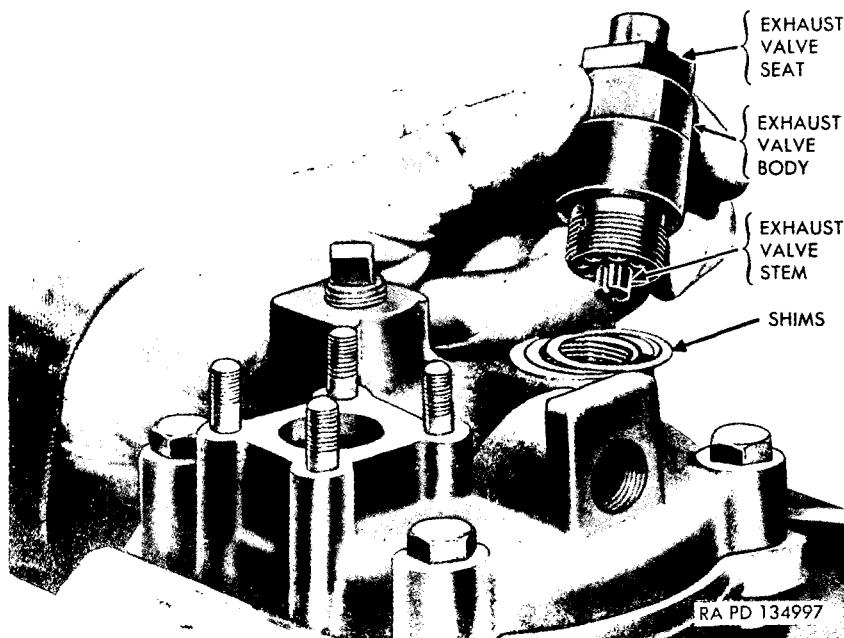


Figure 76: Removing exhaust valve assembly.

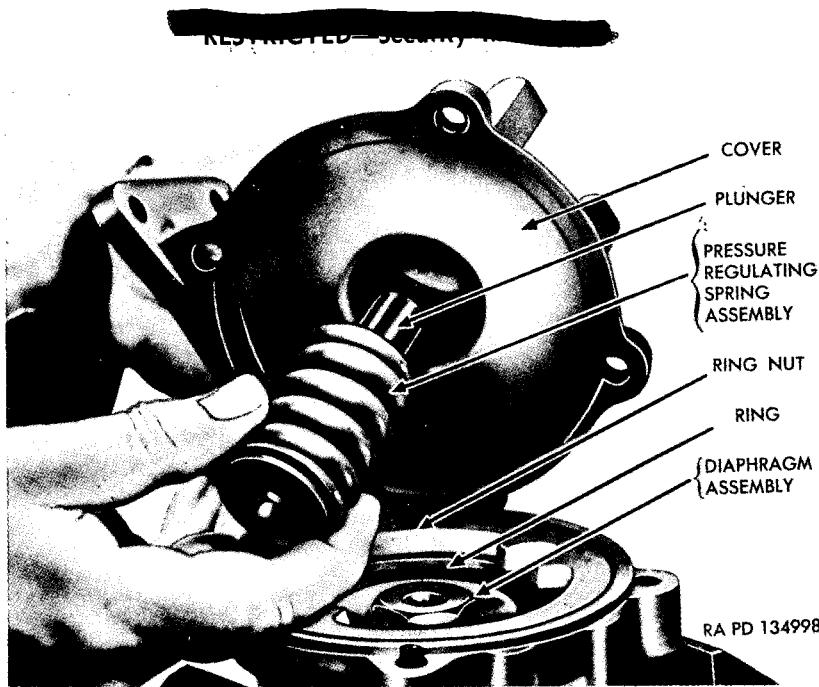


Figure 77. Removing cover.

(2) *Lever.* Inspect lever for cracks or breaks and, if any are found, replace. Inspect lever button for signs of wear where it engages the plunger. If signs of wear are present, replace button (c(1) below). Check fit of lever pin in lever bushings. Pin must be a sliding fit in bushings. Replace pin, bushings, or both, if necessary.

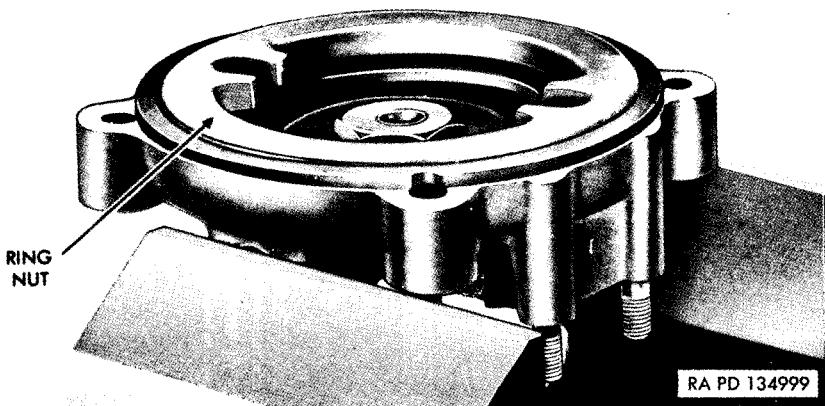


Figure 78. Diaphragm ring nut.

- (3) *Cover.* Inspect cover for cracks or breaks and, if any are found, replace. Check fit of plunger in plunger bushing. Plunger must be a sliding fit. Replace bushing, if plunger is not a sliding fit.
- (4) *Body.* Inspect body for breaks, cracks, or other damage. Also check diaphragm seat for dents or pitting. Replace body, if damaged in any way.
- (5) *Pressure-regulating spring assembly.* The pressure-regulating spring assembly is adjusted and set for preloading the brake valves and special scales are necessary to make this setting. Make no adjustment to this assembly. If visual inspection shows wear or damage, replace the complete assembly.
- (6) *Rocker arm.* Check to be sure rocker arm is not bent. Bottom of rocker arm must be smooth and flat (at points where it contacts the inlet and exhaust valves). Straighten or replace, as necessary.
- (7) *Inlet valve assembly.* Inspect inlet valve and seat (fig. 80) for scoring, pitting, and wear. Valve must be a sliding fit in bore of valve seat. If valve or seat is rounded, pitted, worn, or scored follow procedure prescribed in c(3) below.

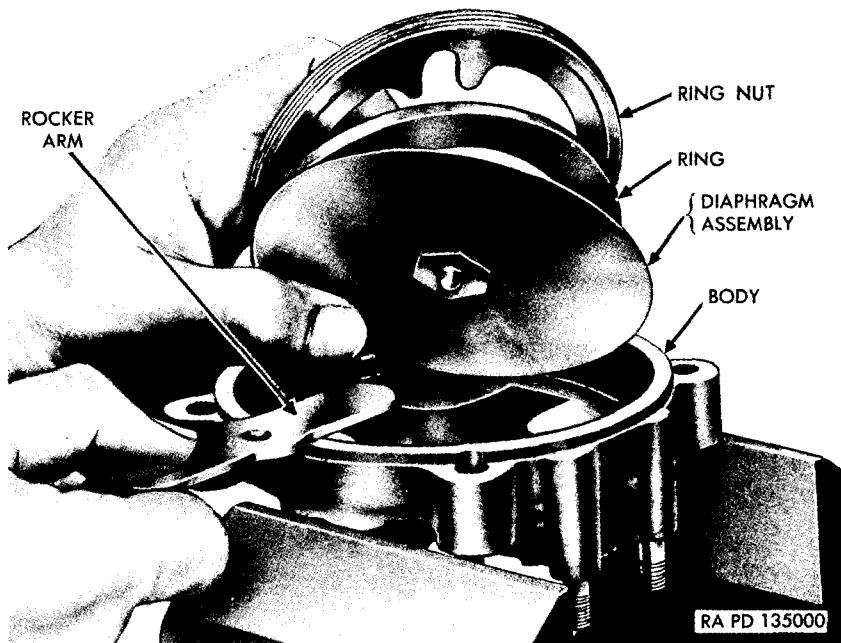


Figure 79. Removing ring nut, ring, diaphragm assembly, and rocker arm.

(8) *Exhaust valve assembly.* Inspect exhaust valve and valve seat (fig. 80) for scoring, pitting, or wear. If valve or seat is rounded, pitted, or scored follow procedure prescribed in c(4) below.

c. *Repair.*

- (1) *Lever.* Lever button is driven out, using a drift pin, through the hole in top of lever cap. A new button must be driven in place. Drive out worn lever pin bushings and press new ones in place. Bushings must be reamed to 0.375-inch minimum to 0.376-inch maximum after being pressed into place.
- (2) *Cover.* To replace plunger bushing, drive out old bushing and press new bushing in place. Ream bushing to 0.624 to 0.626 inch.
- (3) *Inlet valve assembly.*
 - (a) If the valve or valve seat is only slightly scored, pitted, or worn, leakage is corrected by grinding the valve to its seat, using reciprocating valve grinding tool 41-T-3381-15 and inlet valve grinding bit 41-B-662 (fig. 1) and valve grinding compound (fine), as shown in figure 81. Only light pressure is used when grinding and the valve and valve seat must be washed clean in dry-cleaning solvent or volatile mineral spirits after grinding.
 - (b) If the valve or valve seat is badly scored, pitted or worn, either the valve, valve seat, or both must be replaced. New valve seats are reamed, using intake valve reamer 41-R-834 (fig. 2) or a standard 0.3437-inch diameter hand reamer. After reaming, intake valve seat reamer 41-R-2178 (fig. 3) is used to lightly face the valve seat, as shown in figure 82. When using seat reamer, merely remove the sharp corner of the seat as a wide seat will not seal. The flutes of the inlet

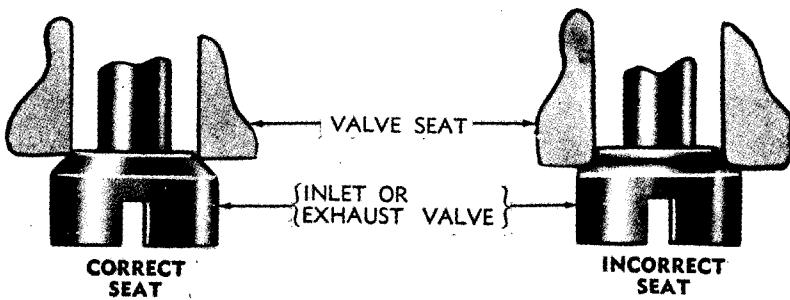


Figure 80. *Correct and incorrect valve seats.*

valve must be a sliding fit in the valve seat. After reaming, the valve must be ground to its seat as outlined in (a) above.

(c) The inlet valve assembly must be tested for leakage before attaching it to the brake valve by connecting it to an air supply of 75 pounds pressure. Use soap suds to test for leakage from the top of the assembly around the valve stem. Since a small leakage is acceptable, the rate of forming a soap bubble is used as a means of determining an acceptable

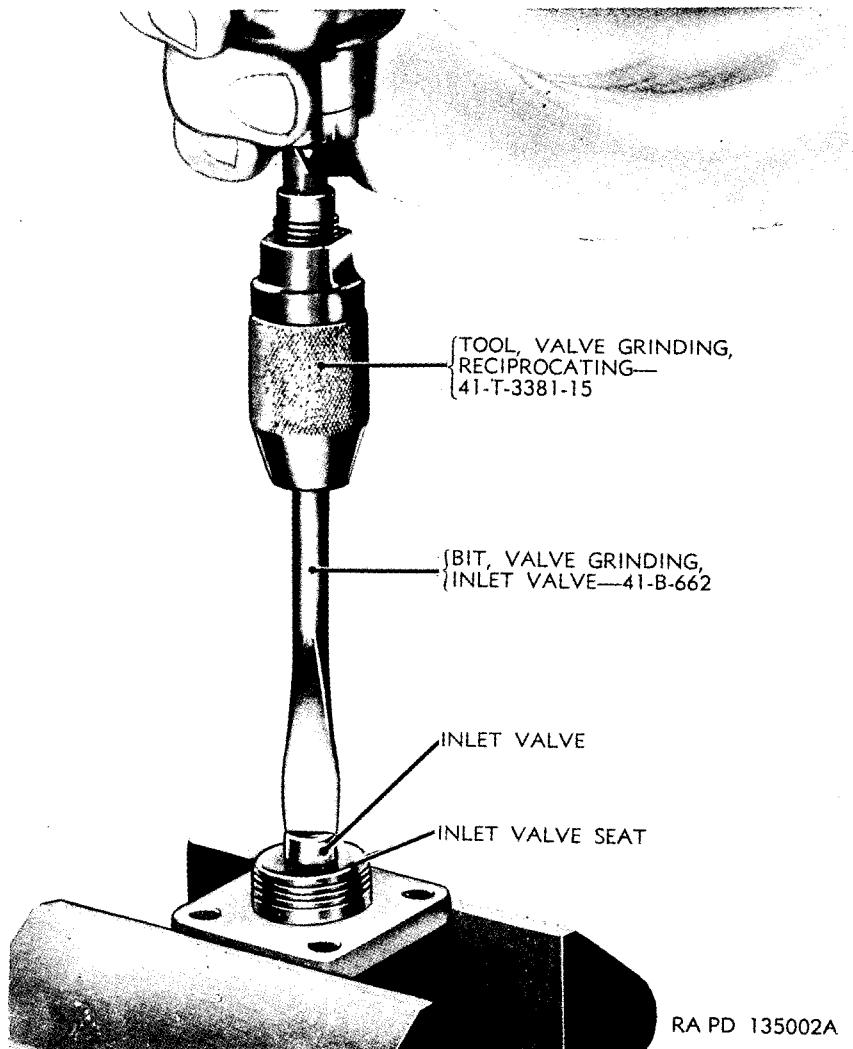


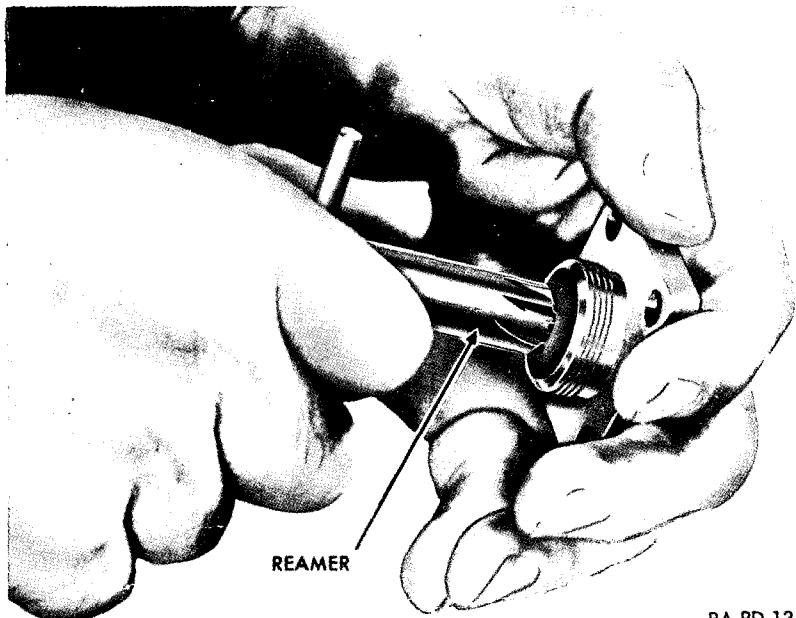
Figure 81. Grinding (lapping) inlet valve.

or an excessive leakage. Leakage which forms a 1-inch soap bubble in less than 5 seconds is considered to be an excessive leakage and the valve must be reground (lapped) to its seat. Leakage which requires 5 seconds, or more, to form a 1-inch soap bubble is acceptable.

(4) *Exhaust valve assembly.*

(a) If the valve or valve seat is only slightly scored, pitted, or worn, leakage is corrected by grinding (lapping) the valve to its seat, using reciprocating valve grinding tool 41-T-3381-15 and valve grinding bit 41-B-661 (fig. 1) and valve grinding compound (fine), as shown in figure 83. Light pressure must be used when grinding and the valve and valve seat must be washed in dry-cleaning solvent or volatile mineral spirits after grinding.

(b) If the valve or valve seat is badly scored, pitted, or worn, either the valve, valve seat, or both must be replaced. New valve seats must be reamed, using exhaust valve reamer 41-R-832 (fig. 2) or a standard 0.3125-inch diameter hand reamer. After reaming, exhaust valve seat reamer 41-R-2175 (fig. 3) is used to lightly face the valve seat, as shown in



RA PD 135003

Figure 82. Reaming inlet valve seat using intake valve seat reamer 41-R-2178.

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figure 84. When using seat reamer, merely remove the sharp corner of the seat as a wide seat will not seal. After reaming, the valve must be ground to its seat as outlined in (a) above.

(c) Exhaust valve assemblies must be tested for leakage after they are installed in the brake valve.

64. Assembly

a. *Assemble and Install Inlet Valve Assembly* (fig. 85). Install inlet valve spring in inlet valve body and place dampener in position. Install a new rubber gasket on top of inlet valve seat. Place the inlet valve into the inlet valve seat, with the flutes of the inlet valve sticking up through

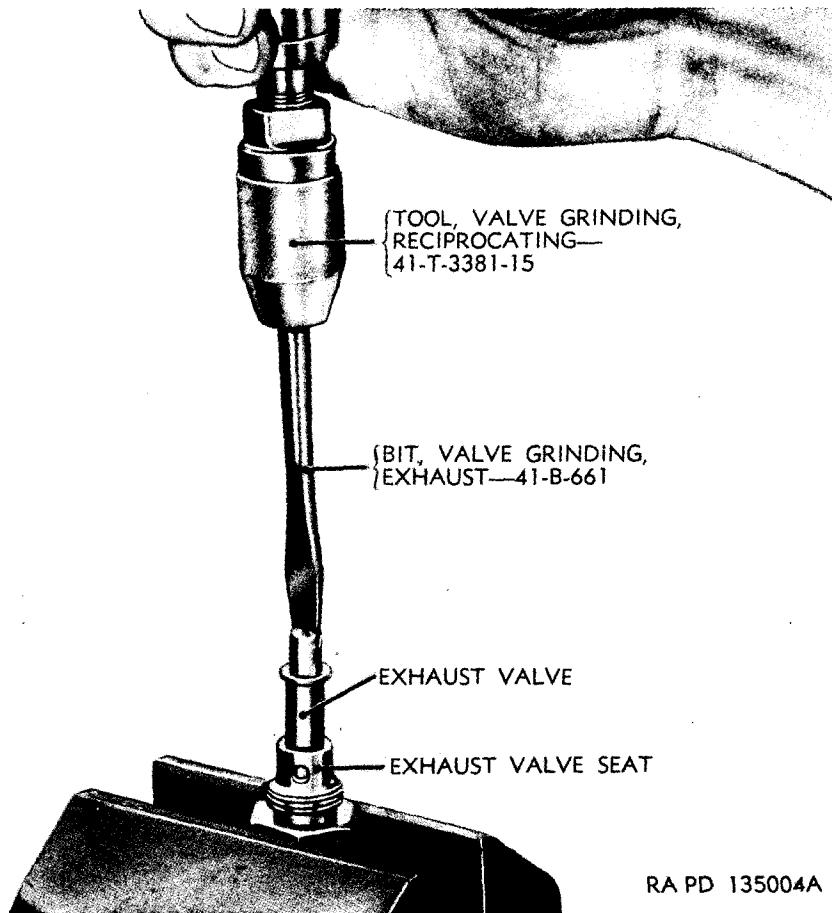
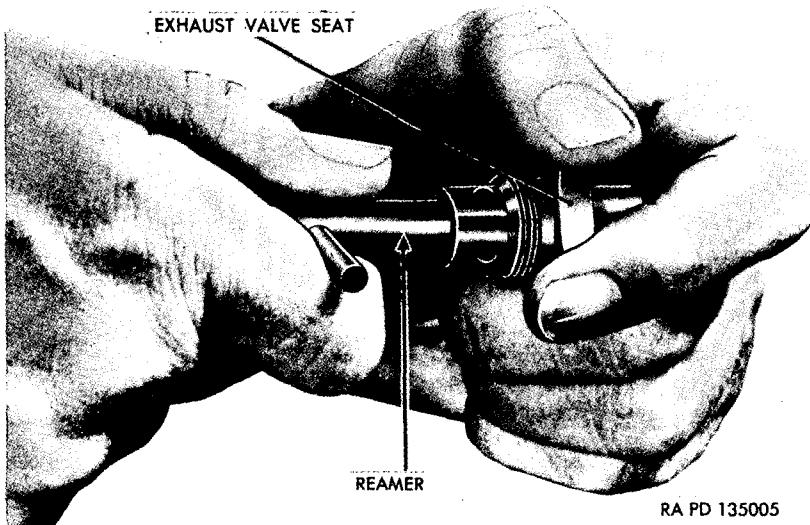


Figure 83. Grinding (lapping) exhaust valve.

the top of the inlet valve seat. Install shim on top of inlet valve body. Screw inlet valve body on inlet valve seat and tighten securely. Position inlet valve assembly (fig. 75) at correct angle on the brake valve body, as marked before disassembly (par. 62a), and install four lock washers and nuts. Evenly tighten the four nuts holding the inlet valve assembly in place, otherwise leakage will occur.

b. Assemble and Install Exhaust Valve Assembly (fig. 85). Position exhaust valve body. Install exhaust valve spring in valve seat and screw valve seat and valve body together. Place shims on top of exhaust valve assembly and install exhaust valve assembly (fig. 76) into body. Tighten securely.

c. Assemble and Install Diaphragm Assembly (fig. 85). Lubricate the two surfaces of the diaphragms which will contact each other with a light coating of OE lubricating oil. Place one diaphragm on the other so that the grain of the first diaphragm makes a 90° angle with the grain of the second diaphragm. Position pivot, diaphragm washer, and pivot nut; tighten pivot nut securely, being careful not to distort the diaphragms. After tightening pivot nut, prick-punch the threads of the pivot and pivot nut to lock the nut in place. Place rocker arm and diaphragm assembly in position in body, and place diaphragm ring in body on top of diaphragm assembly (fig. 79). Place a thin coating of automotive and artillery grease (GAA) on bottom of the ring nut



RA PD 135005

Figure 84. Reaming exhaust valve seat using exhaust valve seat reamer 41-R-2175.

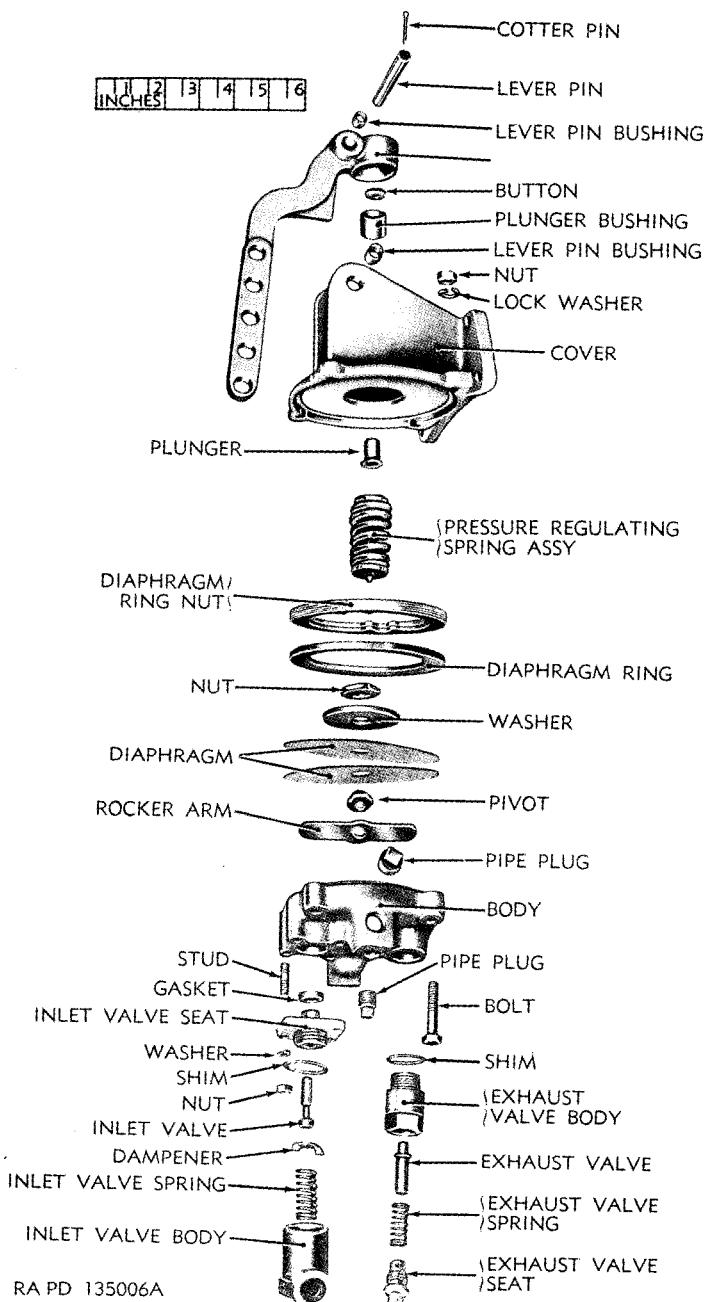


Figure 85. Type B-4-B brake valve exploded view.

to prevent diaphragm ring from turning when diaphragm ring nut is tightened. Use a wrench, such as is shown in figure 4, to install diaphragm ring nut in body. Tighten diaphragm ring nut securely.

d. Install Cover (fig. 85). Position cover so that lever will be directly over inlet valve assembly (fig. 72). Install plunger and pressure-regulating spring assembly in cover and install cover on body. Install four bolts, lock washers, and nuts attaching cover to body.

e. Install Lever. If lever button was removed, drive new button in place. Press in new lever bushing, if old one was removed. Position lever and install lever pin. Install and spread cotter pins in ends of lever pin.

f. Check Exhaust Valve Travel. Check exhaust valve travel by meas-

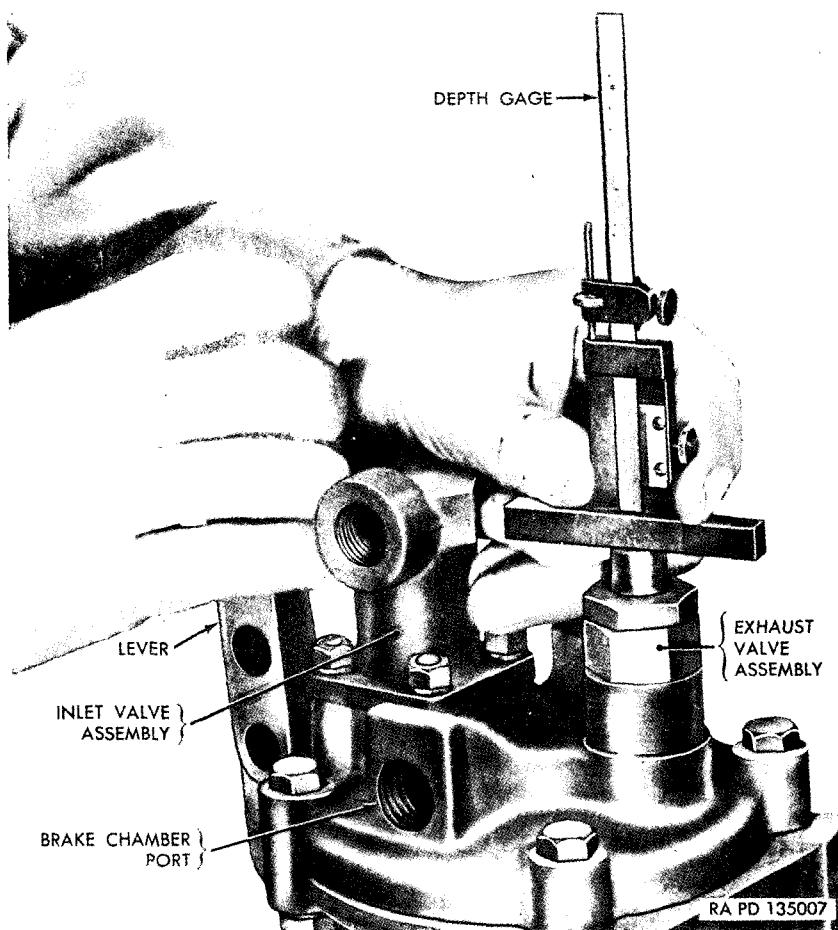
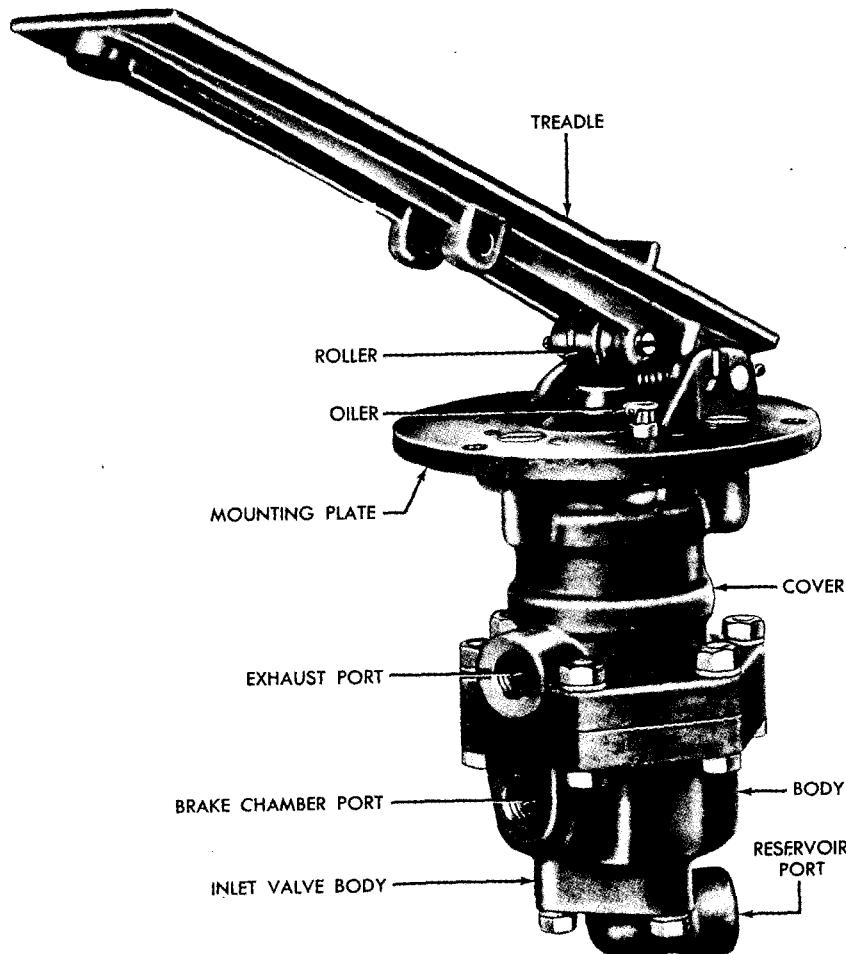


Figure 86. Checking exhaust valve travel.

uring the movement of the exhaust valve, when the lever is moved to applied position, with a depth gage (fig. 86). Exhaust valve travel must not be less than three-sixty-fourths inch nor more than one-sixteenth inch. Exhaust valve travel is reduced by increasing the number of shims between the exhaust valve assembly and the body of the brake valve or increased by reducing the number of shims.

65. Testing Rebuilt B-4-B Brake Valve

See paragraph 60 for test procedure.



RA PD 135008

Figure 87. Type D brake valve.

Section III. TYPE D BRAKE VALVE

66. Description and Operation

a. *Description* (fig. 87). Type D brake valves are fitted with a treadle which is part of the brake valve. Movement of treadle operates an inlet-and-exhaust valve within the brake valve which controls the air pressure delivered to brake chambers. Air pressure delivered is in

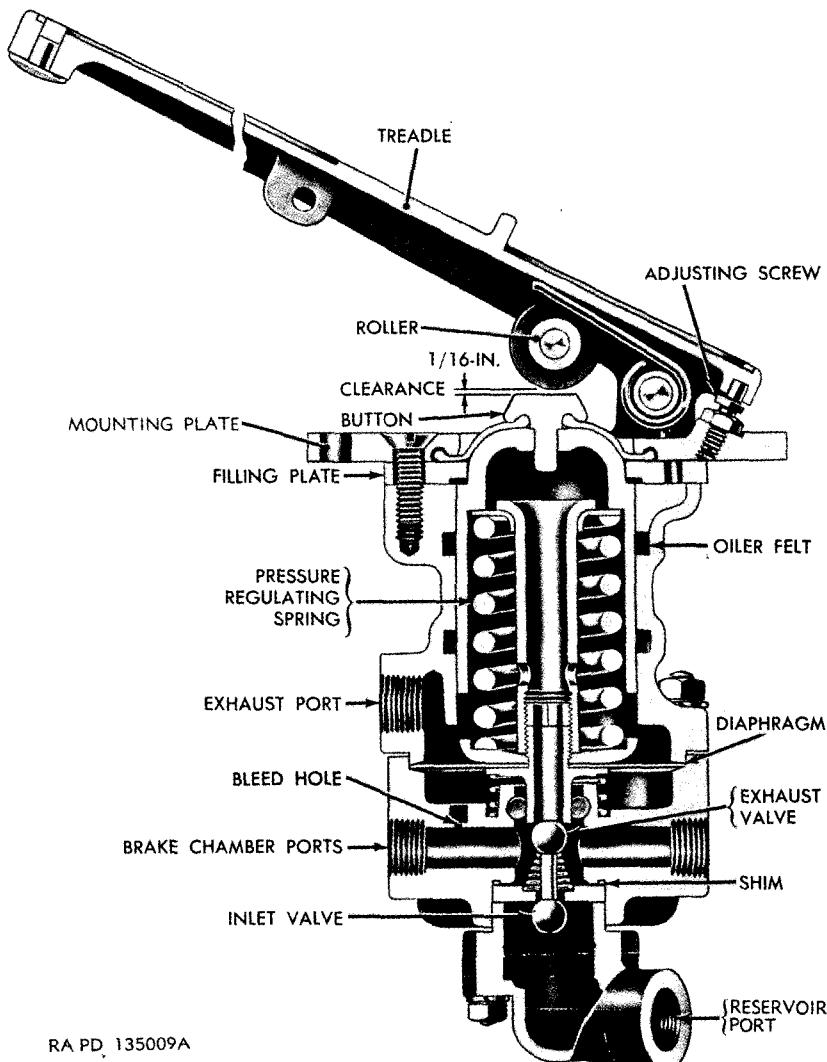


Figure 88. Sectional view type D brake valve.

proportion to the amount the treadle is depressed or released. In this manner, the amount of force applied to the brakes is always under control of driver.

b. Operation (fig. 88).

- (1) Movement of the treadle exerts a force on top of pressure-regulating spring and diaphragm. As diaphragm moves downward, the exhaust valve seat makes contact with exhaust valve and closes it. Continued movement opens inlet valve and admits reservoir air pressure to brake chamber ports, thence to

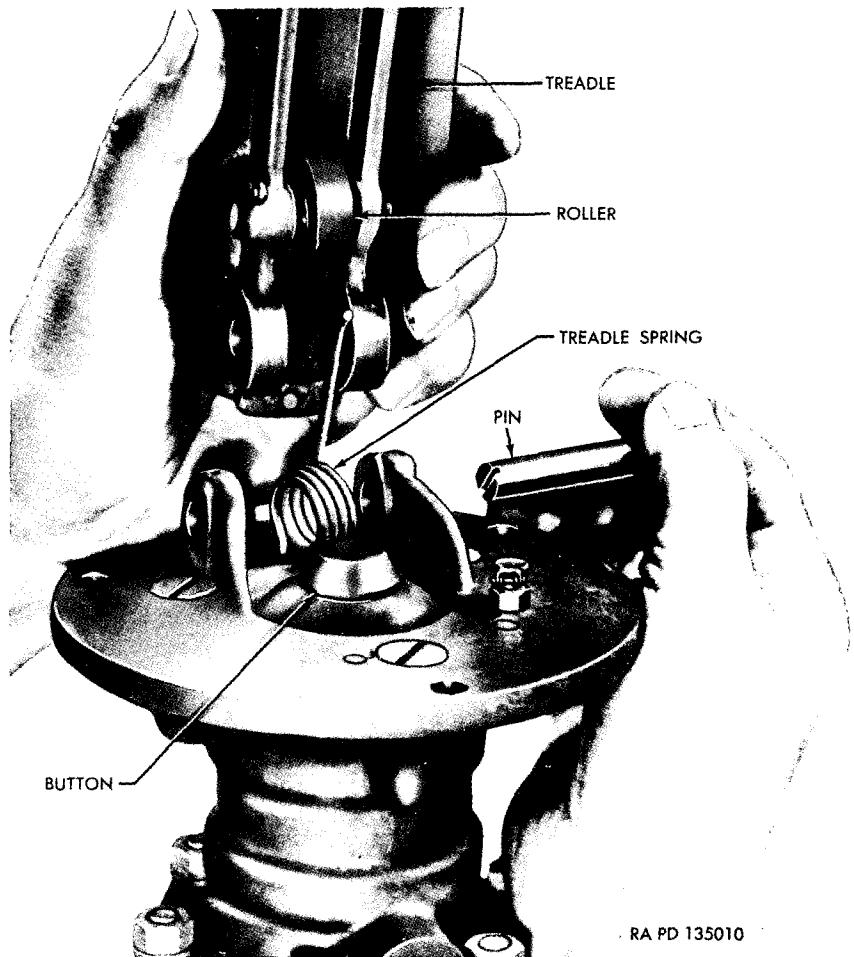


Figure 89. Removing treadle.

brake chambers, and also to the cavity below the diaphragm through the bleed hole.

(2) When the air pressure below the diaphragm equals the mechanical load on top of it, the diaphragm lifts and the inlet

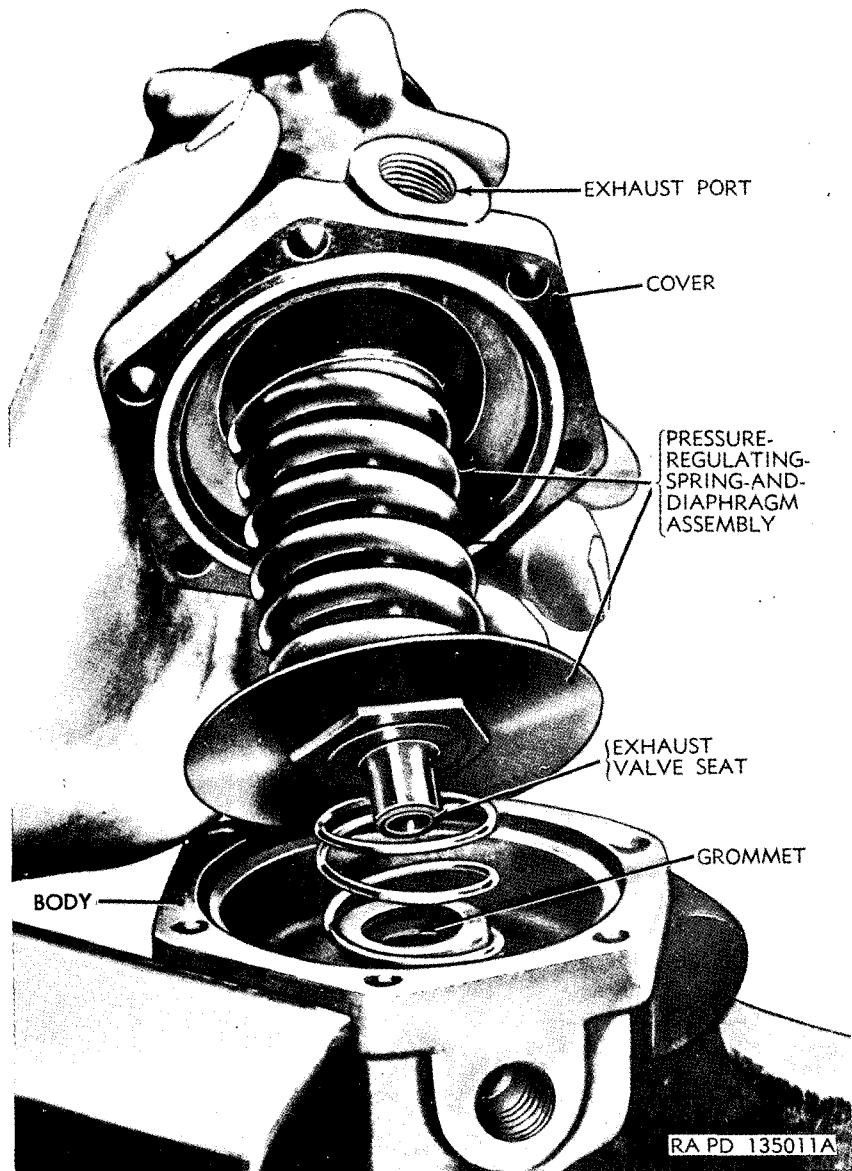


Figure 90. Removing cover from body.

valve closes. Thus, the brake valve assumes a balanced position. Any change in the forces on the diaphragm opens either the inlet or the exhaust valve until the forces on both sides of the diaphragm are again equalized.

(3) When the treadle is fully released, the exhaust valve remains open, releasing the pressure from the brake chambers.

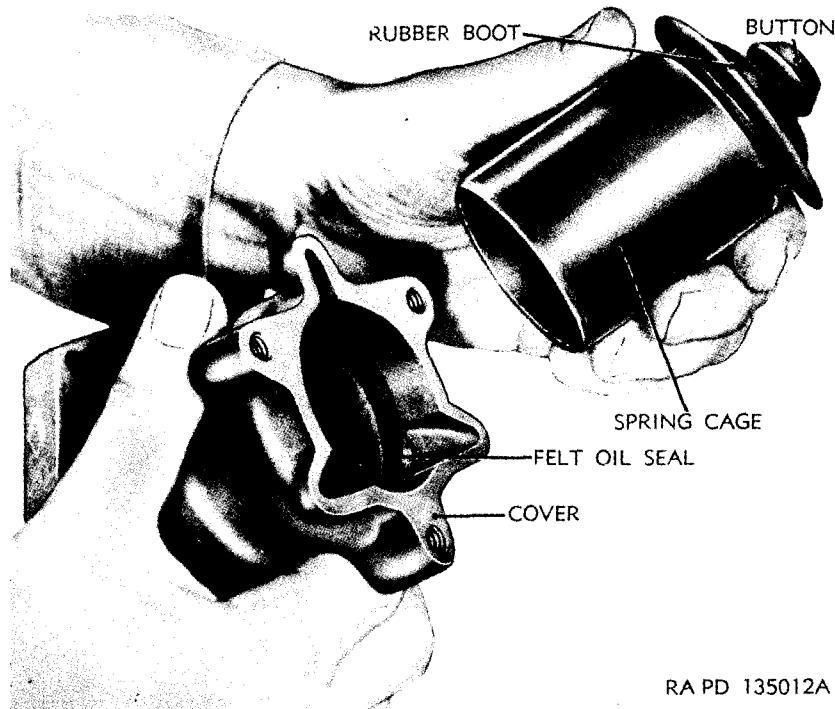
c. *Preparation for Rebuild.*

(1) When condition of brake valve is unknown, it should be subjected to operating tests (par. 70) before disassembly. If valve meets requirements, it will be returned to service.

(2) Each year, or after each 50,000 miles, brake valves will be completely disassembled and rebuilt.

67. Disassembly of Type D Brake Valve

a. *Marking Before Disassembly.* If inlet valve body is the elbow type, punch-mark both elbow and flange and brake valve body to assure proper assembly.



RA PD 135012A

Figure 91. Removing spring cage.

b. *Remove and Disassemble Treadle* (figs. 89 and 95). Remove cotter pin from end of treadle pin. Drive out treadle pin and remove treadle and treadle spring. If treadle roller is to be removed, remove cotter pin from end of roller pin. Drive out roller pin and remove roller.

c. *Remove Mounting Plate and Filling Plate* (fig. 95). Remove three countersunk-head-machine screws attaching mounting plate to body. Lift off mounting plate and filling plate.

d. *Remove Pressure-Regulating-Spring-and-Diaphragm Assembly*. Remove six nuts, lock washers and cap screws attaching cover to body (fig. 95). Remove cover and lift out pressure-regulating-spring-and-diaphragm assembly (fig. 90). Do not disassemble the pressure-regulating-spring-and-diaphragm assembly unless the diaphragms or the exhaust valve seat have to be replaced. If the diaphragm assembly is disassembled, extreme care must be used to be sure the same shims are replaced during assembly. Lift out exhaust valve spring and pull rubber grommet from body (figs. 90 and 95).

e. *Remove Spring Cage From Cover*. Push spring cage, button, and rubber boot out of cover (fig. 91). Drive button out of spring cage and

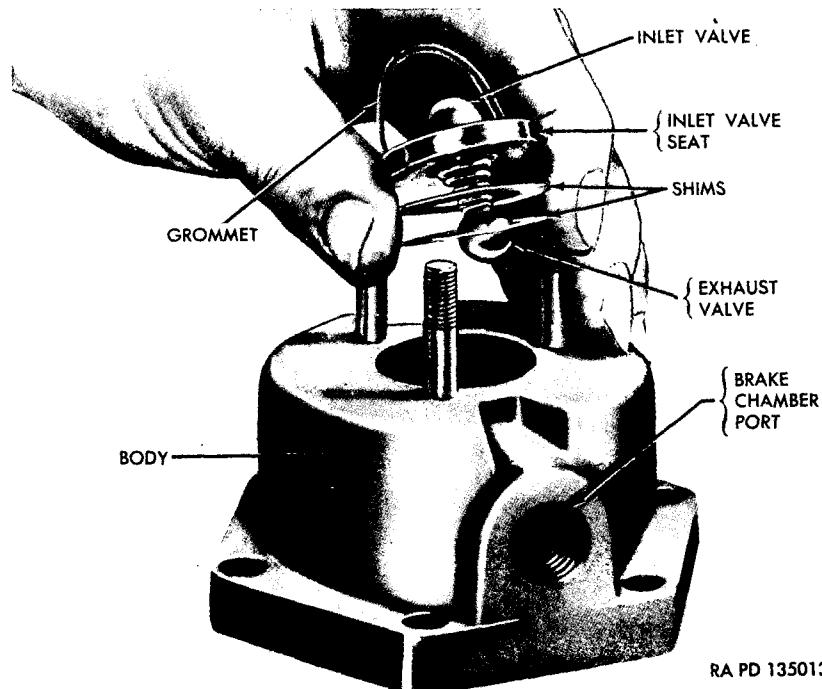


Figure 92. *Removing inlet-and-exhaust valve assembly.*

remove boot (fig. 95). Remove two felt oiler seals from cover (figs. 91 and 95).

f. Remove Inlet-and-Exhaust Valve Assembly. Remove three nuts and lock washers attaching inlet valve elbow to brake valve body (fig. 95). Lift rubber grommet, inlet-and-exhaust valve assembly, and shims out of brake valve body (figs. 92 and 95). Do not disassemble the inlet-and-exhaust valve assembly.

68. Cleaning, Inspection, and Repair

a. Cleaning. Wash all parts with dry-cleaning solvent or volatile mineral spirits.

b. Inspection and Repair.

(1) *Pressure-regulating-spring-and-diaphragm assembly* (fig. 93).

(a) Inspection. Carefully inspect both diaphragms to be sure they are not bent or distorted in any way. If ridges or cracks are found, the diaphragms must be replaced. Inspect condition of exhaust valve seat (fig. 94) and if seat is worn or damaged, it must be replaced. If the spring is damaged in any way, the complete pressure-regulating-spring-and-diaphragm assembly must be replaced.

(b) Repair.

1. If it is necessary to replace the diaphragms or the exhaust valve seat, extreme caution must be used to be sure the same shims are again used in the pressure-regulating-spring-and-diaphragm assembly. To disassemble the pressure-regulating-spring-and-diaphragm assembly, insert a set screw wrench down through the exhaust valve tube to engage the wrench socket of the lock plug, hold the hexagon portion of the exhaust valve seat in a vise and loosen the lock plug. Unscrew the tube from the exhaust valve seat (figs. 93 and 95).

2. Install new diaphragms so the grain of one is at right angles to the grain of the other. After all parts are positioned, the tube and exhaust valve seat must be screwed together until the distance between the end of the exhaust valve seat and the top of the tube is between 3.498-inch minimum and 3.508-inch maximum (fig. 93). After this dimension has been established, the lock plug must be securely tightened.

(2) *Treadle assembly.* Check fit of treadle pin in treadle bushing and mounting plate. It must be a free fit. If bushing in treadle is worn, it must be pressed out and replaced. Inspect treadle

roller for fit on roller pin. It must be a free rolling fit. If wear is found or if the roller has any flat spots, the pin, the roller, or both must be replaced. Check to be sure the stop button at the toe of the treadle and the stop pin at the heel of the treadle are in place and in good condition. Replace, if necessary. Check to be sure treadle spring is not broken or damaged in any way.

- (3) *Cover.* Check fit of spring cage in cover. Spring cage must be a sliding fit in cover. Check to be sure the diaphragm seat on the bottom of the cover is not nicked or damaged in any way to prevent perfect contact with the diaphragm. If diaphragm seat is only slightly damaged, grind flat with a No. 100 aluminum oxide cloth on a flat surface.
- (4) *Brake valve body.* Inspect diaphragm seat in top of body. Be sure it is flat and smooth. If the diaphragm seat is damaged in any way, replace body. Inspect small bleed hole leading to brake chamber port in body to be sure it is open and not obstructed in any way.

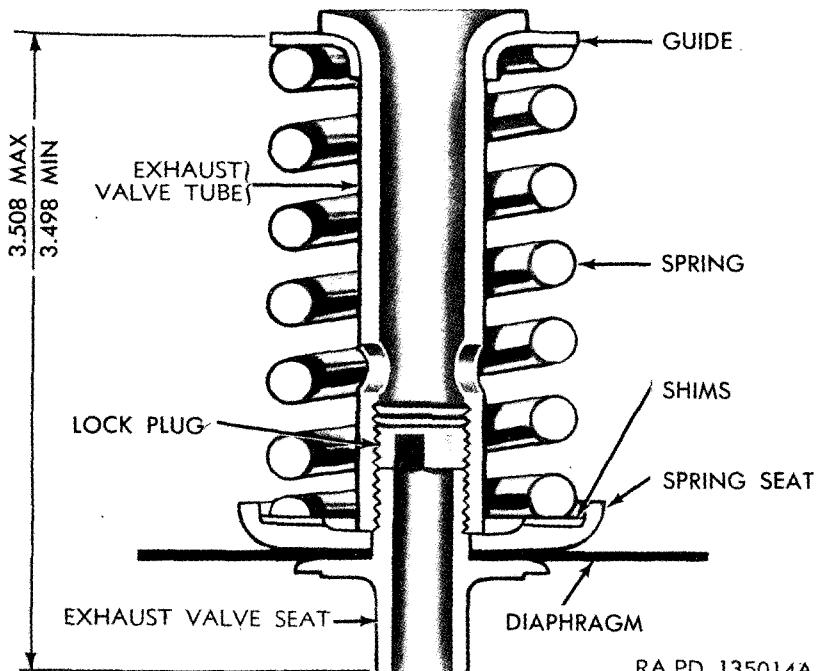


Figure 93. Pressure-regulating-spring-and-diaphragm assembly.

(5) *Inlet-and-exhaust valve assembly.* Inspect assembly for broken spring and worn or damaged seat. If seat is damaged or noticeably worn, as shown on figure 94, assembly must be replaced.

69. Assembly

a. *Install Pressure-Regulating-Spring-And-Diaphragm Assembly* (fig. 95).

- (1) Install a new grommet in body. Position exhaust valve spring in body. Apply a thin coating of automotive and artillery grease on the top and bottom of the diaphragms.
- (2) Dip new felt oiler seals in clean engine oil and install them in the cover (fig. 91).
- (3) Position filling plate on spring cage, being sure the recessed side is against top of the spring cage. Position rubber boot on top of spring cage, drive button into place, and push spring cage into cover (fig. 91). Place pressure-regulating-spring-and-diaphragm assembly in position in body and carefully push into place so that the exhaust valve seat properly enters grommet in the body (fig. 90). Position cover and spring cage on top of body so that the exhaust port in the cover is in line with brake chamber port in body closest to the bleed hole (fig. 88). Install and securely tighten six cap screws, lock washers, and nuts attaching cover to body (fig. 95).

b. *Install Mounting Plate* (fig. 95). Position mounting plate on top of filling plate so that treadle will extend over the exhaust port in the cover. Align holes in mounting plate, filling plate with holes in cover, and install machine screws.

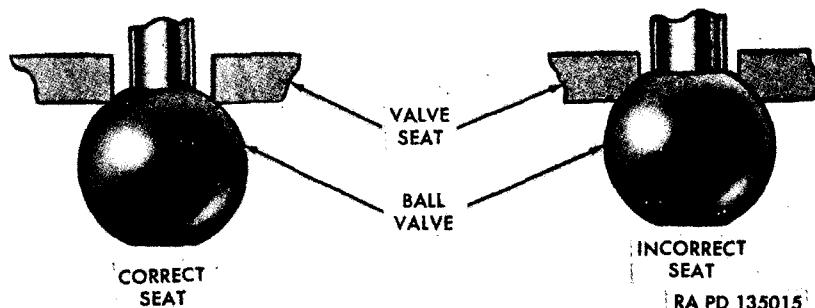


Figure 94. Correct and incorrect valve seats.

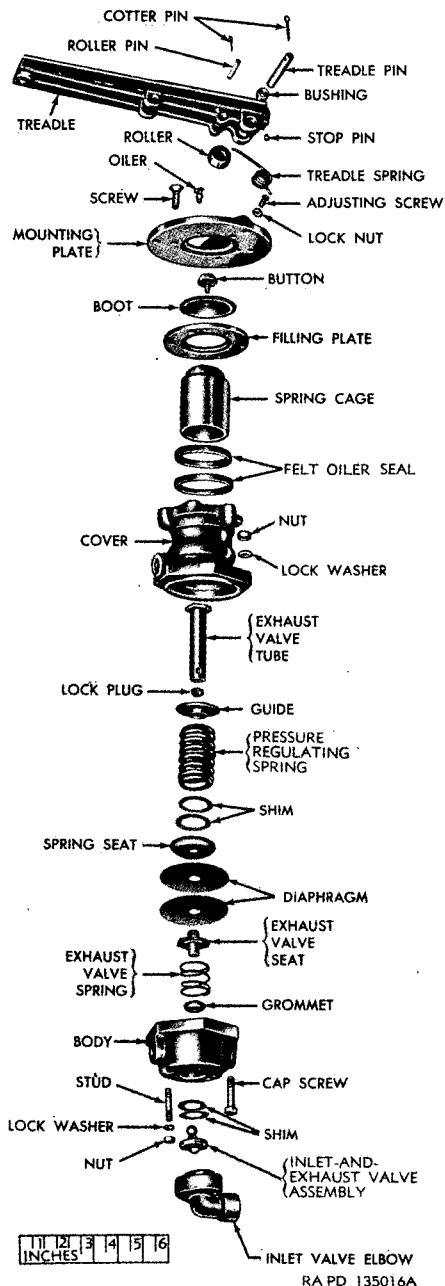


Figure 95. Type D brake valve—exploded view.

c. Install Inlet-And-Exhaust Valve Assembly. Install shims in recess at bottom of body and install inlet-and-exhaust valve assembly in the body with spring and exhaust valve entering the body first. Position grommet in place against inlet valve seat (figs. 92 and 95). Position inlet valve elbow, as marked before disassembly (par 67a), and install three lock washers and nuts (fig. 95). Tighten securely.

d. Install Treadle (fig. 95). Position treadle spring so the short, pro-

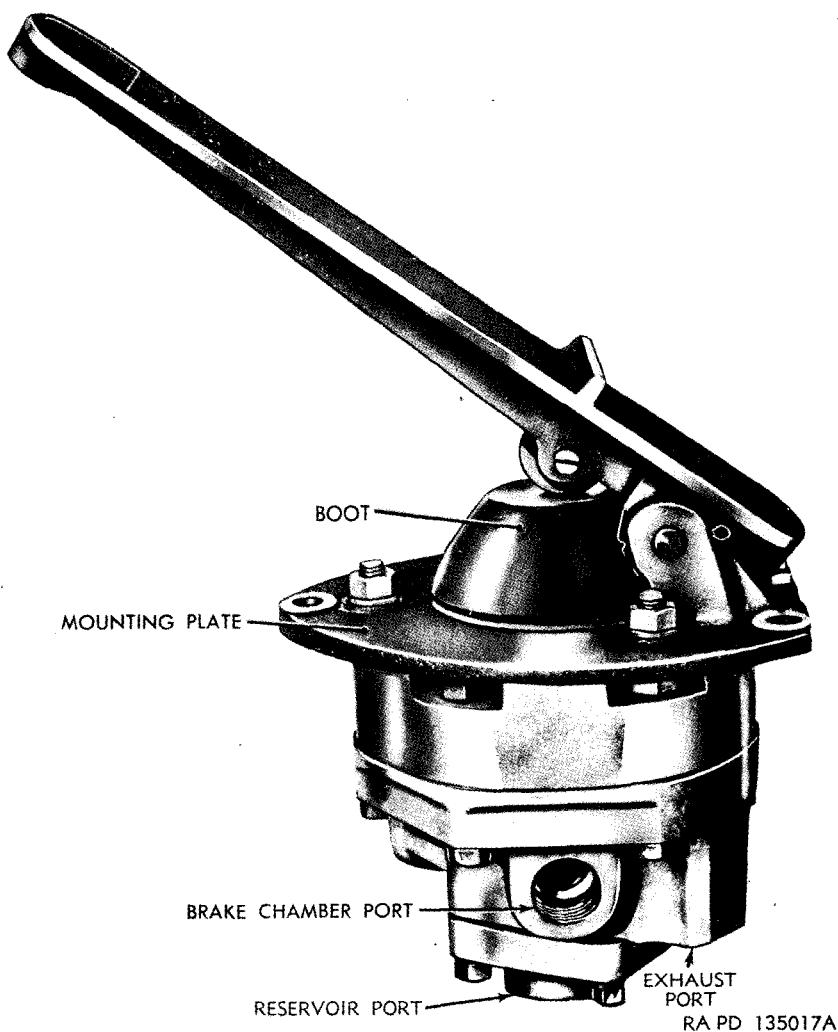


Figure 96. Type D-1 brake valve—treadle-operated.

jecting end of spring engages the hole near the adjusting screw in the mounting plate. Position treadle so that the long, projecting end of spring is at the side of roller and the fulcrum pin holes in mounting plate and spring are alined. Install treadle pin, being sure it passes through the coiled part of the spring. Aline cotter pin hole in mounting lug with hole in pin and install cotter pin. Adjust the adjusting screw until there is $\frac{1}{16}$ -inch clearance between the roller and the button (fig. 88).

70. Test and Adjustment

a. *Test.* Refer to paragraph 60 for procedure.

b. *Adjustment.*

- (1) If brake valve does not release promptly insufficient opening of the exhaust valve is indicated. This can be caused by the filling plate being installed upside down (par. 69a(3)) or by insufficient shims between valve seat and body of valve.
- (2) If brake valve does not fully release, check clearance between treadle roller and button (fig. 88) on top of spring cage. Clearance must be one-sixteenth inch. If clearance is not correct, add additional shim or shims between inlet valve seat and body of valve (fig. 88) to increase opening of exhaust valve.
- (3) If brake valve does not apply promptly, check for proper clearance between treadle roller and button on top of spring cage ((2) above). Remove shims between inlet valve seat and body of valve (fig. 88) to decrease exhaust valve clearance. This will increase inlet valve opening.
- (4) If brake valve does not graduate the delivered pressure promptly, it indicates an obstruction in bleed hole to cavity immediately below the diaphragm. Bleed hole (fig. 88) should be $\frac{1}{16}$ -inch diameter and must be unobstructed.

Section IV. TYPE D-1 BRAKE VALVE

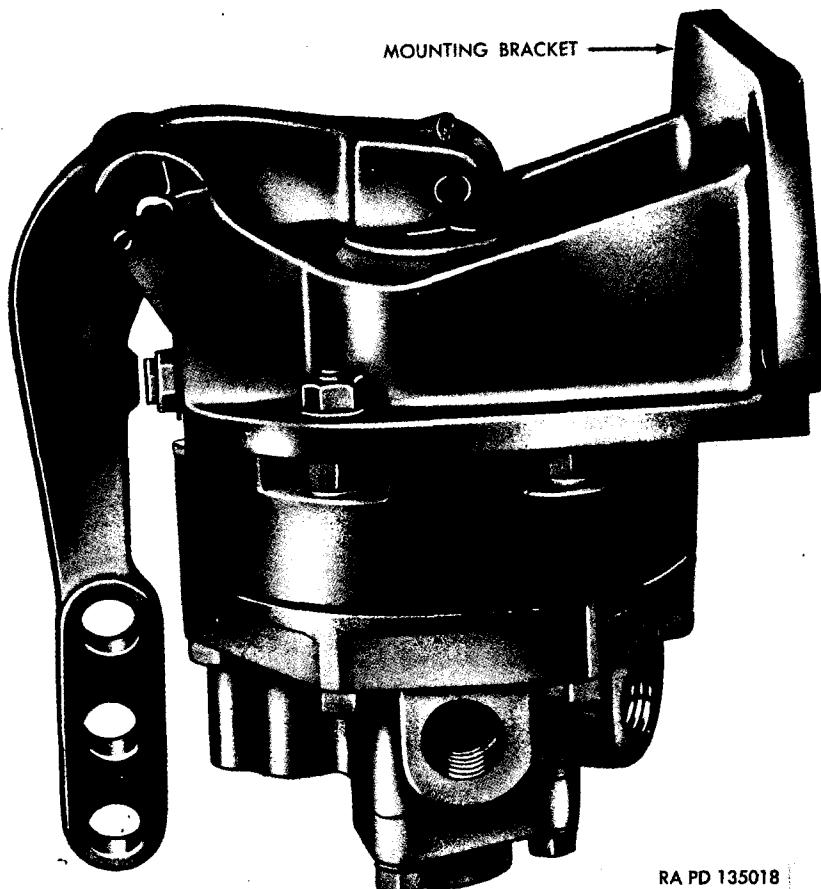
71. Description and Operation

a. *Description.* Type D-1 brake valves have either a foot-operated treadle or a lever suitable for connecting to a conventional brake pedal (figs. 96 and 97). Movement of the treadle or brake pedal controls the movement of an inlet valve and exhaust valve within the D-1 valve which, in turn, control the air pressure being delivered to or released from the brake chambers on the vehicle. To fully apply the brakes with a type D-1 brake valve, the treadle (or brake pedal) must be fully de-

pressed; whereas, when the treadle is only partially depressed, correspondingly less braking force is developed.

b. Operation (fig. 98).

(1) As the treadle is depressed, pressure is exerted on the top of the pressure-regulating spring and diaphragm. As the diaphragm moves downward, the exhaust valve seat moves downward against the exhaust valve and closes it. Continued movement of the diaphragm downward pushes the inlet valve off its seat. Air pressure from the reservoir then flows through the inlet valve and out the brake chamber ports to the brake chambers, applying the brakes. This air pressure also enters the cavity below the diaphragm through the bleed hole.



RA PD 135018

Figure 97. Type D-1 brake valve—lever-operated.

(2) When the air pressure in the cavity below the diaphragm overcomes the mechanical force being exerted on top of the diaphragm, the diaphragm lifts and the inlet valve closes, cutting off further supply of air pressure to the brake chambers while the exhaust valve remains closed, preventing any escape of air pressure through the exhaust port. Should the driver depress the treadle further and put additional force on top of the diaphragm, a corresponding increase in the air pressure being delivered to the brake chambers results.

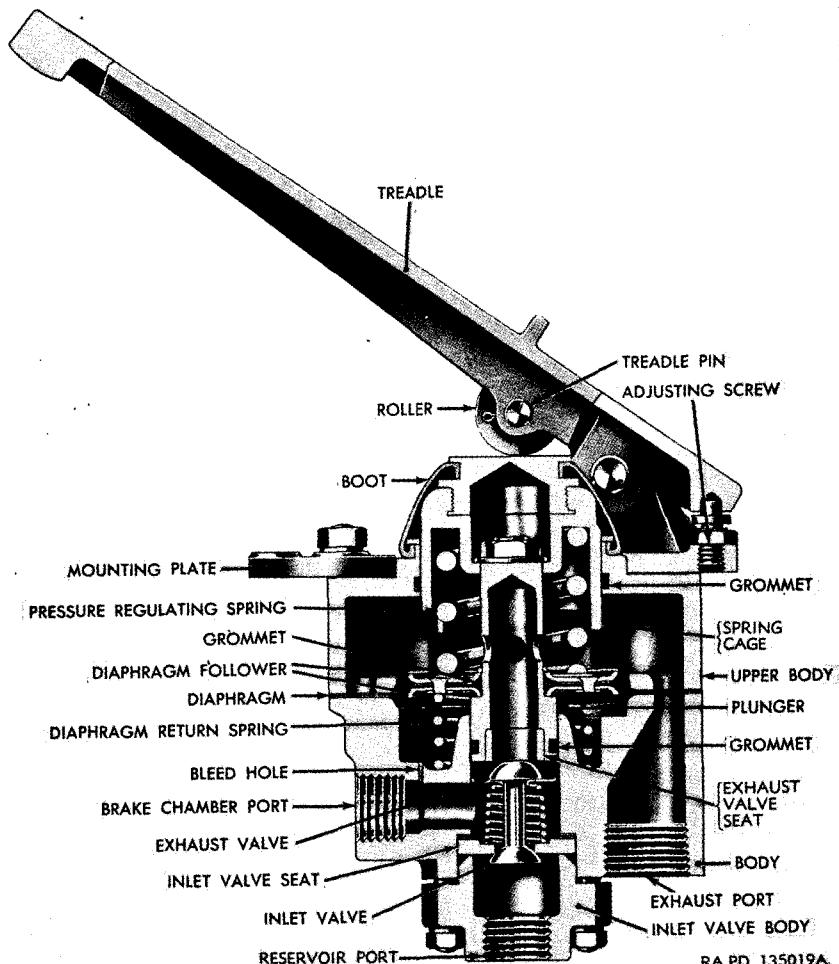


Figure 98. Sectional view of type D-1 brake valve.

[REDACTED]

- (3) If the treadle is partially returned toward its fully released position, thus reducing the mechanical force on top of the diaphragm, the air pressure below the diaphragm overcomes the mechanical force on top of it and the diaphragm lifts slightly. When this happens, the inlet valve remains closed but the exhaust valve opens to exhaust air pressure from the brake chambers until the air pressure below the diaphragm again balances the mechanical force on top of it. If the treadle is returned to fully released position, the exhaust valve remains open and all air pressure from the brake chambers is exhausted and the brakes on the vehicle are fully released.
- (4) If the treadle is depressed to fully applied position, the pressure-regulating spring is compressed and the spring cage strikes the diaphragm follower. Under these conditions, the inlet valve is held open, permitting full reservoir pressure to pass through the brake valve into the brake chambers.

c. *Preparation for Rebuild.*

- (1) When condition of brake valve is unknown, it should be subjected to operating tests before disassembly (par. 60). If valve meets requirements, it will be returned to service.
- (2) Each year or after each 50,000 miles, brake valves will be completely disassembled and rebuilt.

72. Disassembly of Type D-1 Brake Valve

a. *Marking Before Disassembly.* Mark position of body to upper body, with particular attention to position of at least one long cap screw.

b. *Remove and Disassemble Treadle (or Lever)* (fig. 102). Remove cotter pin from end of treadle pin. Drive out treadle pin and remove treadle. If treadle roller is to be removed, remove cotter pin from end of roller pin. Drive out roller pin and remove roller.

c. *Remove Mounting Plate* (fig. 102). Remove three nuts and lock washers attaching mounting plate to upper body. Lift off mounting plate.

d. *Separate Body From Upper Body* (figs. 99 and 102).

- (1) Remove nuts, lock washers, and cap screws holding bodies together and separate the bodies.
- (2) Remove boot from cap. Remove pressure-regulating-spring-and-diaphragm assembly from upper body.

Note. Do not disassemble pressure-regulating-spring-and-diaphragm assembly unless diaphragm assembly or exhaust valve seat must be replaced. If the parts are disassembled, extreme care must be used to

see that the same shims are replaced and the original measurements maintained.

(3) Remove grommet from upper body and from plunger. Remove diaphragm return spring.

e. *Remove Inlet-And-Exhaust Valve Assembly* (figs. 100 and 102).

- (1) Remove three nuts and lock washers attaching inlet body to brake valve body. Remove inlet body.
- (2) Lift rubber grommet, inlet-and-exhaust valve assembly, and shims from brake valve body. Do not disassemble the inlet-and-exhaust valve assembly.

73. Cleaning, Inspection, and Repair

a. *Cleaning*. Wash all metal parts with dry-cleaning solvent or volatile mineral spirits.

b. *Inspection*.

- (1) *Pressure-regulating-spring-and-diaphragm assembly*. Carefully inspect diaphragm for cracks or deterioration. If either condition exists, the diaphragm assembly must be replaced. Inspect exhaust valve seat. If worn or damaged, the plunger or the complete pressure-regulating-spring-and-diaphragm assembly

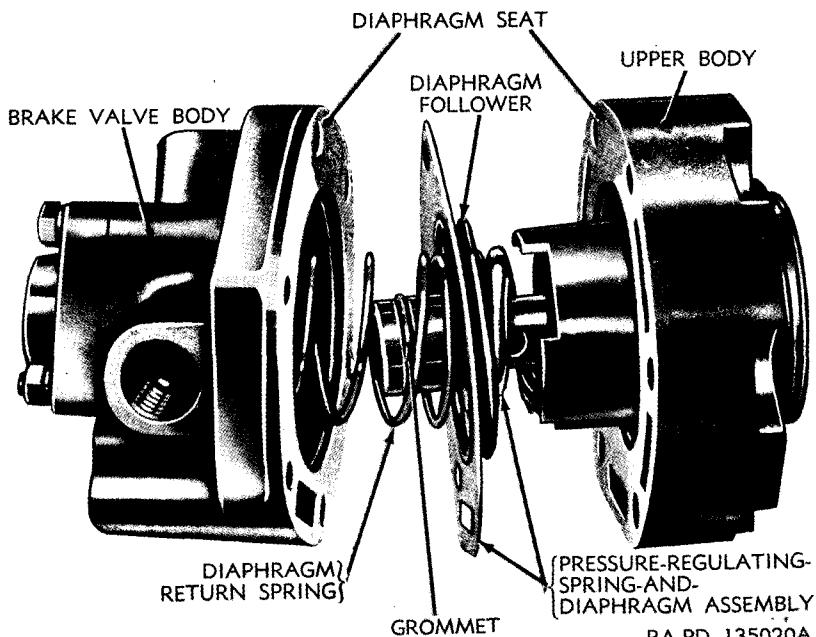
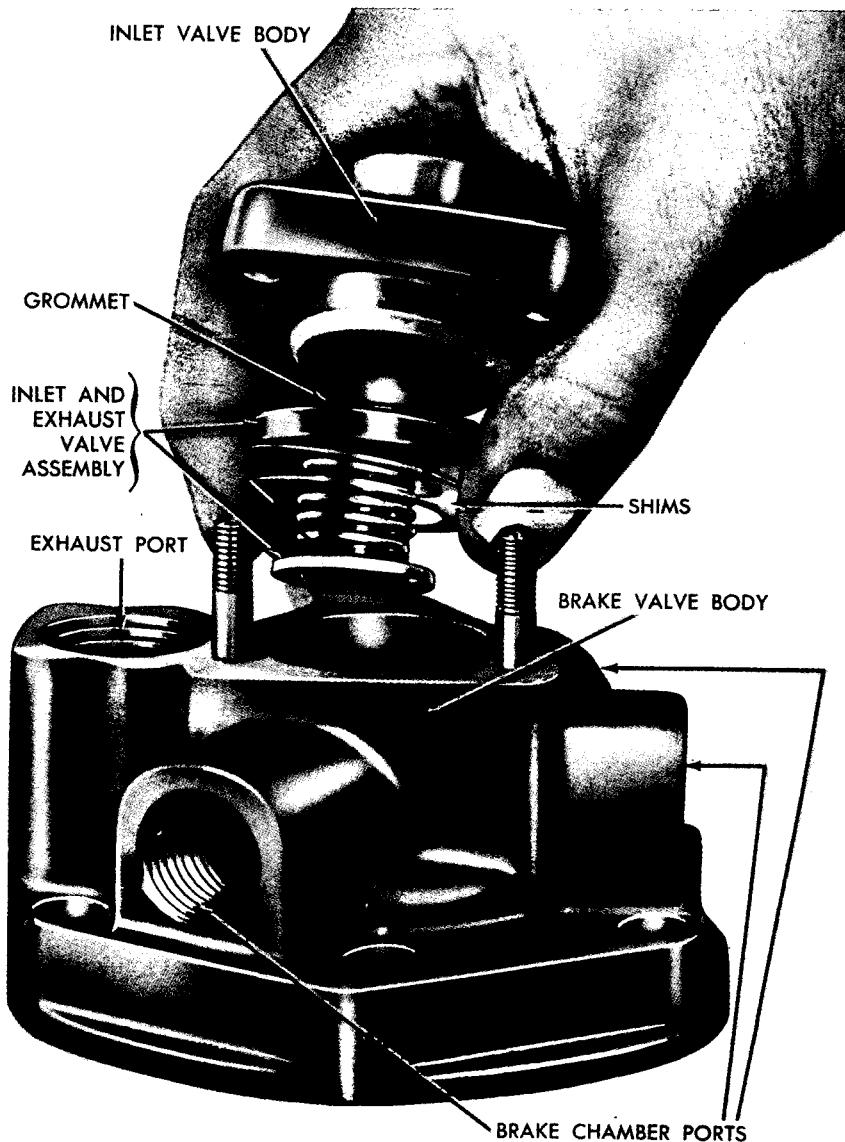


Figure 99. Removing upper body from brake valve body.

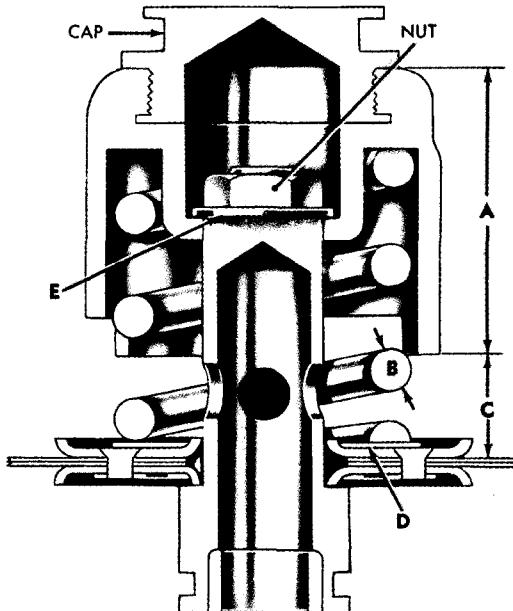


RA PD 135021

Figure 100. Removing inlet-and-exhaust valve assembly.

must be replaced. If the pressure-regulating spring is damaged, it must be replaced.

(2) *Treadle assembly.* Check fit of treadle pin in treadle and mounting plate bushings; it must be a free fit. If bushings in mounting plate are worn, they must be pressed out and replaced. Inspect treadle roller for fit on roller pin; it must be a free-rolling fit. If wear is found or if the roller has any flat spots, the pin, the roller, or both must be replaced. Check to be sure the stop button at the top of the treadle and the stop pin



USE SHIMS "E" TO OBTAIN DIMENSION "C"
THEN USE SHIMS "D" TO OBTAIN 72 TO 80
POUNDS SPRING PRE-LOAD

	SHORT TRAVEL	LONG TRAVEL
A	1.905 in	1.733 in.
B	0.283 in.	0.250 in.
C	0.387 min. 0.393 max.	0.559 min. 0.565 max.

RA PD 135022

Figure 101. Pressure-regulating-spring-and-diaphragm assembly.

at the heel of the treadle are in place and in good condition. Replace, if necessary.

- (3) *Mounting plate.* Check for cracks or breakage. Replace, if necessary. Check adjusting screw and lock nut. If worn or damaged, replace.
- (4) *Boot.* Replace, if cracked or deteriorated.
- (5) *Upper body.* Replace rubber grommet. Check fit of spring cage in upper body; it must be a sliding fit. Check the diaphragm seat on the bottom of the upper body for damage that will prevent perfect contact with the diaphragm. Check diaphragm seat radius for burrs or nicks. If diaphragm seat is damaged, replace upper body.
- (6) *Brake valve body.* Inspect diaphragm seat in top of brake valve body. Be sure it is flat and smooth. If the diaphragm seat is damaged in any way, replace body. Inspect small bleed hole leading to brake chamber port in body to be sure it is open and not obstructed. Inspect diaphragm follower seat for wear or damage. Replace brake valve body, if worn. Place plunger assembly into body; it should be a sliding fit.
- (7) *Inlet-and-exhaust valve assembly.* Inspect inlet-and-exhaust valve assembly for broken spring and worn or damaged valves and seat. If the assembly is damaged or worn, it must be replaced.

c. *Repair.*

- (1) *Pressure-regulating-spring-and-diaphragm assembly* (fig. 101). If it is necessary to replace parts of this assembly, it should be noted that two different assemblies, "Long Travel" and "Short Travel," are in use. Certain parts of these assemblies are not interchangeable, although the complete assemblies can be interchanged. D-1 brake valves which are "Short Travel" are identified by an "S" stamped on upper body.
- (2) *Disassembly* (fig. 102). Clamp spring cage with strap wrench or hold cage by steps in bottom and remove cap. Loosen nut by holding plunger with a rod through exhaust hole and remove nut; washer, and shims. Lift spring cage, spring, and shims from plunger. To remove diaphragm, remove snap ring and slip diaphragm assembly from plunger.

Note. Same shims must be used in assembly.

Install new grommet in diaphragm assembly, position diaphragm on plunger and install snap ring. Position spring and original shims, if any, on diaphragm and install spring cage.

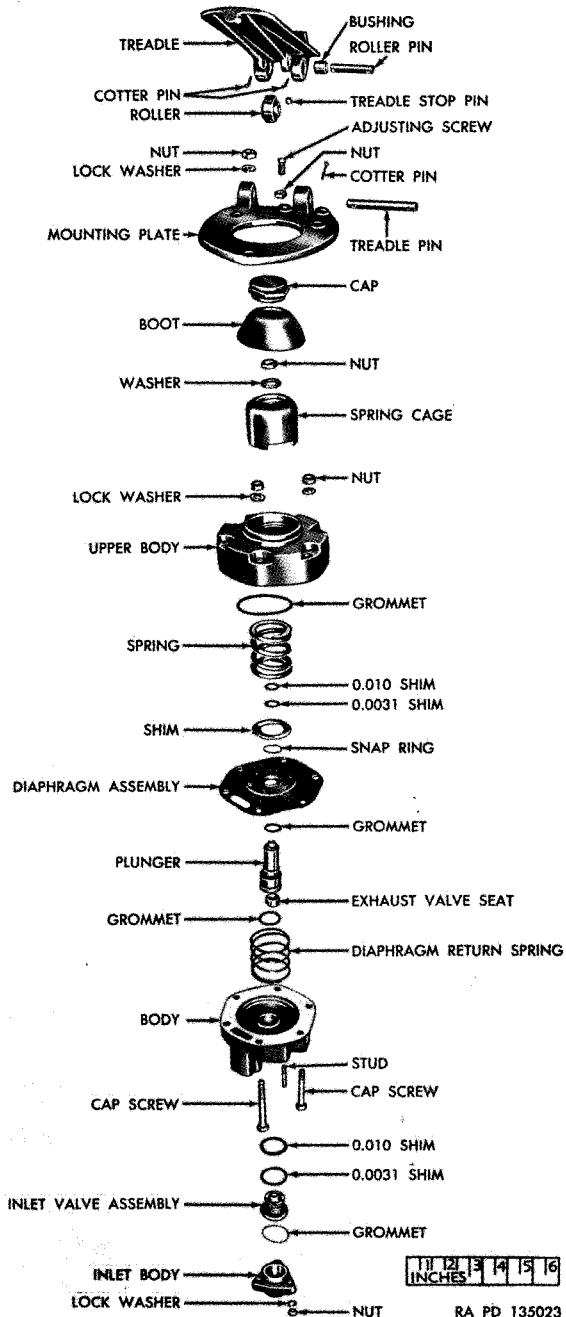


Figure 102. Type D-1 brake valve—exploded view.

Secure cage with shims, washer, and nut. Pull nut down tight and check dimension C (fig. 101). Stake nut after checking. Install and stake cap.

74. Assembly

a. Install Pressure-Regulating-Spring-And-Diaphragm Assembly (figs. 99 and 102). Install new grommet on plunger. Lubricate the plunger grommet, the upper grommet, and the surfaces that they slide against with engine oil (OE-10). Install pressure-regulating-spring-and-diaphragm assembly in body, taking special notice that exhaust hole at edge of diaphragm matches exhaust hole in body and that diaphragm return spring is in place. Position upper body on brake valve body so that the prick punch markings, put on before disassembly, (par. 72a), match. Place long cap screw into the hole for which a marking had been made. Install six cap screws, lock washers, and nuts attaching cover to body. Place long and short bolts alternately. Tighten securely.

b. Install Inlet-And-Exhaust Valve Assembly (figs. 100 and 102). Replace original shims in recess at bottom of body. Install inlet-and-exhaust valve assembly in the brake valve body, with spring and exhaust valve entering the body first. Position grommet in place against inlet valve seat. Position inlet body and install three lock washers and nuts. Tighten evenly and carefully.

c. Install Treadle Assembly (fig. 102). Put roller in place and push roller pin through bushings of treadle assembly. Secure with a cotter pin. Position treadle assembly and install treadle pin, being sure the cotter pin hole in the pin lines with the hole in the treadle, then install cotter pin.

75. Test

Refer to paragraph 60 for procedure.

76. Trouble Shooting

a. Brake valve does not release promptly or does not fully release.

(1) Adjusting screw is screwed out too far, causing the roller on the treadle or lever to exert too much force against the spring cage when the brake is released. Insert a 0.109-inch gage between the treadle (or lever) roller and the cap on the spring cage and turn the adjusting screw until the valve delivers 5 to 7 pounds air pressure; then lock the adjusting screw.

(2) Insufficient shims are being used between the inlet valve seat and the body of the brake valve. Proceed as in *b* (1) and (2) below.

b. Brake valve does not apply promptly or does not fully apply. An insufficient opening of inlet valve, due to too many shims between inlet valve seat and brake valve body, is indicated. Check valve adjustment as follows:

- (1) Place a depth gage against the inlet valve by inserting the gage through the reservoir supply port in the inlet valve body.
- (2) Apply the brake and measure the maximum inlet valve travel. The travel should be 0.148-inch minimum to 0.156-inch maximum. Add shims between the inlet valve seat and the body of the brake valve to decrease the travel. Remove shims to increase the travel. Adding shims increases the exhaust valve opening, when the brake is released and decreases inlet valve

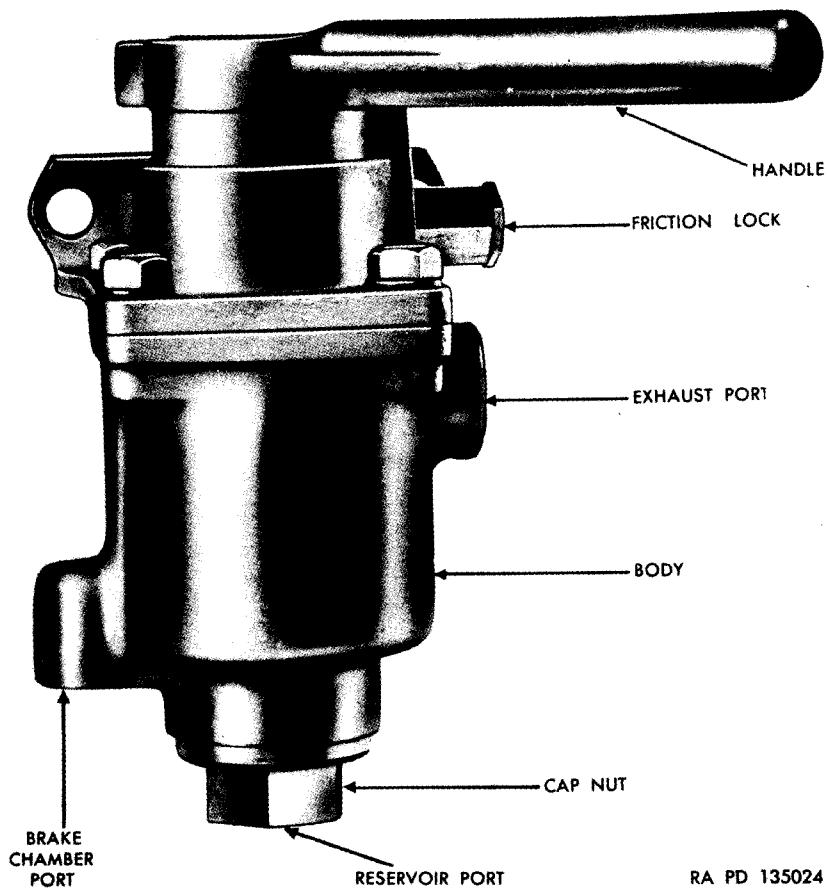


Figure 103. Type HP brake valve.

opening when the brake is applied. Removing shims decreases the exhaust valve opening when the brake is released and increases the inlet valve opening when the brake is applied.

c. Pressure delivered by brake valve does not vary in accordance with position in which lever or treadle is held. Check bleed hole to cavity immediately below diaphragm. Hole must be unobstructed.

Section V. TYPE HP BRAKE VALVE

77. Description and Operation

a. *Description* (fig. 103). Type HP brake valves are used for controlling the brakes on a trailer independently of the brakes on the towing vehicle. They are usually mounted on the steering column or on the instrument panel and the driver may put the handle in any one of several positions between released and fully applied so that the brakes on the trailer are kept applied until the brake valve handle is returned to released position. The distance the brake valve handle is moved in a

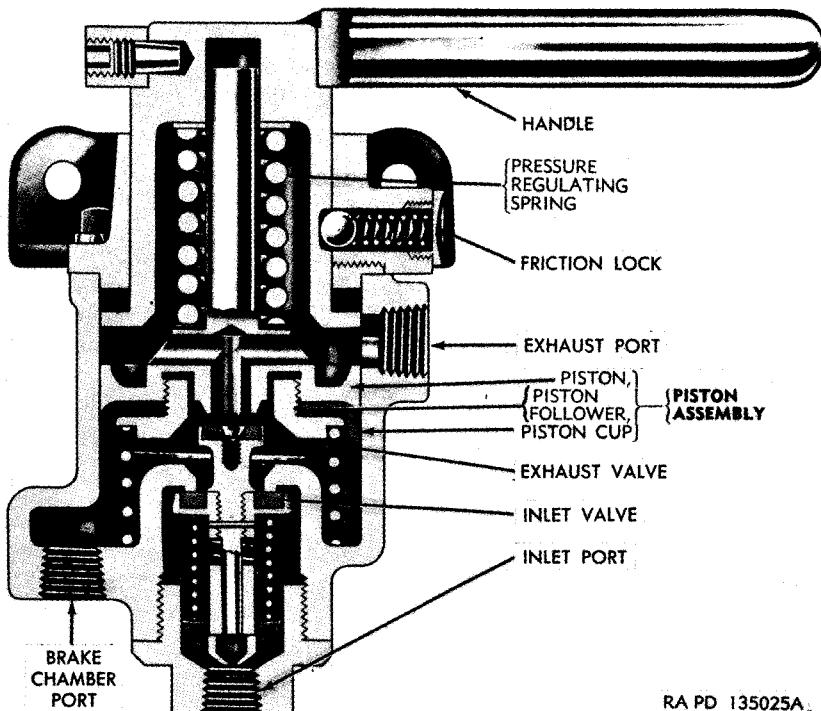


Figure 104. Sectional view—type HP brake valve.

clockwise direction toward applied position determines the force of the brake application.

b. Operation (fig. 104).

- (1) As the handle of the brake valve is moved toward applied position, a force is exerted on the top of the pressure regulating spring and the piston assembly moves downward. When this happens, the exhaust valve seat engages the exhaust valve and closes the passage to the exhaust port. The exhaust valve and the inlet valve are part of the same assembly; therefore, after the exhaust valve is closed and the piston assembly continues its movement downward, the inlet valve is forced off its seat. This permits air pressure from the reservoir to pass through the inlet valve and out the connection leading to the service line and the brakes on the trailer.
- (2) As soon as the air pressure below the piston assembly overcomes the mechanical force on top of it, the piston assembly lifts, the intake valve closes, cutting off any further air supply, and the exhaust valve remains closed, preventing any loss of air pressure through the exhaust port. Any further movement of the handle toward fully applied position adds additional mechanical force on top of the piston assembly and correspondingly increases the delivered air pressure.
- (3) If the brake valve handle is moved toward released position, the mechanical force on top of the piston assembly is decreased. This permits the air pressure below the piston assembly to lift it slightly, thus opening the exhaust valve and permitting air pressure to exhaust from the service line until a lower air pressure is established to balance the lesser mechanical force acting on top of the piston assembly.
- (4) In this manner, the brake application on the trailer may be graduated during both application or release of the brakes and the position of the brake valve handle always determines the air pressure being delivered through the service line to the trailer brake equipment.
- (5) The handle of the brake valve is fitted with a friction lock so it will remain in whatever position it is placed by the driver. The brake valve should never be used, however, to hold the brakes applied when vehicles are being parked or when the driver is off duty. If the vehicles are parked on a hill or grade, other precautions, such as blocking the wheels, must be taken as there is a possibility that leakage in the system may eventually reduce the air pressure sufficiently to release the brakes.

78. Disassembly

- a. Remove set screw from handle and lift handle from spring cage (fig. 106).
- b. Remove plug holding friction lock parts and remove spring, plunger, lock body, and ball from cover (fig. 106).
- c. Remove cover by removing four cap screws and lock washers which secure cover to body (fig. 106). Remove washer, pressure regulating spring, and shims from piston (fig. 106). Pull piston assembly out of body and lift out exhaust valve spring (fig. 106). Remove spring cage from cover.
- d. Disassemble piston assembly by engaging slots in piston follower with a steel bar held in a vise and unscrew piston using a steel rod (fig. 105). Remove piston follower and piston cup (fig. 106).
- e. Remove cap nut from body and lift out inlet-and-exhaust valve and inlet valve spring (fig. 106).

79. Cleaning, Inspection, and Repair

- a. *Cleaning.* Wash all metal parts with dry-cleaning solvent or volatile mineral spirits.

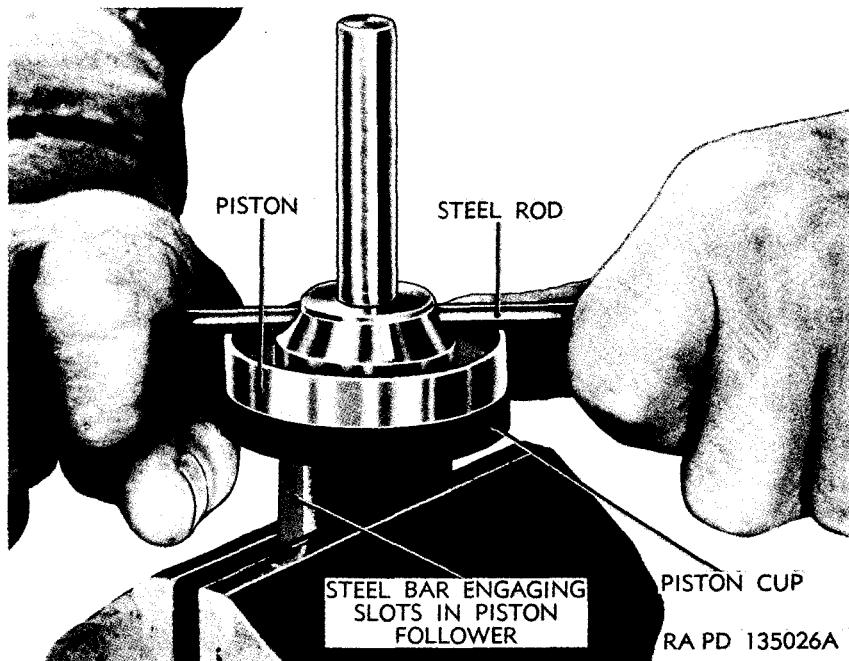


Figure 105. Disassembly of piston assembly.

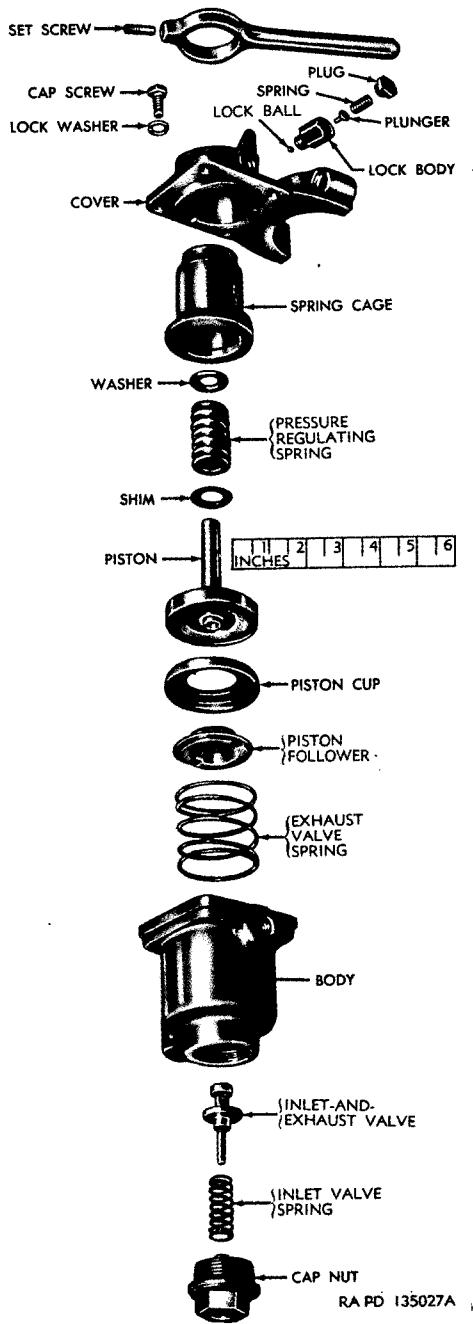


Figure 106. Type HP brake valve—exploded view.

b. Inspection and Repair.

- (1) *Piston bore.* Check piston bore in body for scoring or other damage. Check bore diameter. If diameter exceeds 2.133 inches, replace body. Replace body if bore is 0.004-inch out-of-round.
- (2) *Piston fit.* Piston must be a sliding fit in body.
- (3) *Piston cup.* Check condition of piston cup. Replace, if worn thin or if the sharp edges are damaged.
- (4) *Valve seats.* Check inlet-and-exhaust valve assembly to be sure rubber seats are in good condition. Do not attempt to replace seats. Replace complete valve assembly, if seats are damaged.

80. Assembly

a. *Inlet-And-Exhaust Valve Assembly* (fig. 106). Place inlet valve spring and valve assembly in cap nut, with rubber seats toward top of valve. Install cap nut and tighten securely.

b. *Piston* (fig. 106). Place piston cup on piston and install piston follower. Tighten follower with steel bar and rod (fig. 105) sufficiently to make a good air seal on piston cup, but not enough to distort cup.

c. *Install Piston Assembly* (fig. 106). Lubricate piston cup with graphite grease (soft), position exhaust valve spring in body and enter piston into body over exhaust spring. Extreme care must be used when installing piston assembly as piston cup is easily damaged. Install shim or shims, pressure-regulating spring, and place washer over piston stem and on spring.

d. *Install Cover* (fig. 106). Enter spring cage in cover and place cover in position on body over piston. Position cover so mounting bracket is at rear when brake chamber port is at left (fig. 103). Install four cap screws and lock washers and tighten securely.

e. *Friction Lock* (fig. 106). Install lock body and tighten. Place lock ball, plunger, and spring in body. Install and tighten plug.

f. *Handle* (fig. 106). Place handle in position on spring cage and secure with set screw.

81. Test and Adjustment

a. *Test.* Refer to paragraph 60 for test procedure. Brake valve must deliver at least 60 pounds pressure when handle is in fully applied position. Brake valve must graduate delivery pressure as the position of handle is varied.

b. *Adjustment.* If the delivered pressure is below 60 pounds with the brake valve handle in fully applied position, additional shims may be needed beneath the pressure-regulating spring. If this does not correct the condition, the pressure-regulating spring must be replaced. Care must be used in installing shims to be sure the exhaust valve opening is not reduced sufficiently to cause slow release.

Section VI. TYPE TC BRAKE VALVE

82. Description and Operation

a. *General.* The TC valve (fig. 107), like the HP valve, is a device which permits independent and optional driver control of trailer brakes. Except for refinements in body and mechanical details, the general description of the TC valve is same as for the HP valve (par. 77a). The valve usually is mounted on the steering column or on the instrument panel, convenient to driver or operator.

b. *Description* (fig. 108). The TC valve consists essentially of a piston which divides interior of valve into two separate chambers. The chamber above piston is always open to atmosphere, while the lower chamber may or may not be subject to reservoir pressure. The position of piston

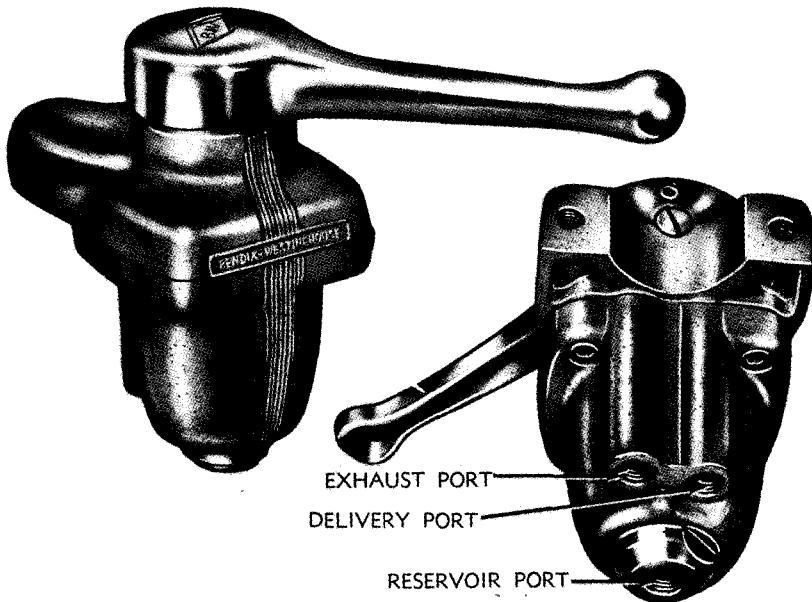
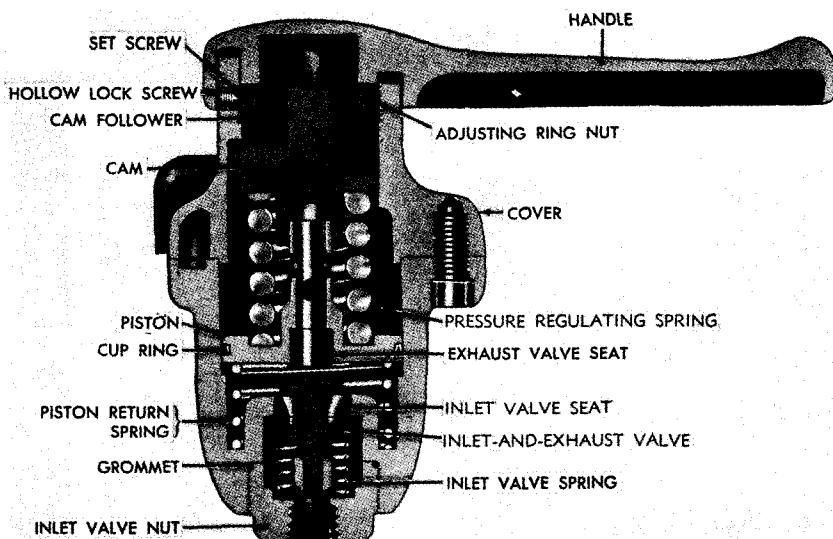


Figure 107. TC brake valve.

is determined by position of operating handle. The nonrigid connection between piston and handle, through a spring, automatically maintains a selected pressure to the trailer brakes.

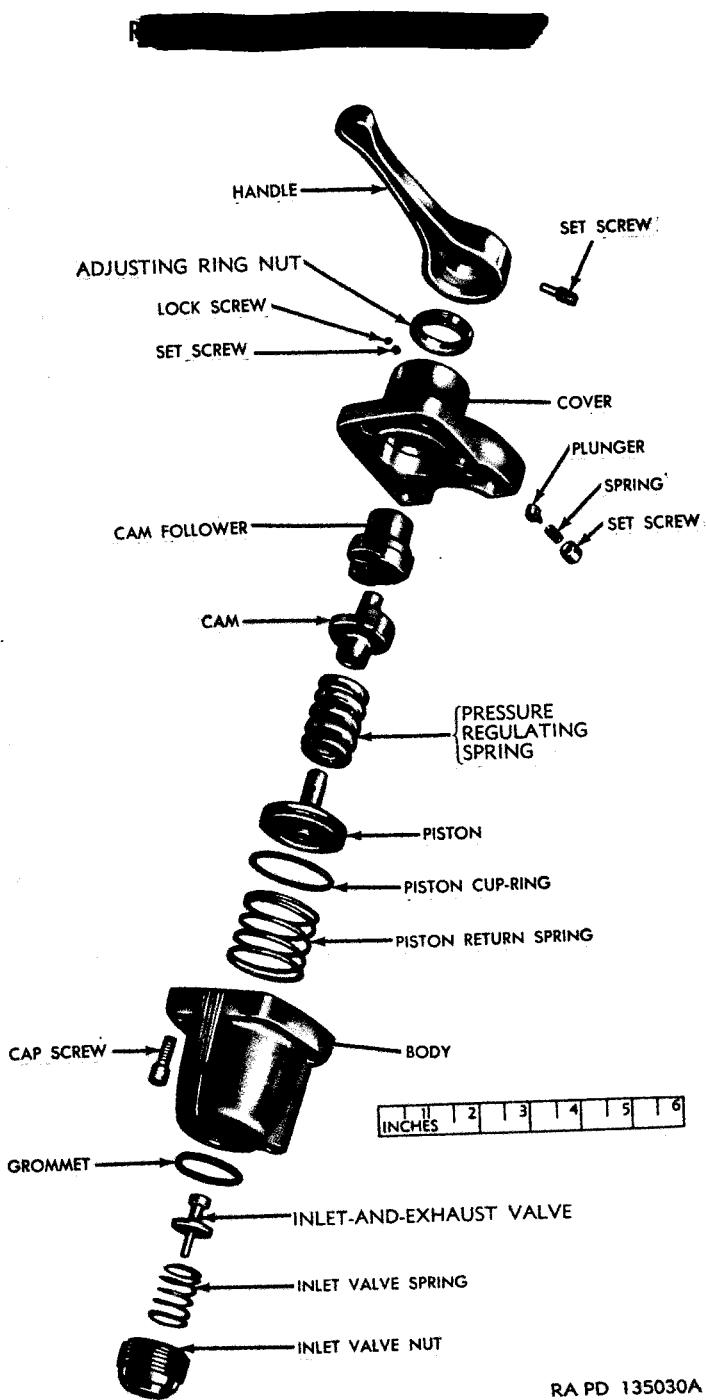
c. *Operation* (figs. 107 and 108).

- (1) *Ports*. The three ports in this valve are shown in figure 107. Air line from main reservoir is connected to port in inlet valve nut. The port marked "DELIVERY" opens from lower chamber and is connected to trailer service line. Upper chamber opens into exhaust port and exhaust air may be conducted, by tubing, to a convenient outlet outside of driver's compartment or permitted to exhaust at valve proper.
- (2) *Released position*. Figure 108 shows valve in released position. The inlet valve is closed and is held in that position by inlet valve spring and reservoir air pressure in the cavity below valve. Piston is held in its upper position by piston return spring. In this position, air pressure from service line is exhausted from lower chamber, through hollow piston stem, into upper chamber and out through exhaust port.
- (3) *Applying brakes*. Operating handle is fixed to a cam follower which is free to rotate in cover. The lower face of follower engages the upper face of cam. Two projections on side of cam



RA PD 135029A

Figure 108. Sectional view—TC brake valve.



RA PD 135030A

Figure 109. TC brake valve—exploded view.

engage slots in cover. This permits axial movement of cam and prevents its rotation. When handle is moved in clockwise direction, the opposing cam surfaces force pressure-regulating spring and piston downward. This downward motion seats the exhaust seat in piston against exhaust valve and closes passage through hollow piston stem. Further downward motion opens inlet valve and admits reservoir pressure to lower chamber and to trailer service line. Lower surface of piston is subject to air pressure admitted to trailer, plus the force of return spring. This combined force is resisted by the pressure-regulating spring until it becomes sufficient to lift piston and allow inlet valve to close. As the pressure necessary to lift piston increases with the distance the pressure-regulating spring must be compressed, the brake pressure delivered to trailer may be varied in any number of steps, between minimum and maximum, by movement of handle from right to left. This control also permits brake pressure to be increased or decreased by movement of handle.

(4) *Releasing brakes.* Moving handle to limit of its travel to the right permits piston return spring to raise piston to its upper limit. This permits intake valve to close and opens exhaust passage through hollow piston stem into upper chamber and to atmosphere through exhaust port.

d. Preparation for Rebuild.

- (1) When condition of brake valve is unknown, it should be subjected to operating tests (par. 60) before disassembly. If valve meets requirements, it will be returned to service without disassembly.
- (2) Each year, or after each 50,000 miles, brake valves will be completely disassembled, cleaned, and rebuilt.

83. Disassembly

(figs. 108 and 109)

- a. Remove set screw from handle and remove handle.
- b. Remove inlet valve nut and lift out inlet valve spring, inlet-and-exhaust valve, and grommet.
- c. Remove set screw, spring, and plunger from rear of upper portion of cover. Plunger is lifted out with spring or may be jarred out with hand.
- d. Loosen cap screw evenly, while holding cover and body together, and remove screws. Separate body and cover and remove pressure-regulating spring.

e. Lift out cam and cam follower.

f. Pull piston from body and remove piston return spring.

Note. Do not remove or loosen adjusting ring nut. Necessary adjustment of this nut is made during test.

84. Cleaning, Inspection, and Repair

a. *Cleaning.* Wash all parts with dry-cleaning solvent or volatile mineral spirits. Blow out passages with compressed air.

b. *Inspection.*

- (1) Examine cover and body for cracks and broken parts. Examine pilot on face of cover for dents. Place cover on body and test fit of pilot in body.
- (2) Examine bore in body for scoring or scratches. If wall is scored, replace body. Minor scratches which can be felt with finger may be polished out with crocus cloth. This bore must be smooth to prevent damage to piston.
- (3) Check outside diameter of piston for rough spots. Examine piston cup ring. If ring is pliable and shows no wear, do not remove. Check fit of piston stem in cam. Fit must be free.
- (4) Examine inlet-and-exhaust valve for damage. If inserted valve seats are grooved or uneven, replace valve. Check fit of valve in cap nut. Valve stem must slide freely, without binding.
- (5) Examine inlet valve seat in body and exhaust valve seat in piston. If the contact surfaces of the seats are grooved or show signs of erosion, replace damaged seat.
- (6) Check springs for any evidence of distorted coils or cracks and replace defective springs.
- (7) Check cam and cam follower for scoring or deep scratches. Remove any raised metal with fine mill file.

c. *Repair.* Repairs consist of replacement of defective parts.

- (1) *Inlet valve seat.* Press damaged seats out from inside body. Replacement seats of 0.010- and 0.020-inch oversize are available. Position the replacement seat in body and press into place with a short tube of a diameter that will clear the projecting valve seat. Do not exert pressure directly on contact surface of seat.
- (2) *Exhaust valve seat.* To remove exhaust valve seat, run a $\frac{3}{8}$ -inch tap into hollow seat at least $\frac{3}{8}$ inch deep. Insert a short piece of round stock against end of tap and press out. Replacement seats 0.010- and 0.020-inch oversize are available. Support piston carefully when pressing replacement in.

~~DETERMINED BY INSPECTION~~

85. Assembly

(figs. 108 and 109)

- a. Coat interior surfaces of cover and body with aircraft and instruments grease (GL).
- b. Place piston return spring in body. If new piston cup ring is necessary, install it with open end of U toward bottom. Coat piston and ring with aircraft and instruments grease (GL) and carefully insert piston, without damage to cup ring.
- c. Insert plunger in rear of upper portion of cover. Note that "V" edge of plunger must be parallel with axis of cover. Install lock spring and set screw. Turn screw in until plunger extends into cover about one-sixteenth inch.
- d. Aline a notch in cam follower with plunger and insert follower in cover. Place handle in position and secure with set screw.
- e. Coat cam with aircraft and instruments grease, aline projections with slots in cover, and install.
- f. Place pressure-regulating spring on piston and assemble body and cover. Install cap screws and tighten evenly.
- g. Install new grommet below inlet valve nut threads. Place inlet valve spring in inlet valve nut. Grease inlet valve stem and insert it in cap nut. Hold valve assembly vertical, insert exhaust valve through valve seat in body, and install inlet valve nut, spring, and inlet-and-exhaust valve. Tighten nut securely.

86. Test and Adjustment

- a. *Test.* Refer to paragraph 60 for test procedure. The TC brake valve must deliver at least 85 pounds pressure when handle is in fully applied position and at least 5 pounds pressure when handle is first moved from released position. The valve must graduate delivery pressure as the position of handle is varied.

- b. *Adjustment.*

- (1) *Handle movement.* The spring plunger, located in upper rear of valve cover, engages a groove in cam follower when handle is in released position. Tighten lock spring set screw just enough to require a trifle more effort to move handle out of released position than to move it through remaining travel. This arrangement is to prevent accidental brake application. Guard against tightening set screw so that plunger does not clear cam when handle is in applied position.

[REDACTED]

(2) *Delivery pressure.* Delivery pressure is adjusted by adjusting ring nut in top of cover (fig. 108). To adjust pressure, remove handle (par. 83a). Adjusting ring nut is locked in position by a No. 10-24 socket-head, cone-point-set-screw and a No. 10-24 hollow lock screw. Remove hollow lock screw and loosen set screw until it clears ring nut. With a small drift or punch, nut can be turned clockwise to increase and counterclockwise to decrease delivery pressure. Six notches are cut in ring nut threads. In adjustment, nut must be turned until a notch alines with lock screw, otherwise threads will be damaged. This adjustment is critical. Test pressure at each change of one notch in ring nut. Secure ring with lock screw after adjustment.

CHAPTER 7

QUICK RELEASE, RELAY, AND RELAY-EMERGENCY VALVES

Section I. QUICK RELEASE VALVE

87. Description and Operation

a. Description. The purpose of the quick release valve (fig. 110) is to reduce the time required to release the brakes by hastening the exhaust of air pressure from the brake chambers. It is most commonly used with front wheel brake chambers. The valve consists of a body containing a spring-loaded diaphragm so arranged as to permit air pressure to flow through the valve in one direction. When the supply is reduced, the air which has passed through the valve is permitted to escape through the exhaust port.

b. Operation (fig. 111).

(1) The quick release valve assumes three positions during normal operation. These three positions are the applying position (when air pressure is passing through the valve into the brake chambers), the holding position (when pressure is being held

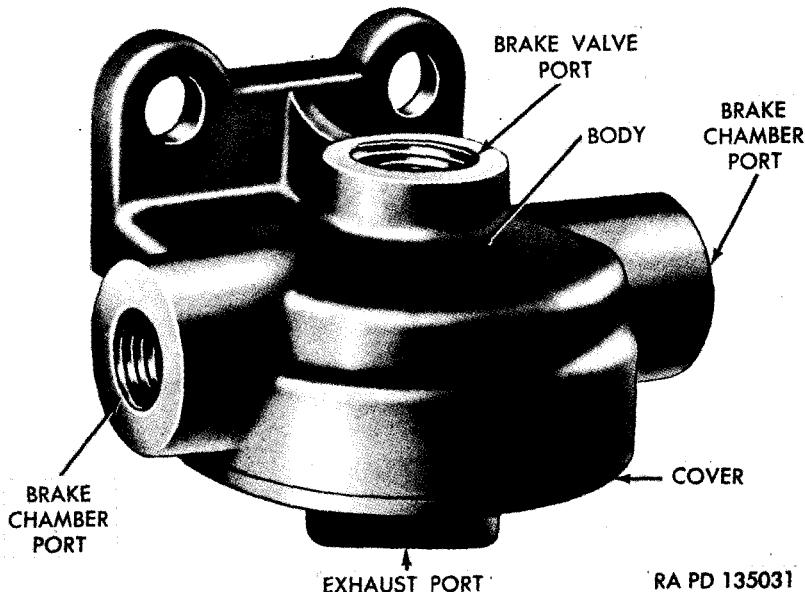
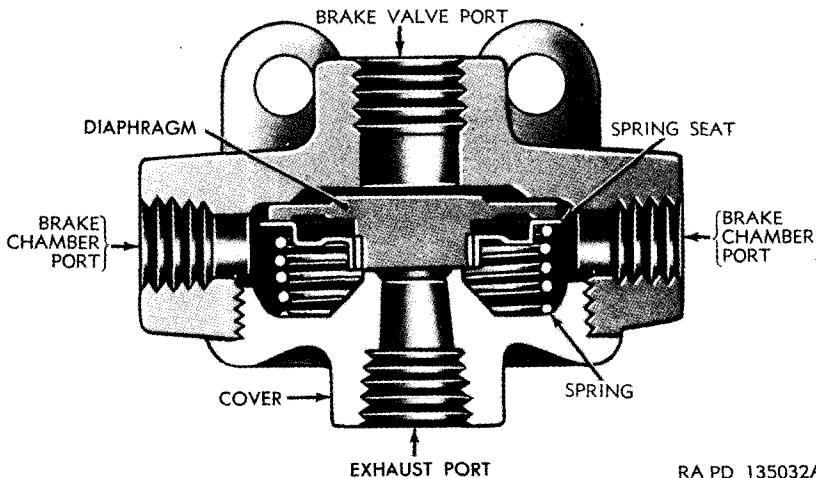


Figure 110. Quick release valve.

in the brake chambers), and the releasing position (when brake chamber pressure is being exhausted).

- (2) When air pressure from the brake valve enters the top connection of the valve, the diaphragm moves down and closes the exhaust port. Air pressure then deflects the outer edges of the diaphragm and flows out the side connections to the brake chambers, applying the brakes.
- (3) As soon as the brake chamber pressure below the diaphragm equals the brake valve pressure above the diaphragm, the force of the spring below the diaphragm forces the outer edge of the diaphragm back up against the body, although the center of the diaphragm keeps the exhaust port closed. This is the holding position.
- (4) If the brake valve pressure on top of the diaphragm is reduced, the brake chamber pressure below the center of the diaphragm raises it. This opens the exhaust port and permits brake chamber pressure to be released through the exhaust port.
- (5) If the brake valve pressure on top of the diaphragm is only partially released, the diaphragm assumes its holding position as soon as the pressure above and below it are equalized.
- (6) In this manner, the quick release valve reacts to pass any increased brake valve pressure through it to the brake chambers or to quickly release the brake chamber pressure when the



RA PD 135032A

Figure 111. Sectional view quick release valve.

brake valve pressure is reduced. It thus maintains the same pressure in the brake chambers as the brake valve is delivering.

88. Disassembly

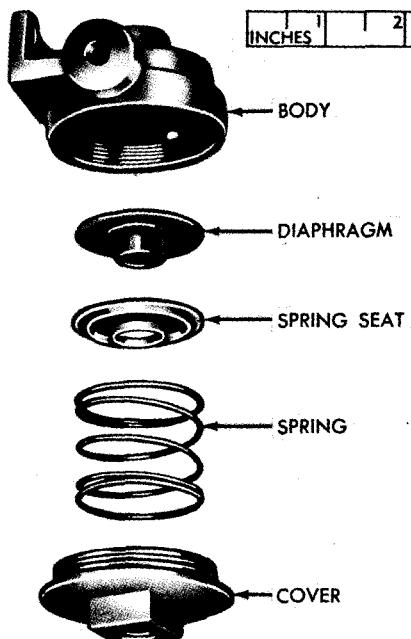
Unscrew cover from body and lift out diaphragm, spring seat, and spring (fig. 112). Older style valves contained a dampener which is to be discarded from the assembly.

89. Cleaning, Inspection, and Repair

a. Cleaning. Wash metal parts with dry-cleaning solvent or volatile mineral spirits.

b. Inspection.

- (1) Examine diaphragm for signs of cracking, wear, or damage. Carefully examine the lower face of the diaphragm which contacts the exhaust port seat in the cover for signs of pitting or grooving. Replace diaphragm, if any of these conditions are found.



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Figure 112. Quick release valve—exploded view.

(2) Inspect condition of exhaust port seat on cover for signs of pitting. The seat must be smooth and flat.

c. *Repair.*

(1) If the exhaust port seat shows scratches or pitting, it can sometimes be repaired by carefully smoothing the seat, using a flat plate and a piece of fine aluminum oxide cloth (fig. 113).
(2) Replace all defective and broken parts.

90. Assembly

(fig. 112)

a. Assemble diaphragm on spring seat.
b. Place diaphragm assembly in body and install spring and cover. Tighten cover securely.

91. Test

a. *Test Procedure.* Refer to paragraph 60b for preparation of test bench.

b. *Test Specifications.*

(1) The quick release valve must respond promptly, when brakes are released, by exhausting air pressure through exhaust port.
(2) When tested with soap suds leakage at exhaust port, with valve delivering pressure, must require more than 1 second to pro-



Figure 113. Smoothing exhaust port seat.

duce a 1-inch soap bubble. If greater leakage at the exhaust port is discovered, disassemble (par. 88) and repair (par. 89c).

(3) Leakage at any other point, when delivering pressure, is not permissible.

Section II. RELAY VALVES

92. Description and Operation

a. The relay valve speeds up the application and release of the rear wheel brakes. It is controlled by the brake valve and keeps the air pressure in the rear brake chambers the same as the pressure being delivered by the brake valve. It reacts to even slight changes in pressure and raises, lowers, or completely exhausts the air pressure in the rear brake chambers as the brake valve raises, lowers, or completely exhausts air pressure from it. Two types of relay valves will be found in service—type R (fig. 114) and type R-1C (fig. 115). The valves differ in construction but both types answer the above description. Type R can be

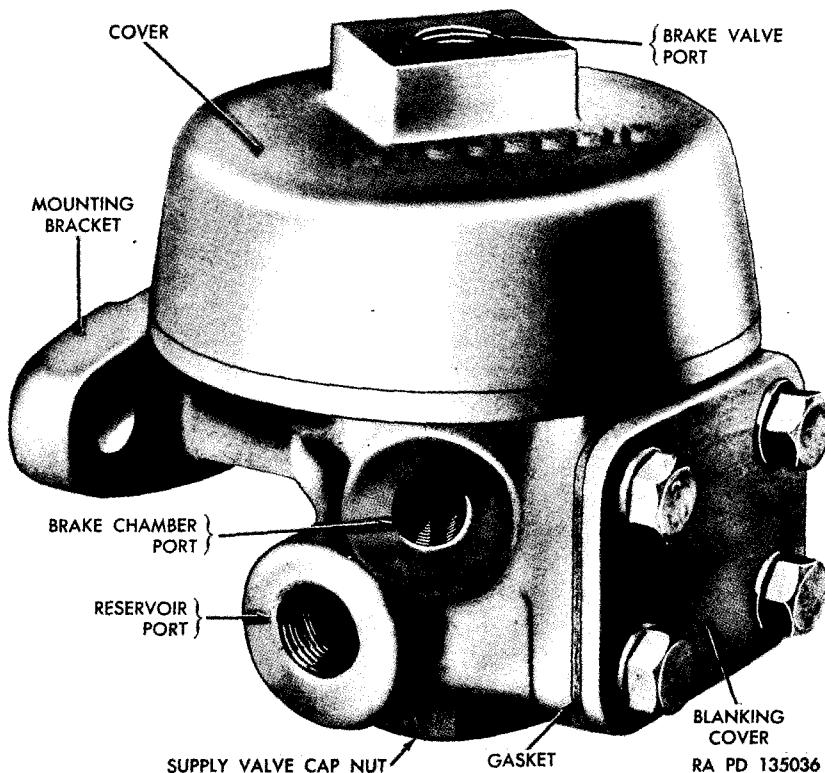


Figure 114. Type R relay valve.

identified by the threaded cover and brake chamber ports in the body. Type R-1C has a bolted cover and brake chamber ports are in an attached adapter.

b. *Operation* (figs. 116 and 117).

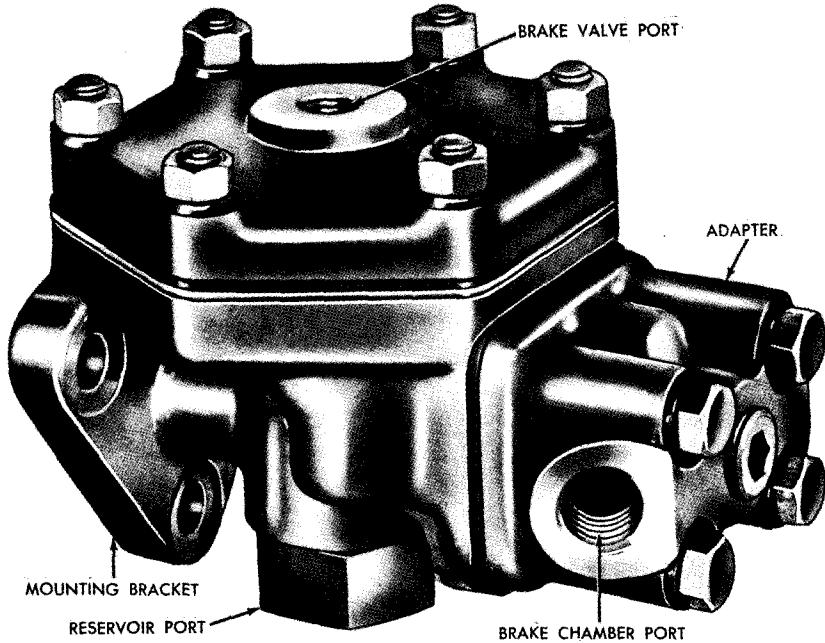
(1) *General*. Although the valves are constructed differently, their operation is identical. Air pressure delivered by the brake valve controls operation of relay valve. Air pressure from brake valve enters a cavity above diaphragm. Because this cavity is small, it is subject to quick changes in air pressure and the action of valve in changing its delivered pressure is, therefore, very rapid.

(2) *Operation*. The valve mechanism assumes four positions during normal operation. They are—

Released position. When there is no air pressure in brake chambers.

Applying position. When valve is delivering air pressure to brake chambers.

Holding or balanced position. When valve is maintaining a constant pressure to brake chambers.



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Figure 115. Type R-1C relay valve.

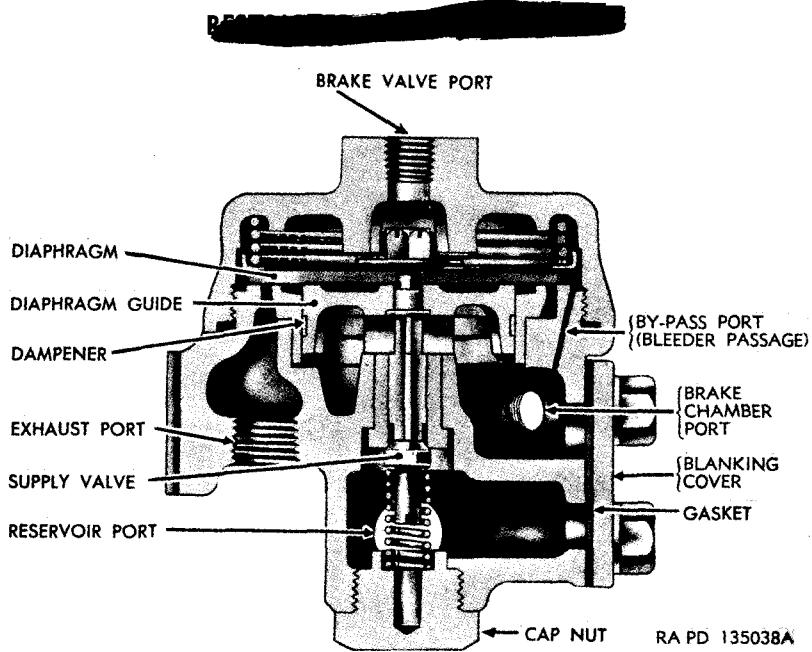


Figure 116. Sectional view type R relay valve.

Releasing position. When the valve is releasing air pressure from brake chambers.

- (a) *Released position.* Reservoir pressure is in the cavity below supply valve, which is closed. Diaphragm is in normal position resting upon diaphragm guide.
- (b) *Applying position.* When the brake valve is applied, it sends air into the cavity above the diaphragm and the pressure depresses the diaphragm. The diaphragm thus seals the annular exhaust port beneath its outer edge and its center is deflected, forcing the diaphragm guide and the supply valve down. This opens the supply valve and allows air pressure from the reservoir to flow through the supply valve and into the cavity below the diaphragm which is connected to the brake chambers. With the mechanism in this position, air pressure is flowing directly from the reservoir through the relay valve into the brake chambers, applying the brakes.
- (c) *Holding or balanced position.* As soon as the air pressure below the diaphragm equals the air pressure above the diaphragm, force of the supply valve spring lifts the center of diaphragm and closes the supply valve. This limits the air pressure being delivered to the brake chambers by the

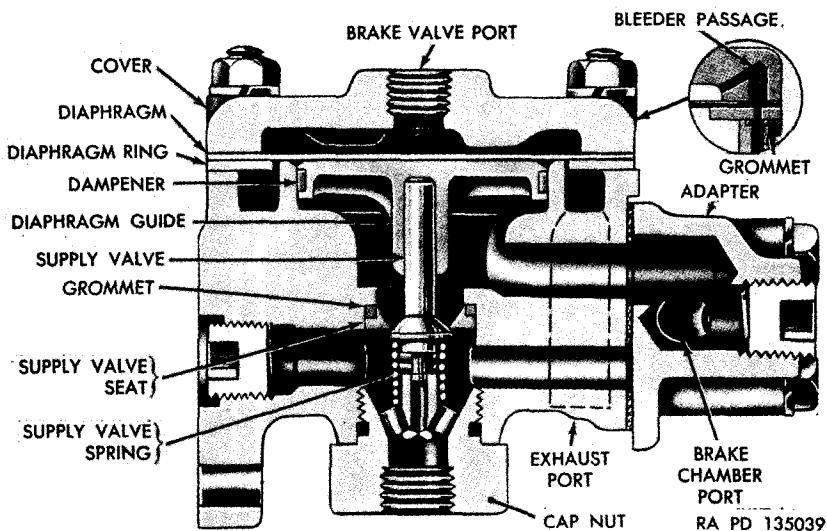


Figure 117. Sectional view type R-1C relay valve.

relay valve to the same pressure as that being delivered by the brake valve to the relay valve. In this position the supply valve is closed and the force of air pressure on top of the diaphragm keeps the outer portion of the diaphragm down, sealing the exhaust port. Thus, the valve is in its balanced position, maintaining the same air pressure in its brake chambers as the brake valve is delivering to it. An increase in brake valve pressure repeats the action (as in the applying position) until the higher pressure in the brake chambers is again established. The purpose of the bypass port or bleeder passage in the valve is to assure that air pressure delivered to the brake chambers is exactly the same as air pressure delivered by the brake valve to the relay valve.

(d) *Releasing position.* If brake valve pressure above the diaphragm is reduced, the brake chamber pressure below the diaphragm overcomes it and lifts the diaphragm. This opens the exhaust port under the outer edge of the diaphragm, permitting the pressure in the brake chamber to exhaust until a lower balanced pressure is reached. If air pressure delivered by the brake valve collapses entirely, the relay valve releases all pressure from its brake chambers, full releasing the brakes, and the valve returns to its released position.

c. *Preparation for Rebuild.* Perform leakage and operation tests (par. 96). If valve meets tests, it will be returned to service.

Note. Regardless of valve condition, every year or after every 50,000 miles, it will be disassembled, cleaned, and assembled with new diaphragm, gasket, and grommets.

93. Disassembly of Type R Relay Valve

a. Unscrew cover and lift out spring and spring seat (figs. 118 and 126). Remove cover gasket (figs. 118 and 126).

b. Using fingers, lift outer edge of diaphragm and pull out diaphragm assembly and dampener (fig. 119).

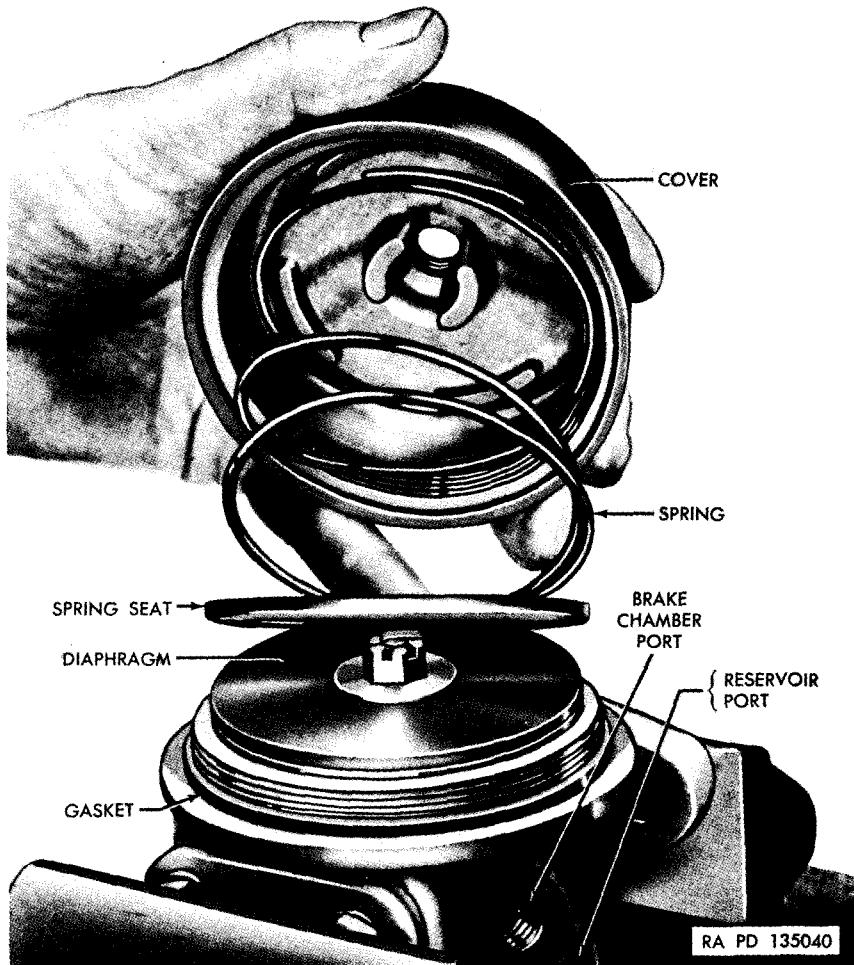


Figure 118. Removing cover.

c. Remove cotter pin from diaphragm screw (fig. 126). Unscrew nut and lift washer, diaphragm, and diaphragm guide off diaphragm screw (fig. 126).

d. Unscrew supply valve cap nut and remove spring and supply valve (fig. 126).

e. Remove four cap screws and lock washers attaching blanking cover and lift off cover and gasket (fig. 126).

94. Cleaning, Inspection, and Repair

a. Cleaning. Wash all metal parts with dry-cleaning solvent or volatile mineral spirits.

b. Inspection.

- (1) *Diaphragm.* Replace any used diaphragm with a new diaphragm.
- (2) *Diaphragm guide.* Check fit of diaphragm guide in diaphragm guide bushing of the body. It must be a free sliding fit.
- (3) *Diaphragm dampener.* Check condition of diaphragm dampener. When lying on a flat surface, the ends of the dampener

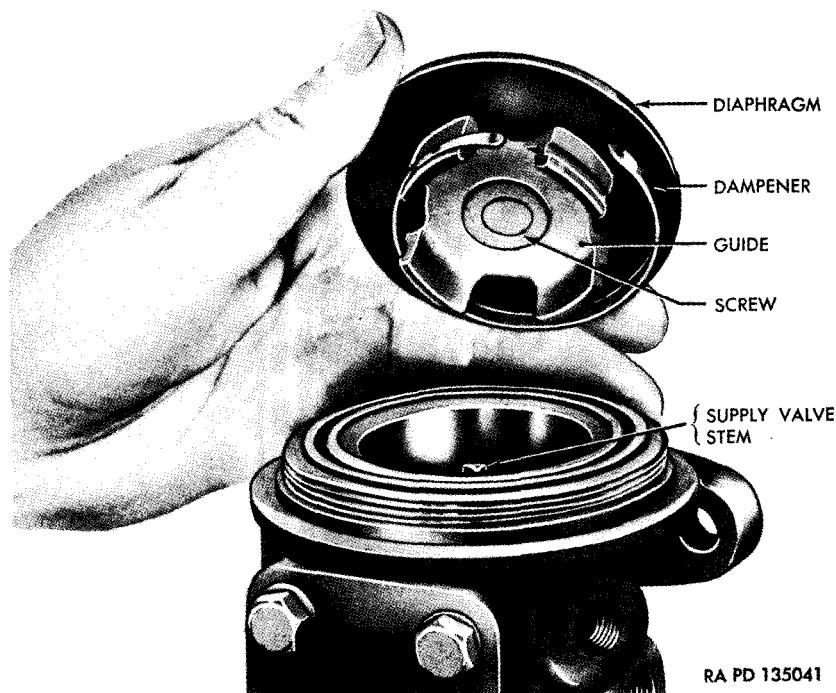


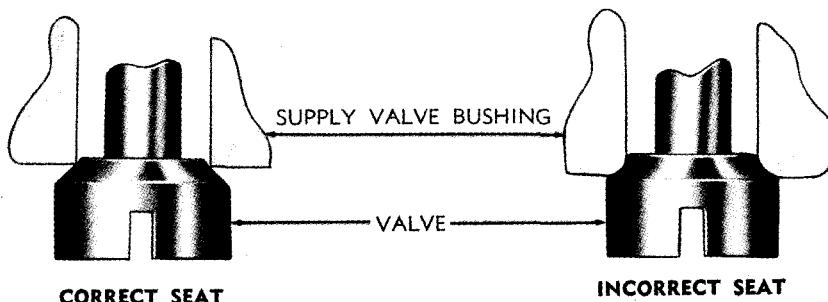
Figure 119. Removing diaphragm and guide assembly.

must not be in line like the ends of a piston ring but twisted so one end is about $\frac{3}{8}$ inch higher than the other.

- (4) *Diaphragm guide bushing.* If the diaphragm guide bushing is damaged or loose, no attempt should be made to replace it. Use a new body complete with bushing.
- (5) *Supply valve and seat.* Inspect condition of supply valve and seat (fig. 120). Check fit of supply valve in supply valve bushing. It must be a sliding fit. If valve or valve seat (valve bushing) is worn, it must be replaced.
- (6) *Diaphragm seat.* Inspect diaphragm seat on top edge of body and diaphragm guide bushing. Seat must be smooth, flat, and free from dents or scratches.

c. *Repair.*

- (1) *Diaphragm seat.* If diaphragm seat on top of body and guide bushing is only slightly scratched or dented, repair by smoothing the body on a flat plate covered with very fine aluminum oxide abrasive cloth (fig. 121).
- (2) *Supply valve and seat.*
 - (a) If the supply valve and seat are not too badly worn (fig. 120), repair by carefully grinding (lapping) the valve to its seat, using reciprocating valve grinding tool 41-T-3381-15 with valve grinding bit 41-B-660 (fig. 1) and valve grinding compound (fine), as shown in figure 122. *Do not use ordinary valve grinding compound.*
 - (b) Worn supply valves or supply valve bushings must be replaced. A worn bushing is pressed or driven out through the bottom of the body. A new bushing must be pressed into place. After being pressed into place, the bushing must be



RA PD 182856

Figure 120. Correct and incorrect valve seats.

reamed with intake valve reamer 41-R-834 (fig. 2) and intake valve seat reamer 41-R-2178 (fig. 3). When using seat reamer 41-R-2178 (fig. 123), only the sharp corner of the supply valve seat must be removed. After reaming, a new valve must be ground (lapped) to the seat ((a) above).

(c) After grinding (lapping), clean the supply valve and seat thoroughly with dry-cleaning solvent or volatile mineral spirits and test for leakage. To test for leakage, install supply valve, spring, and cap nut. Then install blanking cover and gasket. Plug one reservoir port and connect an air line with 100 pounds air pressure to the reservoir port. Test for leakage by applying soap suds around the top of the supply valve stem (fig. 124) and evaluate leakage. Leakage which forms a 1-inch soap bubble in less than 3 seconds is not permissible and must be corrected by again grinding (lapping) the valve to its seat ((a) above). Sometimes leakage is reduced by tapping the top of the supply valve stem several times with a light rawhide hammer while the air pressure remains applied.



Figure 121. Smoothing diaphragm seat.

(d) After leakage has been reduced to the maximum permitted, place diaphragm screw in diaphragm guide and place diaphragm guide in body. Use a straightedge (fig. 125) to check the alignment of the center and edges of the diaphragm guide with the diaphragm seat on the body. The top of the diaphragm guide must not be above the top of the diaphragm seat; otherwise, when the relay valve is assembled, the supply valve will be held off its seat and leakage will occur.

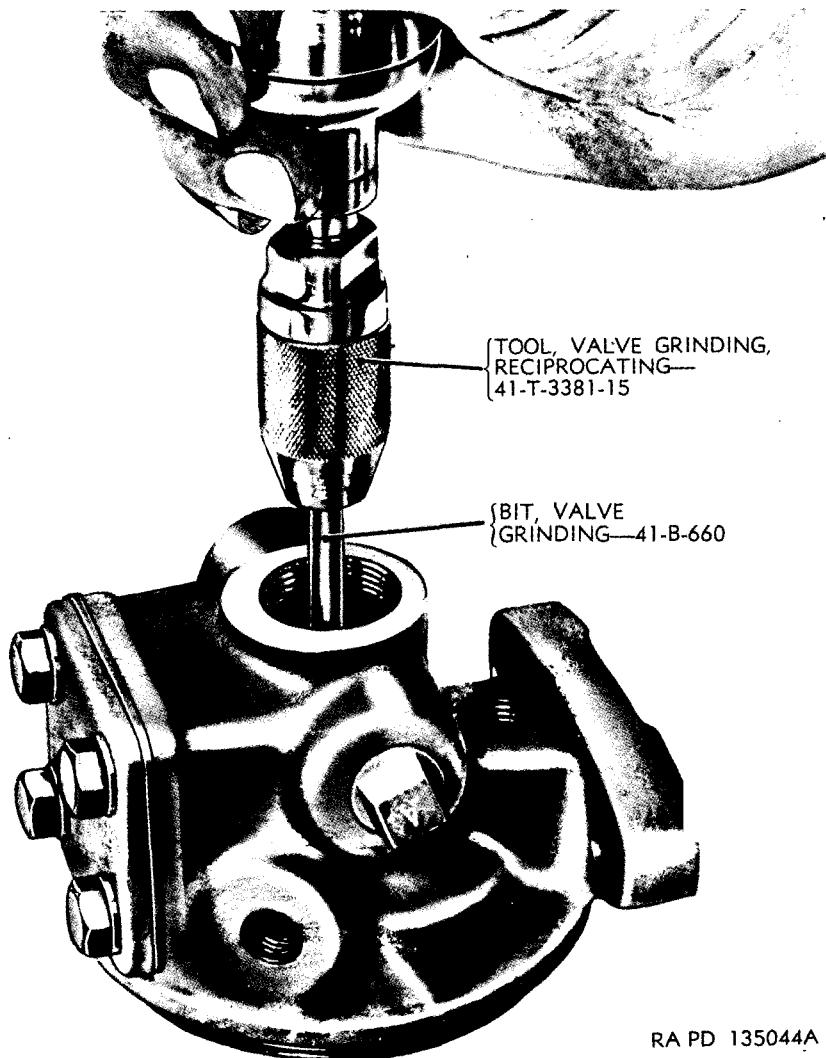
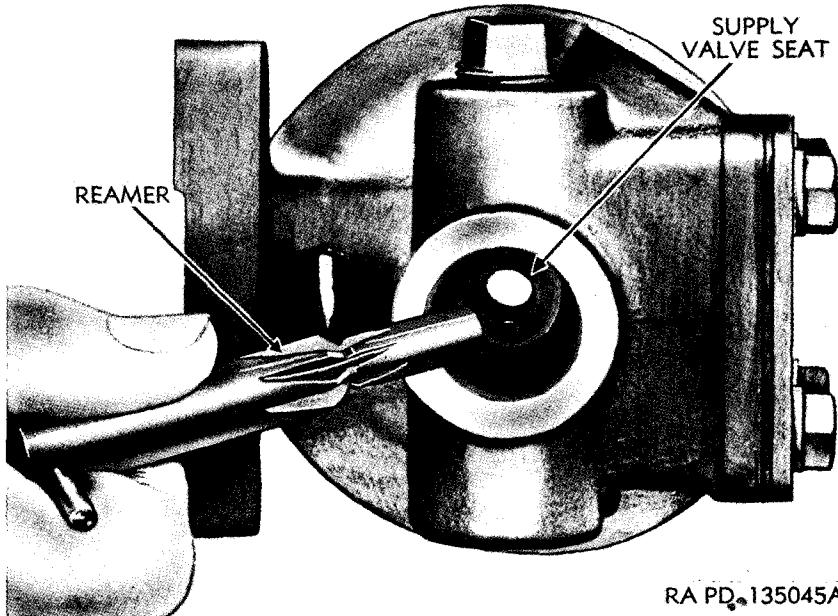


Figure 122. Grinding (lapping) supply valve.

The top of the diaphragm guide must not be more than 0.005 inch below the top of the diaphragm seat or the relay valve will not deliver correct air pressure. Supply valve stems which are too long must be carefully filed to proper length. Supply valves of insufficient length must be replaced.

95. Assembly of Type R Relay Valve

- a. *Install Blanking Cover* (fig. 126). Position blanking cover and gasket and install four cap screws and lock washers attaching blanking cover to body.
- b. *Install Supply Valves* (fig. 126). Position supply valve and spring and install supply valve cap nut. Tighten supply valve cap nut securely.
- c. *Assemble Diaphragm Assembly* (fig. 126). Insert diaphragm screw through diaphragm guide and diaphragm. Install diaphragm washer with convex side of washer next to the diaphragm. Install diaphragm screw nut but only tighten sufficiently to prevent leakage and not sufficiently to distort the diaphragm. When the nut is tightened correctly, it is still possible to turn the diaphragm with the guide held stationary. Install cotter pin securing diaphragm nut.



RA PD-135045A

Figure 123. Inserting intake valve seat reamer 41-R-2178 to ream supply valve seat.

d. Install Diaphragm Assembly (fig. 127). Position dampener in groove of diaphragm guide and, while holding it in place with the fingers, push assembled diaphragm and dampener into place.

e. Install Cover (fig. 126). Position a new cover gasket in place. Position spring seat and diaphragm spring on diaphragm and install cover. Tighten cover securely.

96. Test of Type R Relay Valve

a. Prepare test bench (fig. 71 and par. 60b).

b. Connect line 1 (fig. 71) to reservoir port of relay valve and open valves Nos. 2 and 3. Connect line 2 to brake valve port of relay valve. Connect line 4 to brake chamber port of relay valve. Plug other brake chamber port (figs. 114 and 115). Close valve 6 (fig. 71).

c. With normal pressure in the system, operate valve 4 (fig. 71) from release to applied position several times to insure proper seating of the supply valve and diaphragm of the relay valve.

d. With valve 4 (fig. 71) in the release position, coat the exhaust port of the relay valve with soap suds to detect and evaluate leakage past the supply valve.

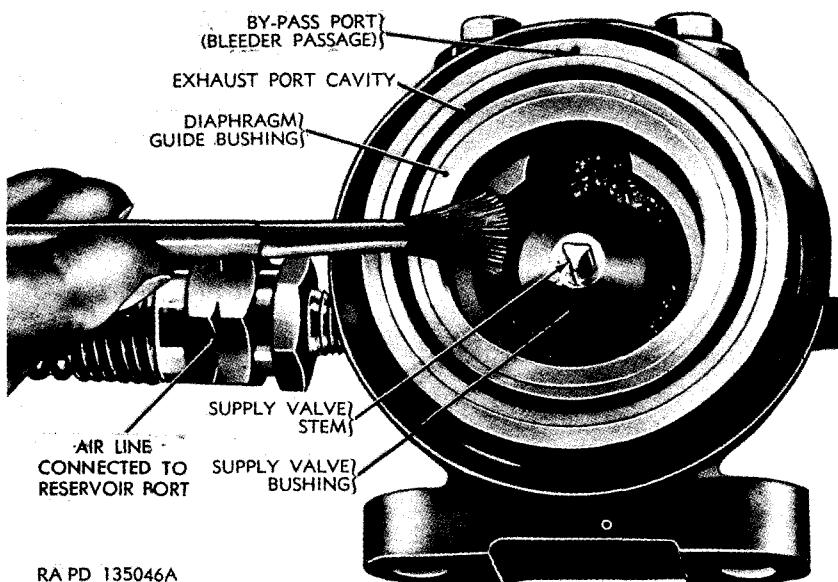


Figure 124. Testing supply valve for leakage.

e. With valve 4 (fig. 71) in the applied position, repeat the above to detect and evaluate leakage past the relay diaphragm and exhaust seat.

f. Leakage in either of the tests (d and e above) should not produce a 1-inch soap bubble in less than 1 second. Greater leakage, with valve 4 (fig. 71) lightly applied, indicates insufficient clearance between the top of supply valve stem and bottom of diaphragm screw.

g. When valve 4 (fig. 71) is moved to its applied or released position, the relay valve must quickly deliver or release the same pressure. Gages 2 and 4 should read approximately the same (within 3 pounds).

h. Failure of the relay valve to respond quickly indicates there is too much clearance between the top of supply valve stem and bottom of diaphragm screw (par. 100b(1)).

i. Move the valve 4 (fig. 71) to the released position. Turn the handle of valve 3 at right angles to the body of the valve (closing valve No. 3) and disconnect relay valve.

97. Disassembly of Type R-1C Relay Valve

(fig. 128)

a. Remove four cap screws and lock washers attaching adapter to body. Remove adapter and gasket.

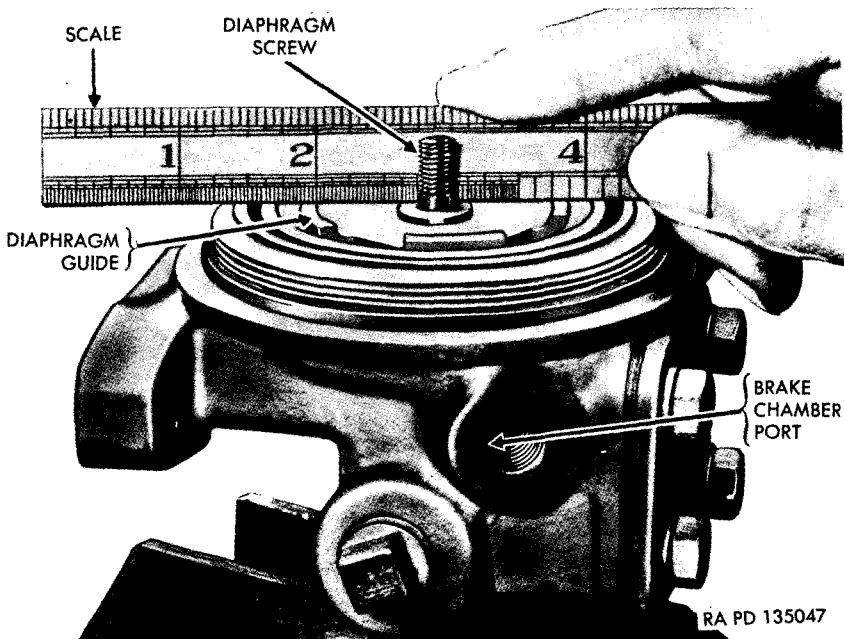


Figure 125. Checking length of supply valve stem.

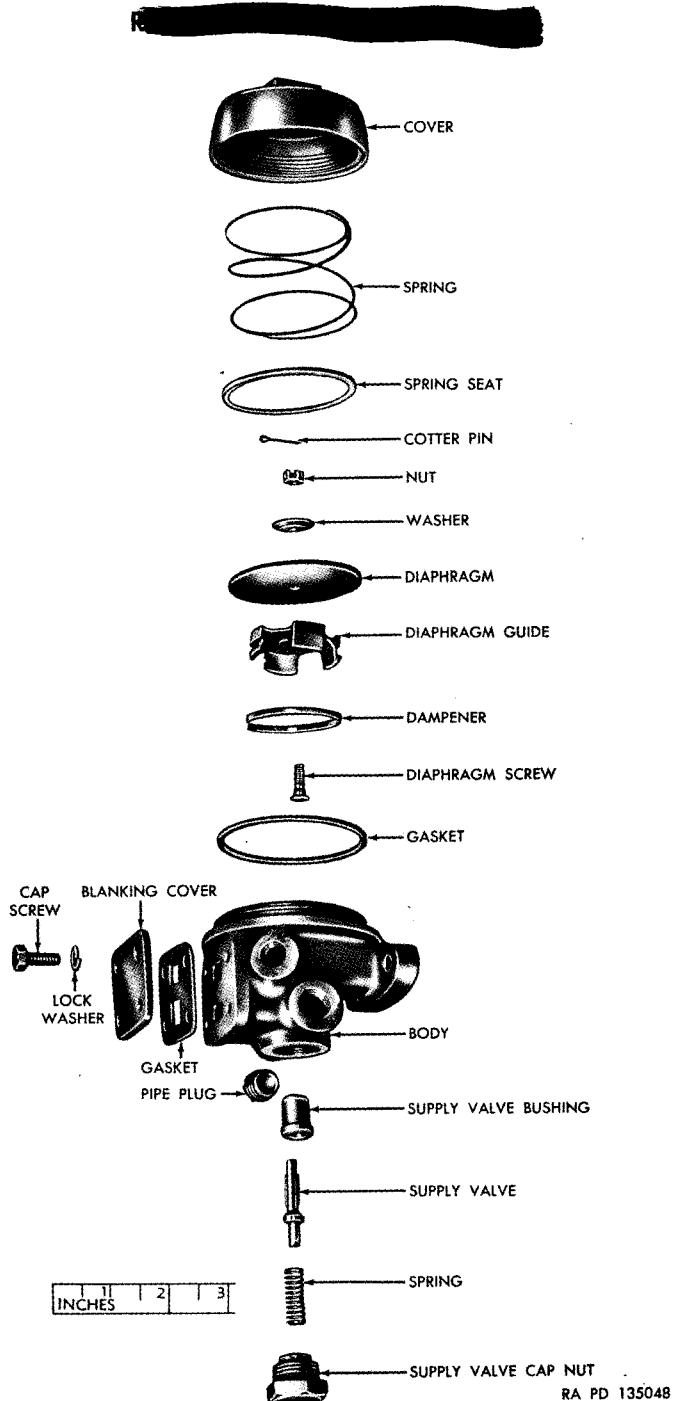


Figure 126. Type R relay valve—exploded view.

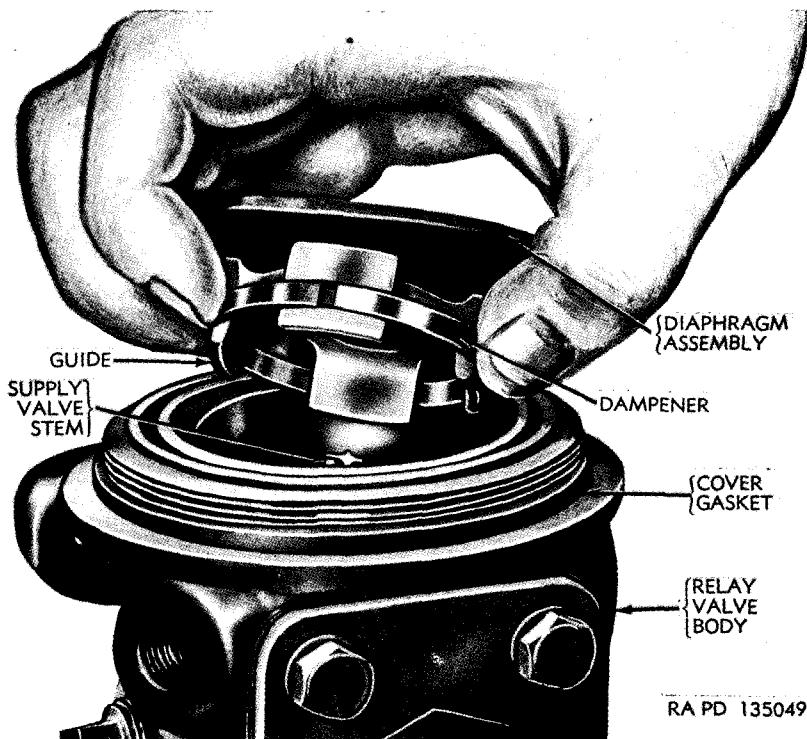
- b. Remove six nuts and lock washers attaching cover to body. Remove cover, diaphragm, diaphragm ring, and lower grommet from body (figs. 128 and 129).
- c. Using fingers, pull out diaphragm guide and dampener (fig. 130).
- d. Unscrew supply valve cap nut and remove supply valve spring and supply valve.

98. Cleaning, Inspection, and Repair

a. *Cleaning.* Wash all metal parts with dry-cleaning solvent or volatile mineral spirits. Be sure bleeder passage (figs. 129 and 130) is clean and unobstructed.

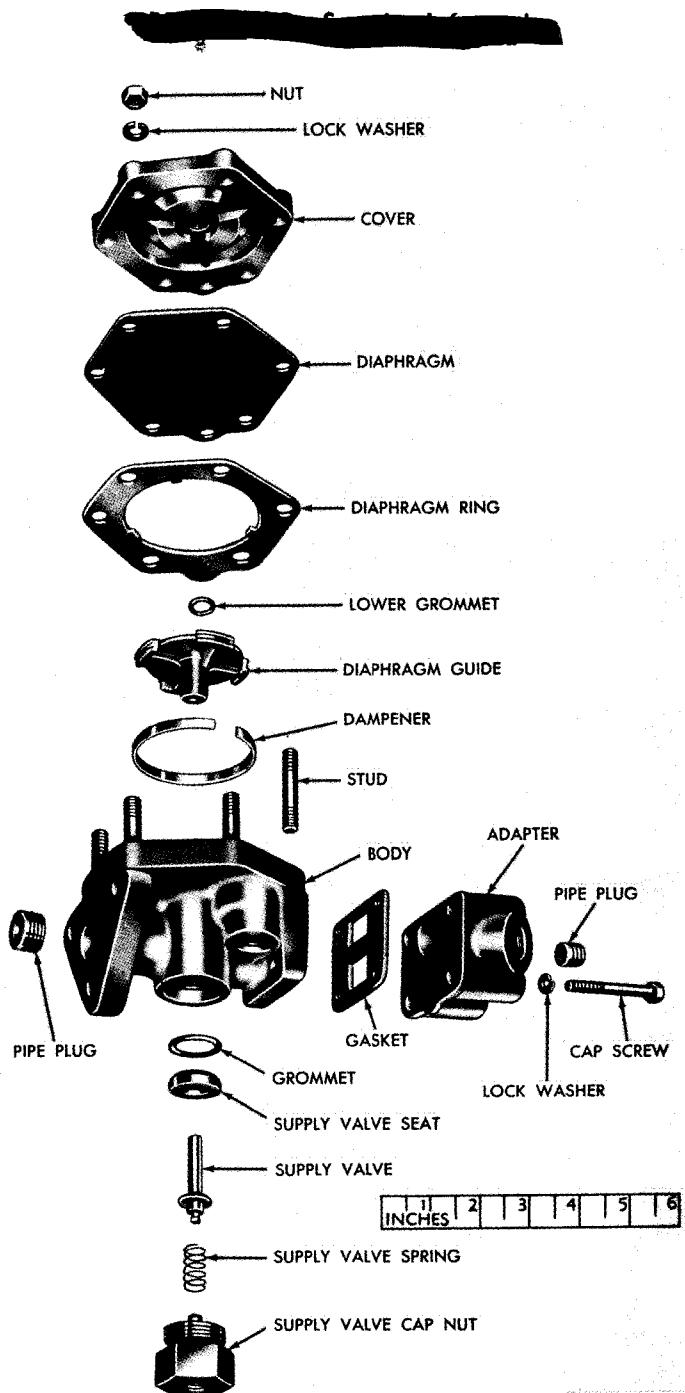
b. *Inspection.*

- (1) Discard all used diaphragms, grommets, and gasket.
- (2) Inspect fit of diaphragm guide in relay valve body. It must be a free sliding fit.
- (3) Inspect condition of dampener. When lying on a flat surface, the ends of the dampener should not be in line like the ends of



RA PD 135049A

Figure 127. Installing dampener and diaphragm assembly—type R relay valve.



RA PD 135050

Figure 128. Type R-1C relay valve—exploded view.

a piston ring but twisted so one end is about $\frac{3}{8}$ inch higher than the other.

- (4) Inspect condition of supply valve and seat (fig. 131). If valve or seat is worn, it must be repaired or replaced.
- (5) Inspect diaphragm seat on top of body. Seat must be smooth and free from dents or scratches.
- (6) Inspect diaphragm ring. Both sides should be smooth and the inside diameter must be smooth and free from nicks, scratches, burrs, and sharp edges.
- (7) Inspect cover. Outer ring (that diaphragm touches) must be smooth and free from nicks, scratches, and sharp edges. Make sure that bleeder passage is open and clean.

c. Repairs.

- (1) *Diaphragm seat.* Remove the six studs from the body before repairing the diaphragm seat. The question of repairing the diaphragm seat is a matter of judgment. Very slight scratches can be removed by smoothing the diaphragm seat in the body on a flat surface covered with crocus cloth. Extreme care must be used in smoothing this surface. Not more than 0.005 inch can be removed and the surface must be kept flat.

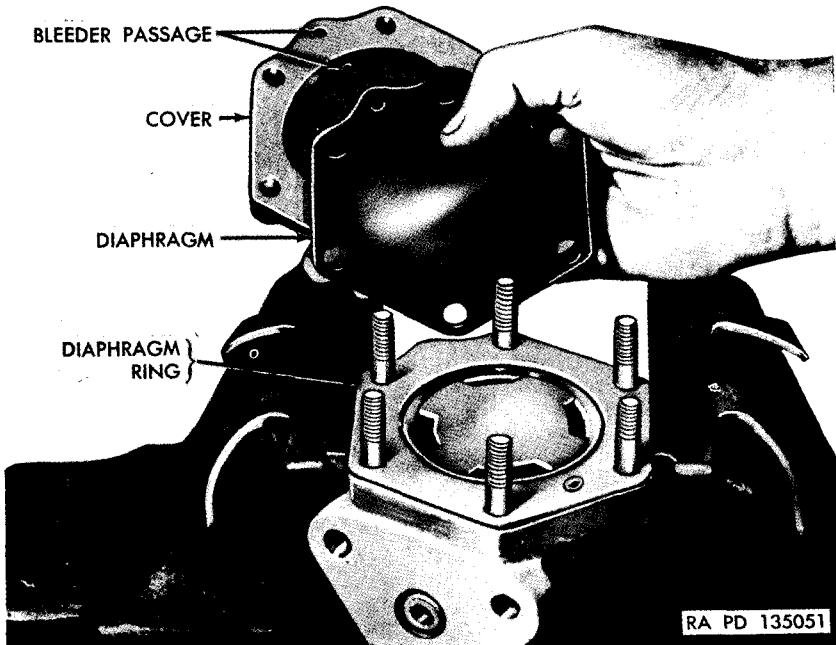


Figure 129. Removing cover.

(2) Supply valve and seat.

(a) If the supply valve and seat are not too badly worn, repair by carefully grinding (lapping) the valve to its seat, using reciprocating valve grinding tool 44-T-3381-15 and slip collet 7083459 (fig. 1) and valve grinding compound (fine). The top of the grinding tool should be moved in a circle while grinding the valve as shown in figure 132. After grinding, clean the supply valve and seat thoroughly with dry-cleaning solvent or volatile mineral spirits.

(b) Noticeably worn supply valves or supply valve seats must be replaced. A worn seat is pressed or driven out through the bottom of the body and a new seat and grommet are pressed in place. When replacing seats, make sure that the bore for the seat is smooth. Be sure the body is supported so that the exhaust seat is not damaged. Coat bushing and grommet with automotive and artillery grease (GAA) and use care while pressing into place so as not to shear grommet.

(c) After pressing new supply valve seat and grommet in place, use ream and facing tool 7083457 with pilot bushing

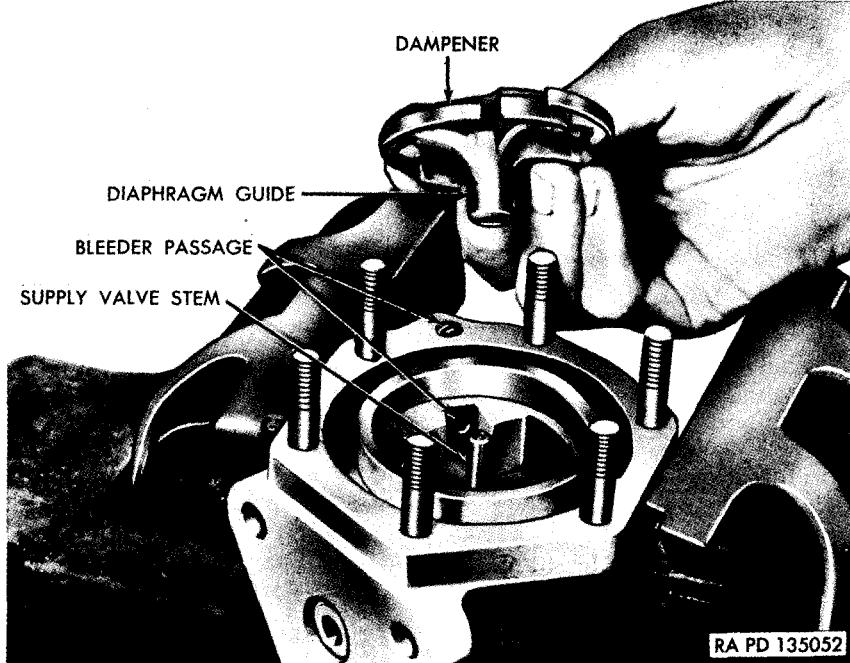


Figure 130. Removing diaphragm guide.

7083458 (fig. 3) as shown in figure 133. After reaming, the new valve must be ground (lapped) to its seat ((a) above).

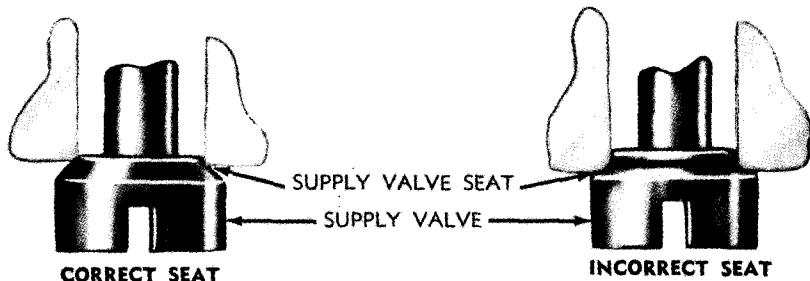
(3) *Testing supply valve for leakage.* Install supply valve, spring, supply valve cap nut, adapter, and gasket and test (par. 94c(2)(c)).

(4) *Checking length of supply valve stem.* After leakage of the supply valve has been reduced to less than the maximum permitted (par. 94c(2)(c)), place the diaphragm guide in body. Use a straightedge to check the alinement of the guide with the diaphragm seat (fig. 134) on the body. The top of the guide should not be above the top of the diaphragm seat, otherwise at low application air pressures, there may be leakage between the diaphragm and its seat. The top of the guide should not be more than 0.015 inch below the top of the diaphragm seat, otherwise the relay valve may not deliver the correct air pressure. If the top of the guide is too high, carefully grind off the top of the supply valve stem to the proper length. If the guide is too low, the supply valve, diaphragm guide, or both must be replaced.

99. Assembly of Type R-1C Relay Valve

(fig. 128)

- a. Position supply valve and spring and install supply valve cap nut. Tighten supply valve cap nut securely.
- b. Position dampener in groove of diaphragm guide and, while holding it in place with fingers, push diaphragm guide (fig. 130) into place.
- c. Install lower grommet in body.
- d. Install diaphragm ring.



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Figure 131. Correct and incorrect valve seats.

e. Install diaphragm.

f. Install cover on body.

Note. Use care to line up bleeder passage openings in body, diaphragm ring, diaphragm, and cover.

g. Install lock washers and tighten nuts securely.

h. Position gasket and adapter. Install lock washers and cap screws and tighten securely.

100. Test and Adjustment of R-1C Relay Valve

a. *Test.* Test procedure is the same as for type R relay valve (par. 96).

b. *Adjustment.*

- (1) Failure of relay valve to respond quickly indicates that top of diaphragm guide is too far below diaphragm seat. This condition is corrected by replacing either supply valve, diaphragm, or both.
- (2) Greater leakage at the relay valve than the limit specified in paragraph 96f, indicates that diaphragm is too high in relation to its seat. Correct by carefully grinding top of supply valve stem to proper length (par. 98c(4)).

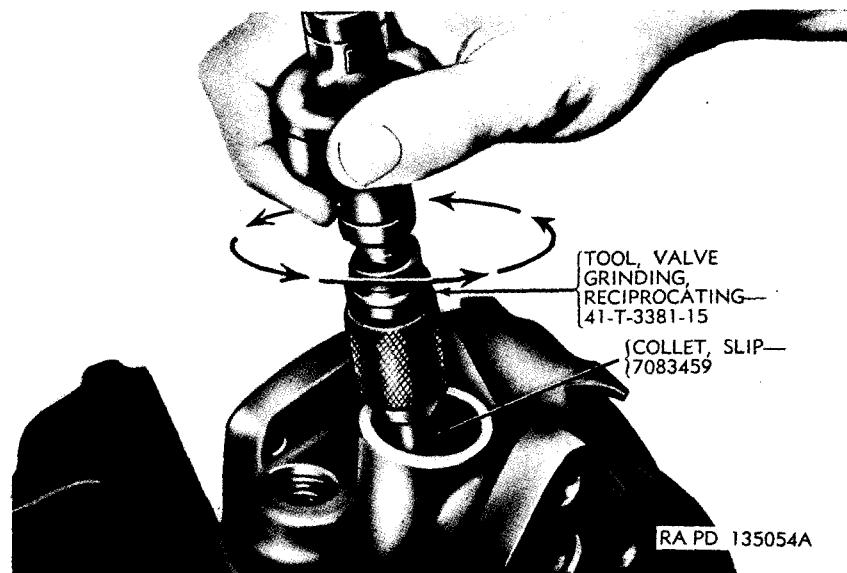


Figure 132. Grinding (lapping) supply valve

Section III. RELAY-EMERGENCY VALVES

101. Description and Operation

a. Description.

- (1) *General.* The relay-emergency valve is a combination of a relay valve and an emergency valve. The assembly is regularly used in the air brake system of trailers. The function of the relay-emergency valve is to act as a relay station to control the brakes on the trailer and also to automatically apply the trailer brakes in the event the trailer breaks away from the towing vehicle. In addition to this safety feature, the relay-emergency valve speeds up the operation of the brakes both during application and release. Three types of relay-emergency valves will be found in service—the RE, RE-1, and RE-1C.
- (2) *Type RE* (figs. 135 and 136). Two valves are included in this type, their only difference being that one includes a pressure regulating valve (fig. 135) whereas the other (fig. 136) does not. These valves are interchangeable, as their functions are the same. When installation clearance permits, the valve shown in figure 135 is preferred. In general, the valve without pressure regulating valve is used exclusively on gun mounts where clearance is limited. The valve without pressure regulating

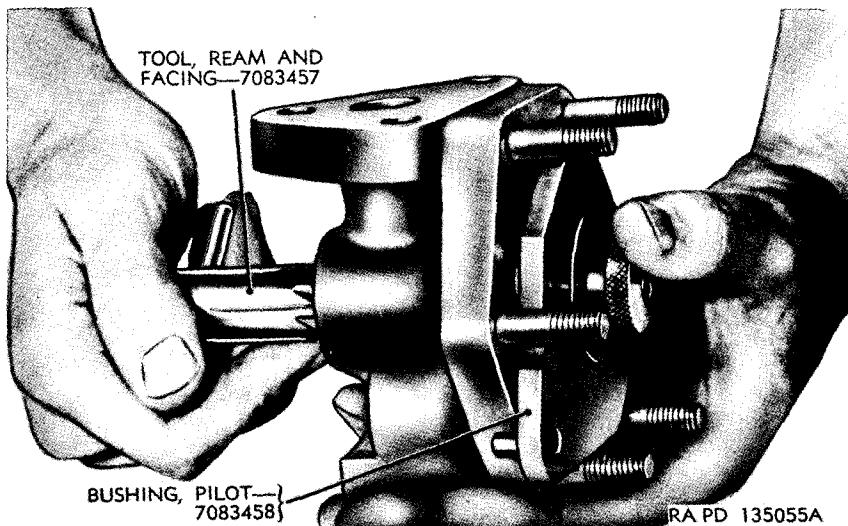


Figure 133. Reaming supply valve.

feature can be converted to the other by installation of an emergency cover that includes the pressure regulating valve assembly.

(3) *Types RE-1 and RE-1C* (figs. 137 and 138). These valves differ somewhat in construction from the RE valves although the functions are the same. Construction differences will be apparent on reference to sectional views of the three types (figs. 139, 140, and 141). Types RE-1 and RE-1C differ only in manner of installation on vehicle. RE-1 valves are attached directly to trailer reservoir, making supply line from trailer reservoir to valve unnecessary. RE-1C valves are independently mounted, the reservoir port in mounting flange being plugged and supply line from reservoir connected to valve.

b. *Operation.*

(1) *General.* Operation of the three types of relay-emergency valves is the same. Air pressure from service line from brake valve on towing vehicle operates relay section of valve as described in paragraph 92. Air pressure to brake chambers is supplied by trailer reservoir. The emergency section of these valves maintains pressure in trailer reservoir and also functions to apply full reservoir pressure to brake chambers on

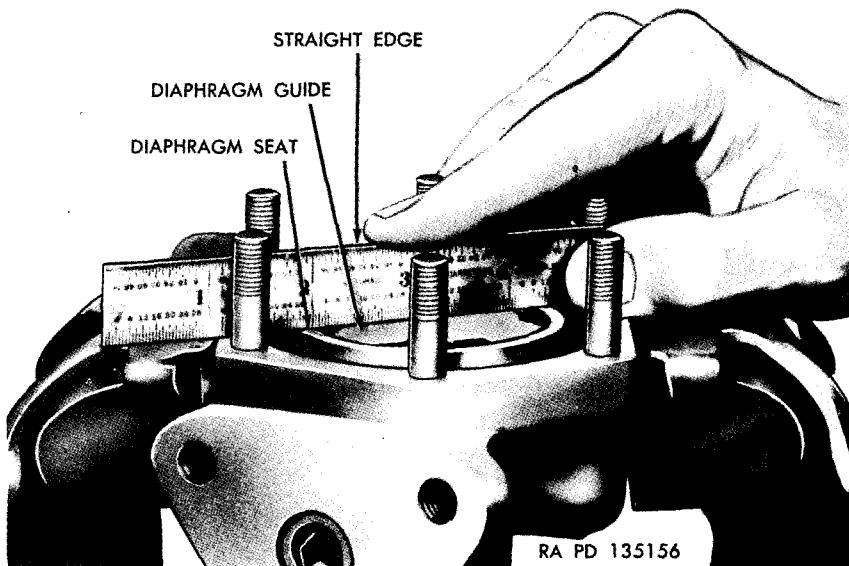
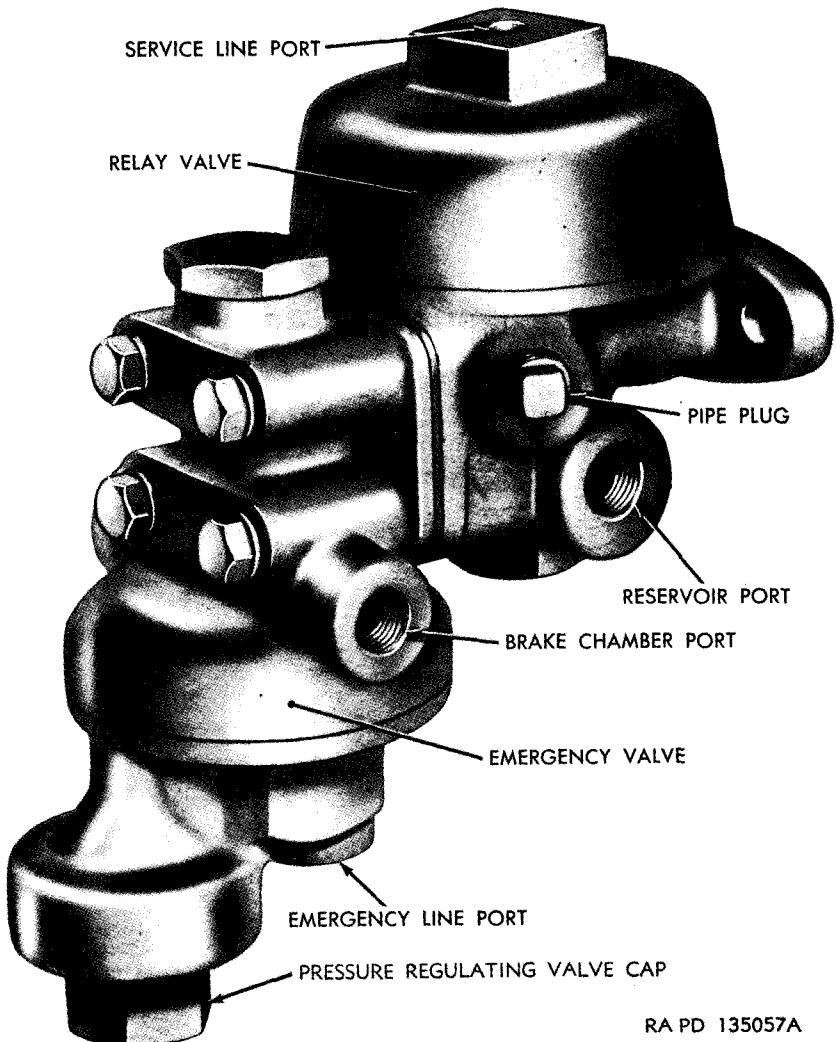


Figure 134. Checking length of supply valve stem.

trailer when air line connections between tractor and trailer are broken. The mechanism inside the valve assumes several positions during operation. References in following text refer to sectional views (figs. 139-141).

(2) *Released position.* When brakes are released, air pressure above and below relay diaphragm and in brake chambers is exhausted and supply valve is closed. Trailer reservoir pres-

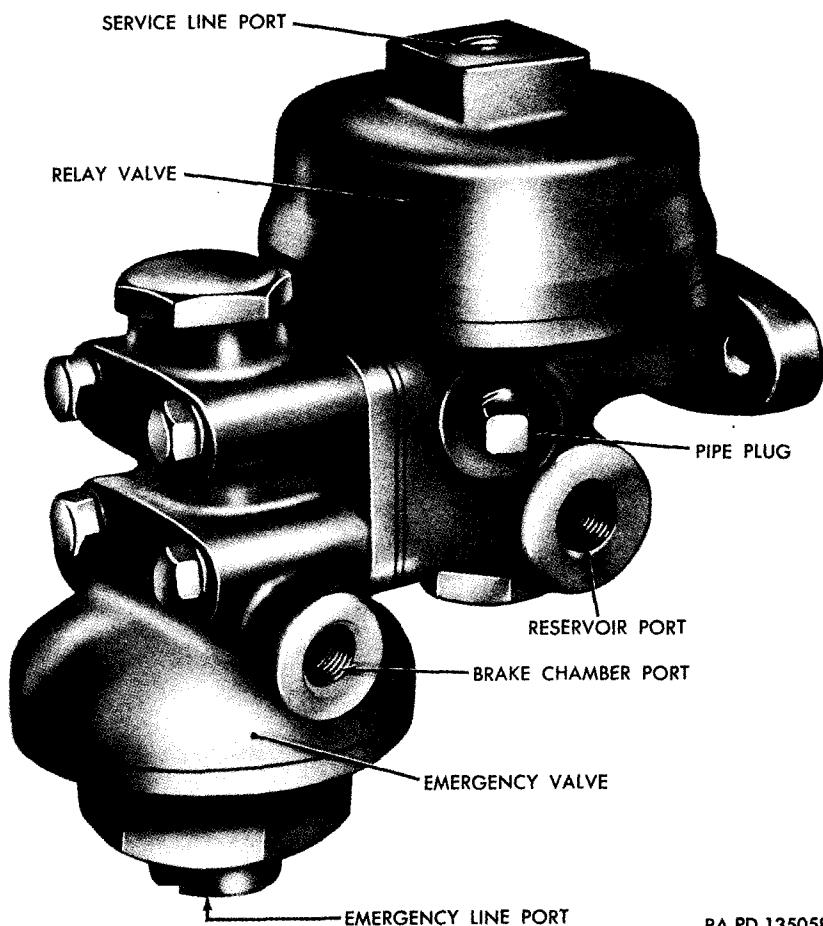


RA PD 135057A

Figure 135. Type RE relay-emergency valve with pressure regulating valve.

sure and tractor reservoir pressure is maintained in cavities in lower portion of relay valve.

(3) *Applying position.* When the brake valve in the tractor is applied, it sends air through the service line into the cavity above the relay diaphragm, and the force developed depresses the diaphragm. The diaphragm thus seals the annular exhaust port beneath its outer edge and its center is deflected, forcing the diaphragm guide and the supply valve down. This opens the supply valve and allows air pressure from the trailer reservoir to flow by the supply valve and into the cavity below the relay diaphragm

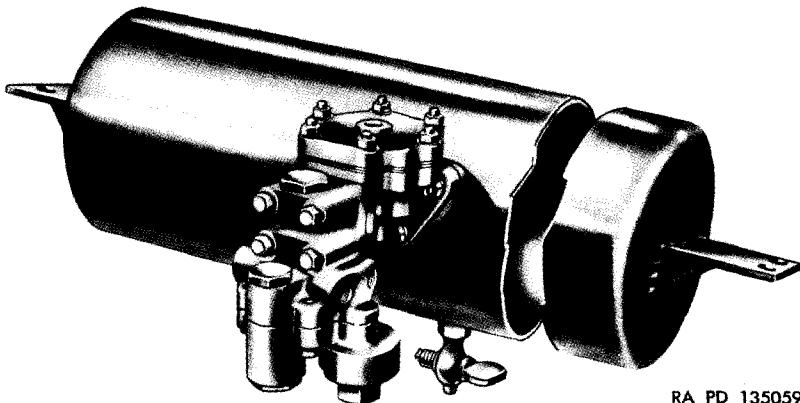


RA PD 135058

Figure 136. Type RE relay-emergency valve without pressure regulating valve.

which is connected to the brake chambers. With the mechanism in this position, air pressure is flowing directly from the trailer reservoir, through the relay-emergency valve into the brake chambers, applying the brakes.

- (4) *Balanced position.* As soon as air pressure below the relay diaphragm equals the air pressure above the diaphragm, the supply valve spring lifts the center of the diaphragm and closes the supply valve. This limits the air pressure being delivered to the brake chambers by the relay-emergency valve, to the same pressure as that being delivered by the brake valve to the relay-emergency valve. In this position, with the supply valve closed, the force of the air pressure on the top of the relay diaphragm keeps the outer portion of the diaphragm down, sealing the exhaust port. Thus, the valve is in the balanced position, maintaining the same air pressure in the brake chambers as the brake valve delivers to it. An increase in brake valve pressure repeats the action (as in the applying position) until the higher pressure in the brake chambers is again established. The purpose of the bleeder passage (or bypass port) in the valve is to assure that air pressure delivered to the brake chambers is exactly the same as air pressure delivered to the relay-emergency valve by the brake valve.
- (5) *Releasing position.* If brake valve air pressure above the relay diaphragm is reduced, the brake chamber air pressure below the diaphragm overcomes it and lifts the diaphragm. This opens the exhaust port under the outer edge of the diaphragm, permitting pressure in the brake chambers to exhaust until a lower

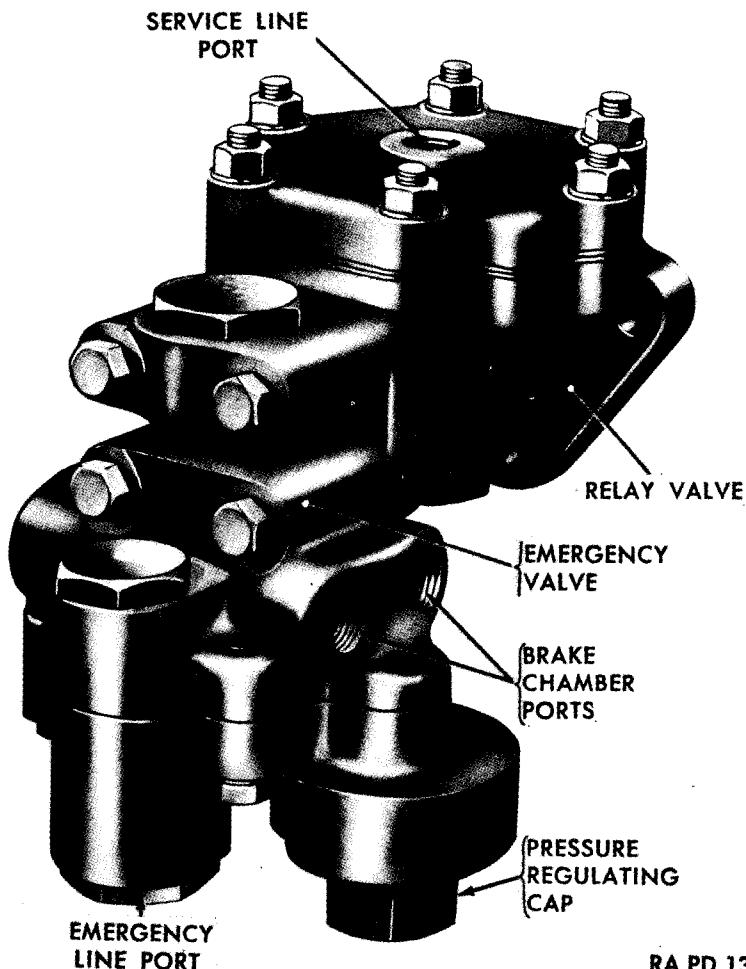


RA PD 135059

Figure 137. Type RE-1 relay-emergency valve.

balanced pressure is reached. When the brake valve is released completely, the relay-emergency valve releases all pressure from its brake chambers and fully releases the brakes and the valve returns to its released position.

(6) *Going into emergency.* The relay-emergency valve is designed to go into its emergency position and apply the trailer brakes when there is a rapid pressure drop in the cavity below the emergency diaphragm caused by uncoupling the emergency



RA PD 135060

Figure 138. Type RE-1C relay-emergency valve.

line (when parking a trailer) or by the trailer breaking away from the towing vehicle. If the emergency line is "broken," air pressure in the cavity below the emergency diaphragm flows out the broken emergency line. Air pressure above the emergency diaphragm depresses the diaphragm, pulls the upper emergency valve (fig. 141) down, and closes it. Air pressure above the check valve (fig. 141) holds it down and closed. Thus, air pressure from the trailer reservoir flows across the top of the depressed emergency diaphragm into the cavity leading to the brake chambers, applying the brakes. As air pressure escapes from below the emergency diaphragm, pressure above the pressure-regulating diaphragm drops instantly and the spring below the pressure-regulating diaphragm pushes it up, closing the pressure-regulating valve. Pressure above the pressure-regulating diaphragm drops instantly because the air in the cavity above the diaphragm can escape through the large passageway into the cavity below the emergency diaphragm faster than air can flow through the small passageway from above the emergency diaphragm into the cavity above the pressure-regulating diaphragm.

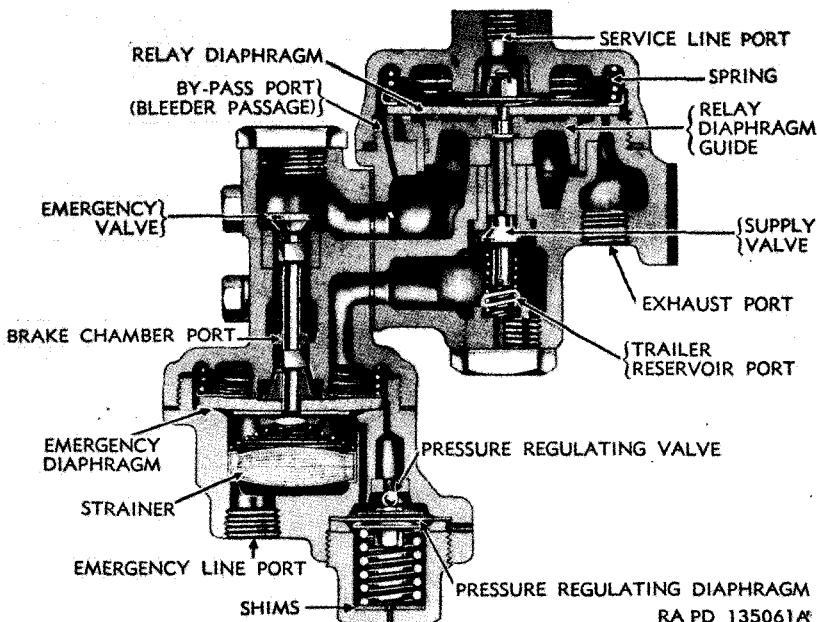


Figure 139. Sectional view type RE relay-emergency valve.

(7) *Emergency position.* If the emergency line is "broken," air pressure in the trailer reservoir is prevented from escaping past the upper emergency valve and supply valve to the exhaust port, past the pressure-regulating valve, the check valve, or through the emergency diaphragm to the broken emergency line. Air pressure in the brake chambers may be released either by draining the air from the trailer reservoir, allowing air in the brake chambers to return through the relay-emergency valve to the reservoir and atmosphere, or reconnecting the emergency line which again places air pressure under the emergency diaphragm, pushing it up, and opening the upper emergency valve (fig. 141), which allows air pressure in the brake chambers to escape through the exhaust port. Building up the tractor reservoir pressure by running the engine may be necessary to release the relay-emergency valve when connecting the emergency line.

(8) *Charging trailer reservoir.* Connection of the trailer emergency line to the tractor (or truck) emergency line allows air to flow from the tractor reservoir, through the emergency line, and into the relay-emergency valve. This air flows through the strainer

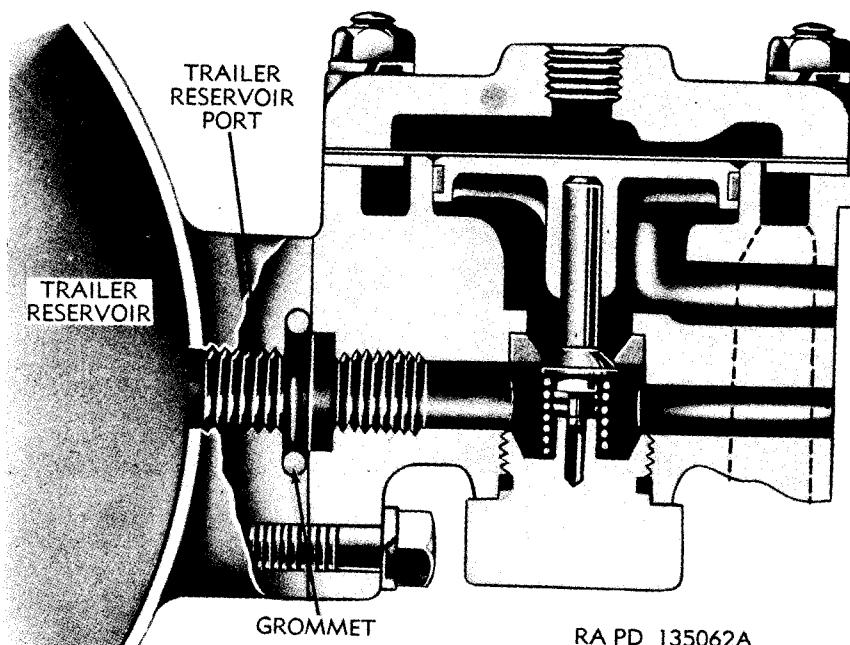


Figure 140. Sectional view type RE-1 relay-emergency valve.

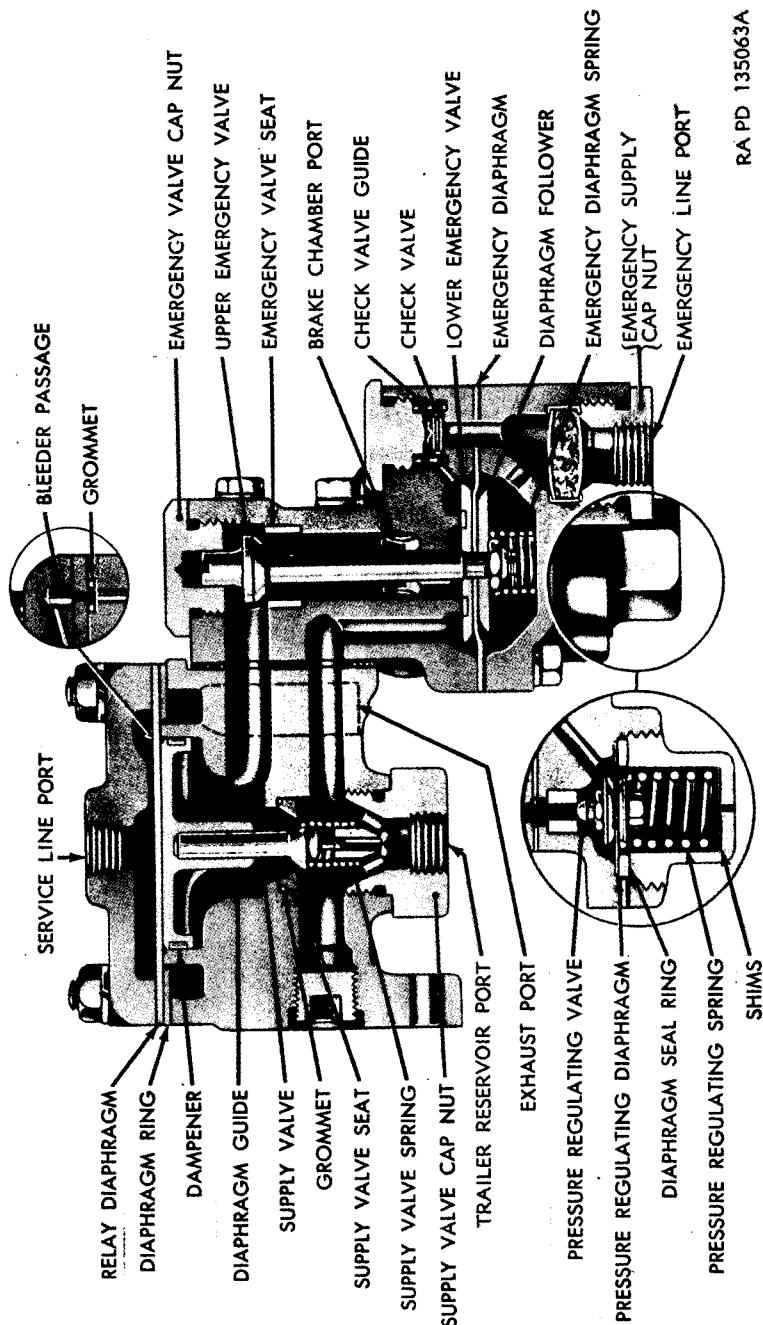
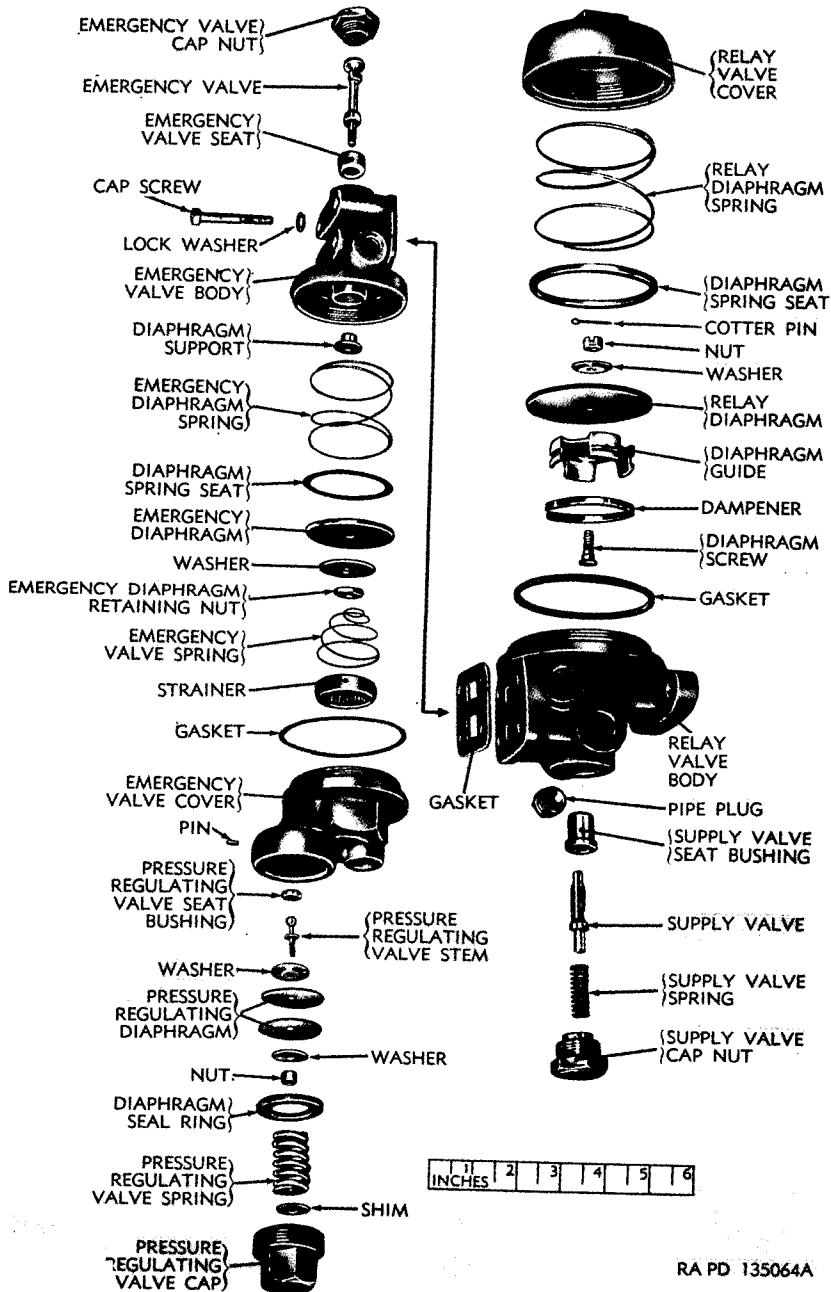


Figure 141. Sectional view type RE-1C relay-emergency valve.



RA PD 135064A

Figure 142. Type RE relay-emergency valve—exploded view.

(fig. 139), lifts the check valve (fig. 141), and flows over the top of the emergency diaphragm into the supply line to charge the trailer reservoir. At the same time, air has also been flowing below the emergency diaphragm and into the cavity above the pressure-regulating diaphragm. Air continues to flow in this manner until air pressure in the cavity above the pressure-regulating diaphragm reaches approximately 70 pounds.

c. *Preparation for Rebuild.* Remove all dirt and grease from exterior of valve with dry-cleaning solvent or volatile mineral spirits. Inspect for broken or damaged parts. If condition of valve is unknown, perform leakage and operation tests (par. 105). If valve meets tests, it will be returned to service.

Note. Regardless of valve condition, every year or after every 50,000 miles, it will be disassembled, cleaned, and assembled with new diaphragms, gaskets, grommets, in all valves, and a new check valve in RE-1C valves.

102. Disassembly of Relay-Emergency Valves

a. Relay Valves.

- (1) *Type RE.* Proceed as in paragraph 93 and refer to figure 142. Note that gasket and relay valve body are secured to emergency valve body. Continue with the procedure in b(1) below.
- (2) *Type RE-1C.* Proceed as in paragraph 97 and refer to figure 143. Note that gasket and relay valve body are secured to emergency valve body. Continue with procedure in b(2) below.

b. Emergency Valves.

- (1) *Type RE valve (fig. 142).*

(a) Remove pressure-regulating valve cap and lift out pressure-regulating spring and shim from the cavity in the cap.

Note. Do not misplace any shims as the same number must be replaced in the valve during assembly.

Lift out diaphragm seal ring. Lift out pressure-regulating diaphragm assembly.

- (b) Remove pressure-regulating diaphragm valve nut, and lift off large washer, two diaphragms, and small washer from valve stem.

- (c) Hold emergency valve body in a vise and remove emergency valve cover and gasket. Remove spring and strainer from emergency valve cover.

- (d) The pressure-regulating valve seat bushing should not be removed unless it has to be replaced. If this bushing has to be removed, it will have to be drilled out.

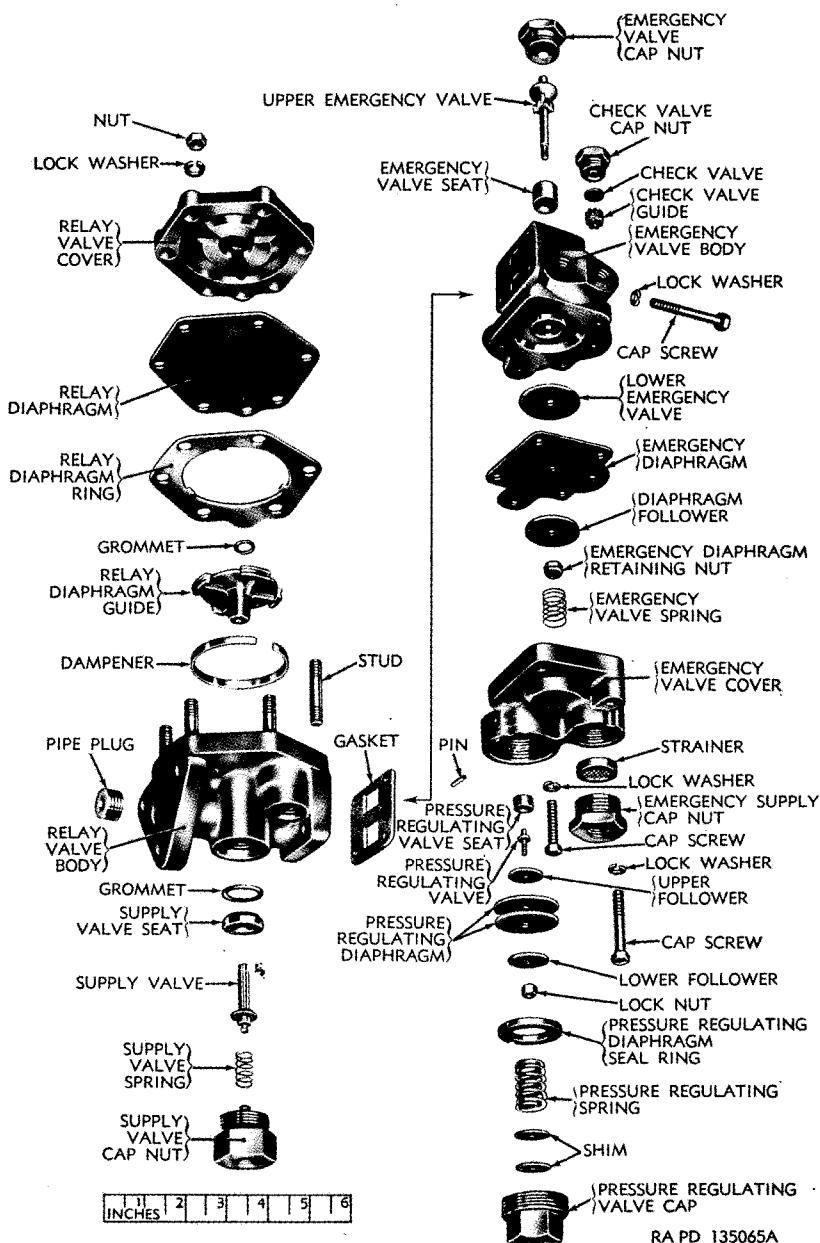


Figure 143. Type RE-1C relay-emergency valve—exploded view.

(e) Remove emergency valve cap nut. Use a screw driver to keep the emergency valve stem from turning and remove emergency diaphragm retaining nut. Remove washer, emergency diaphragm, diaphragm spring seat, spring, and diaphragm support. Remove emergency valve.

(f) Do not remove the emergency valve seat unless replacement is absolutely necessary. Remove the seat with a punch and hammer by driving it out through the opening for the emergency valve cap nut.

(2) *Type RE-1C valve (fig. 143).*

(a) Remove pressure-regulating valve cap and lift out pressure-regulating spring and shims from the cavity in the cap. *Note.* Do not misplace any shims as the same number must be replaced in the valve during assembly.

Lift out pressure-regulating diaphragm seal ring. Lift out pressure-regulating diaphragm assembly.

Note. The pressure-regulating valve seat should not be removed unless it has to be replaced. If this seat has to be removed, it will have to be drilled out.

(b) Remove emergency supply cap nut and strainer from emergency valve cover.

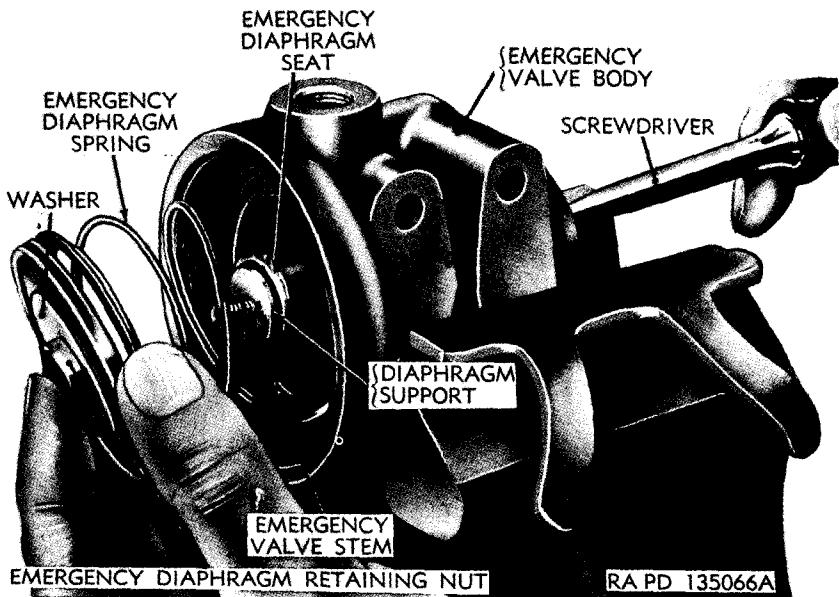


Figure 144. Removing type RE emergency diaphragm.

[REDACTED]

- (c) Remove check valve cap nut. Lift out check valve guide and check valve from cavity in the emergency valve body.
- (d) Remove emergency valve cover from body by removing four cap screws. Remove emergency valve spring from emergency valve body.
- (e) Remove emergency valve cap nut. Using screw driver to keep the upper emergency valve stem from turning, remove the emergency diaphragm retaining nut (fig. 145). Remove diaphragm follower, emergency diaphragm, and lower emergency valve. Remove upper emergency valve.

Note. Do not remove emergency valve seat unless replacement is absolutely necessary. When necessary, remove the seat by pressing out with a tap through the opening for the emergency valve cap nut.

103. Cleaning, Inspection, and Repair

a. *Cleaning.* Wash all metal parts with dry-cleaning solvent or volatile mineral spirits.

b. *Inspection.*

(1) *Relay valves.*

- (a) *Type RE.* Follow the procedure described in paragraph 94b.
- (b) *Type RE-1C.* Follow the procedure described in paragraph 98b.

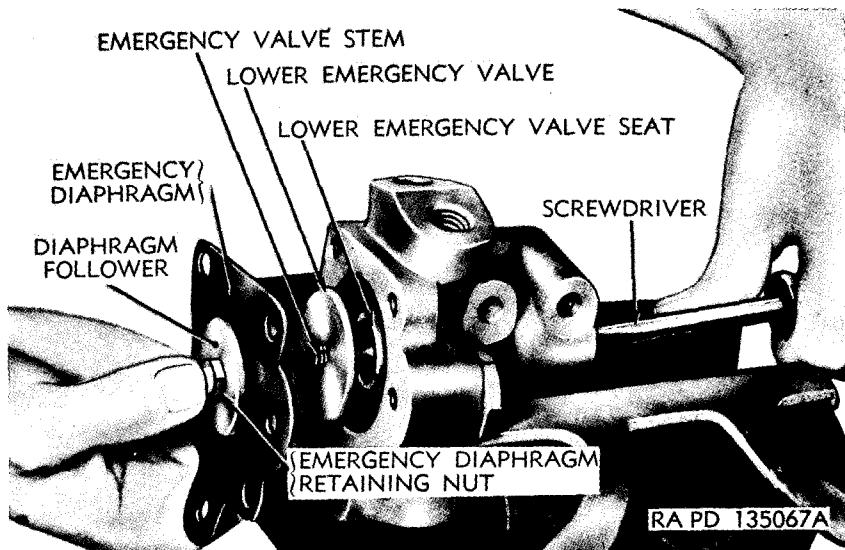


Figure 145. Removing type RE-1C emergency diaphragm.

(2) *Emergency valves.*

(a) *Type RE.*

1. *Passages.* Be sure passages leading to pressure-regulating valve cavity are clean.
2. *Diaphragms.* Replace all used diaphragms with new diaphragms.
3. *Emergency valve and seat.* Inspect condition of emergency valve and seat (fig. 146). If valve or seat is worn or damaged, it must be replaced.
4. *Emergency diaphragm seat.* Inspect emergency diaphragm seats in body and cap. Seats must be smooth, flat, and free from scratches.
5. *Pressure regulating valve and seat.* Inspect pressure regulating ball valve and seat for wear (fig. 147). Replace, if necessary.
6. *Strainer.* Inspect strainer for rust and corrosion. Replace if necessary.

(b) Type RE-1C valves.

1. *Items replaced each time emergency valves are assembled.*
Replace used diaphragm, check-valve, and lower emergency valve.
2. *Upper emergency valve and seat.* Inspect condition of upper emergency valve and seat. If valve or seat is worn or damaged, it must be replaced.
3. *Lower emergency valve seat.* Inspect condition of lower emergency valve seat on body. If seat is worn or damaged, the body must be replaced.

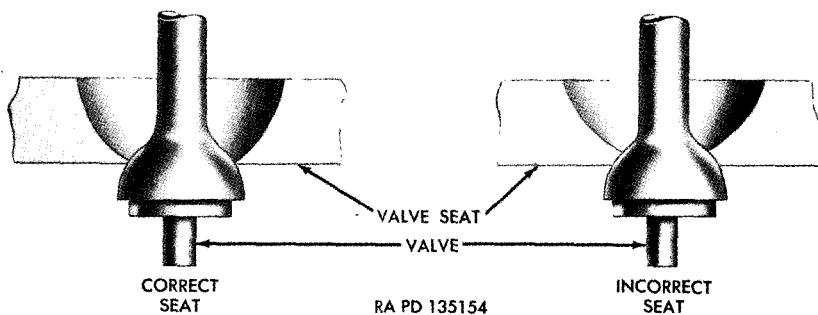


Figure 146. Correct and incorrect valve seats.

4. *Body and cover.* Inspect surfaces on body and cover where diaphragm is clamped. They must be smooth and free from nicks, scratches, and sharp edges.
5. *Check-valve seat.* Inspect check-valve seat. It must be flat and smooth.
6. *Pressure regulating valve and seat.* Inspect pressure-regulating valve and seat for wear. Replace, if necessary.
7. *Strainer.* Inspect strainer for dirt, rust, and corrosion. Clean or replace, if necessary.

c. *Repairs.*

(1) *Relay valves.*

- (a) *Type RE.* Proceed as described in paragraph 94c.
- (b) *Type RE-1C.* Proceed as described in paragraph 98c.

(2) *Emergency valves.*

(a) *Type RE valves.*

1. If emergency valve and seat are not too badly worn, repair by grinding (lapping) valve to its seat, using reciprocating valve grinding tool 41-T-3381-15 and valve grinding bit 41-B-660 (fig. 1) with a valve grinding compound (fine), as shown in figure 149.
2. Badly worn valves or valve seats must be replaced. Old seats are drilled out and new ones are pressed into place. Replaced seats must be reamed, using emergency valve reamer 41-R-830 (fig. 2) and reamer 41-R-2125 (fig. 3), as shown in figure 148. When using reamer, only the sharp corner on valve seat must be removed. After reaming, a new valve must be ground (lapped) to seat (fig. 149 and 1 above).

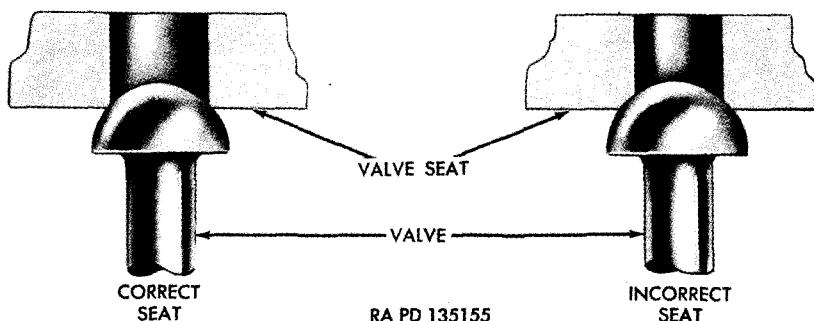
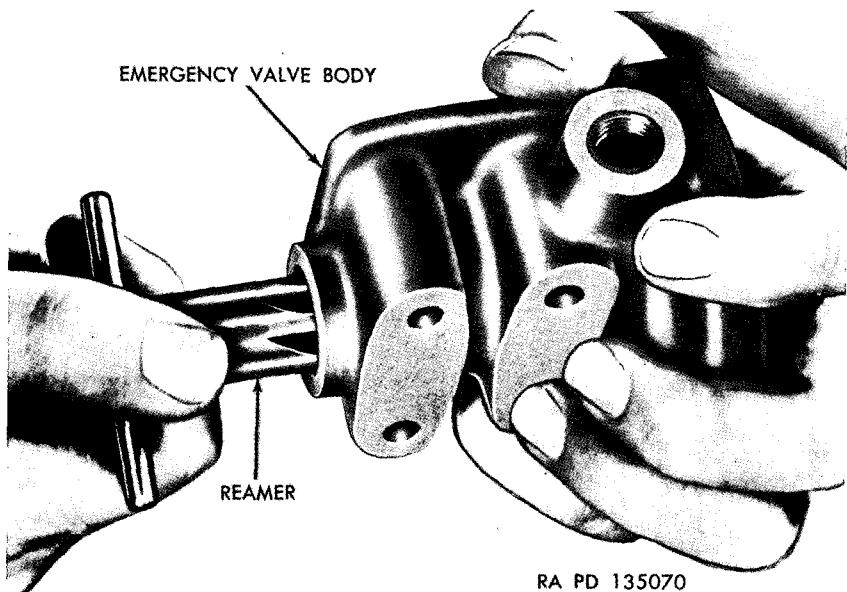


Figure 147. Correct and incorrect valve seats.

3. If pressure-regulating valve seat is damaged, run a $\frac{1}{4}$ -20 thread tap into seat. Remove tap and thread a bolt of the same size into seat. Use bolt to pull out seat. New seat must be pressed into place. The ball valve is seated by tapping it lightly.

(b) *Type RE-1C valves.*

1. *Upper emergency valve and seat.* If the valve and seat are not too badly worn, repair by grinding (lapping) valve to seat, using reciprocating valve grinding tool 41-T-3381-15 and valve grinding bit 41-B-660 (fig. 1) with a valve grinding compound (fine) as shown in figure 149. Badly worn valves or valve seats must be replaced. To remove valve seat, press out with a tap. Coat the outer surface of the new valve seat (that surface which will come into contact with the emergency body) with shellac and press into place. Ream valve seat with ream and facing tool 7083456 (fig. 3) as shown in figure 150. Install new valve and press into its seat with approximately 1,000 pounds pressure. Force must be against flat top of valve and not on end of stem. Grind new valve to its seat after pressing into seat.



RA PD 135070

Figure 148. Reaming emergency valve seat using emergency valve reamer 41-R-2125.

2. *Pressure-regulating valve seat.* Replace damaged valve seat. To remove, tap seat, insert cap screw, and pull seat from cover body. Press new valve seat into place. Replacement seat should be 0.005 inch larger than the one removed. Seats 0.005-, 0.010-, and 0.015-inch oversize are available. Valve is fitted to its seat by tapping with a light hammer.

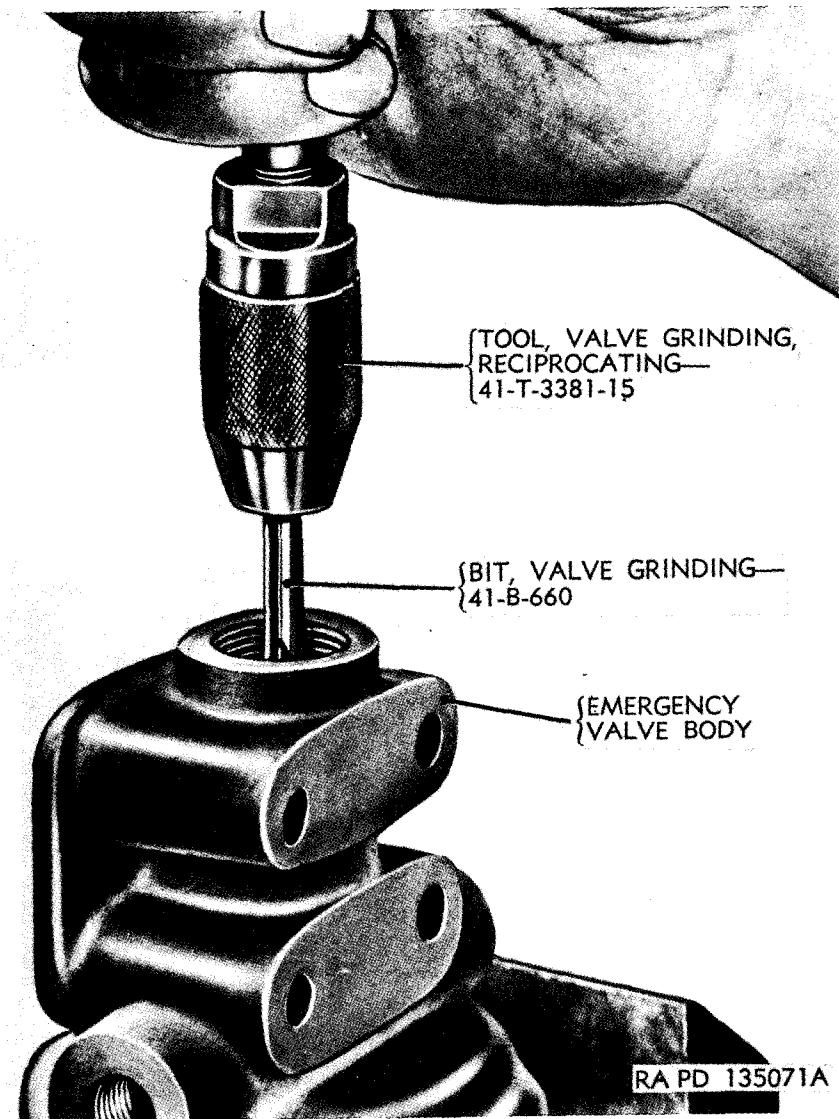


Figure 149. Grinding (lapping) emergency valve to seat.

104. Assembly of Relay-Emergency Valves

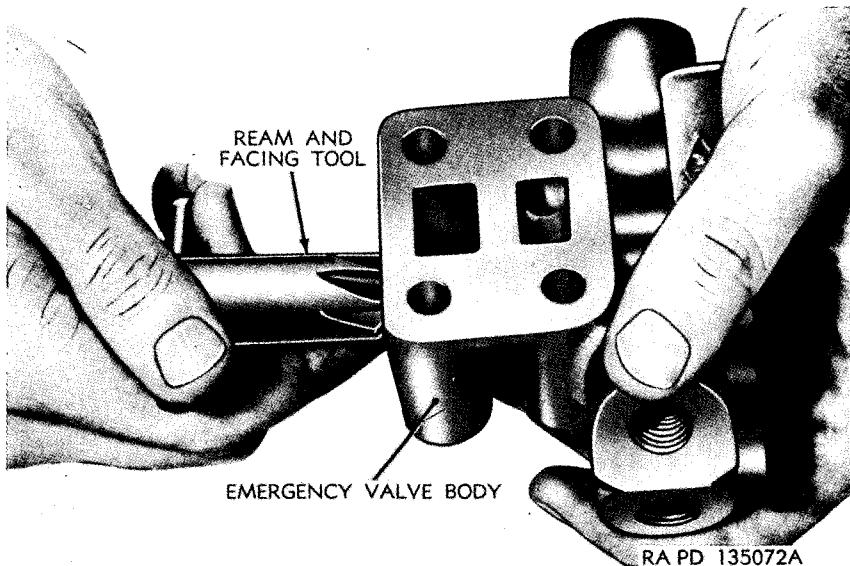
a. Relay Valves.

- (1) *Type RE valve.* Proceed as described in paragraph 95 and refer to figure 142. Note that gasket and relay valve body are secured to emergency valve body.
- (2) *Type RE-1C valve.* Proceed as described in paragraph 99 and refer to figure 143. Note that gasket and relay valve body are secured to emergency valve body.

b. Emergency Valves.

- (1) *Type RE valve (fig. 142).*

- (a) Position emergency valve in emergency valve body. Place diaphragm support on stem of emergency valve. Place emergency diaphragm spring and spring seat in position and install emergency diaphragm, washer, and nut on stem of emergency valve. Hold stem of emergency valve from turning with a screw driver (fig. 151) and tighten nut sufficiently to prevent leakage. Do not tighten nut sufficiently to distort the diaphragm. Install emergency valve cap nut. Tighten securely.



RA PD 135072A

Figure 150. Reaming upper emergency valve seat using ream and facing tool 7083456.

(b) Position small washer, diaphragms, and large washer on stem of pressure-regulating valve and install nut. Tighten nut sufficiently to prevent leakage but not sufficiently to distort the diaphragms. Prick punch nut and valve stem to lock nut securely.

(c) Position pressure-regulating diaphragm assembly in emergency valve cover, being sure edges of diaphragms are beneath the end of the pin. Position diaphragm ring so the notch in the edge of the ring engages the pin. Position the same number of shims and the same spring, as were removed during disassembly, in the pressure-regulating valve cap and screw cap into position. Tighten cap securely.

(d) Position strainer and spring in emergency valve cover and, using a new gasket, screw emergency valve cover to emergency valve body. Tighten securely.

(e) Using a new gasket, position relay valve and emergency valve and install four cap screws and lock washers attaching relay valve to emergency valve (fig. 142).

(2) *Type RE-1C valve (fig. 143).*

(a) Holding check-valve cap nut so that threads are up, place check-valve guide in groove in cap nut and place check

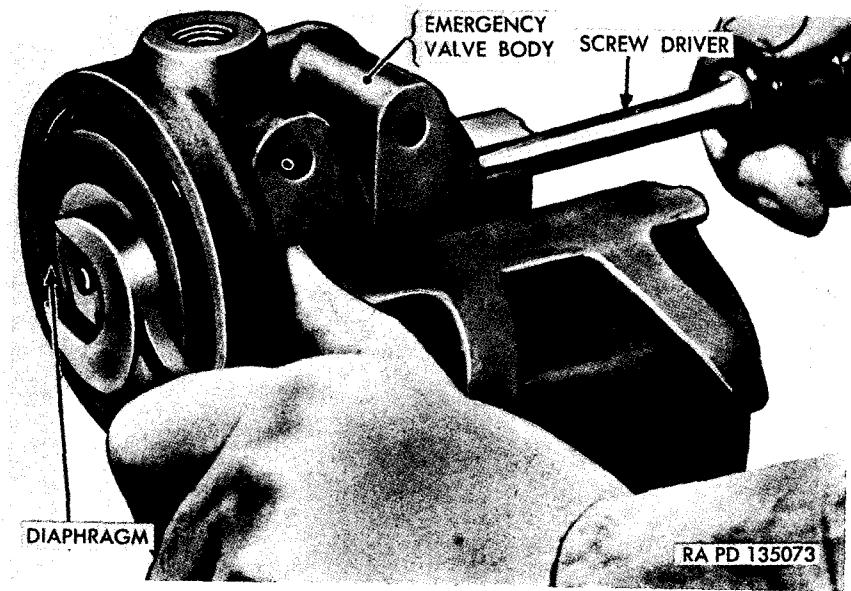


Figure 151. Installing emergency diaphragm.

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valve in guide. Then, holding emergency body upside down, screw check-valve cap nut in body. Tighten securely.

(b) Position upper emergency valve in emergency valve body. Install lower emergency valve, diaphragm, and diaphragm follower on stem of emergency valve. Curved sides of lower emergency valve and diaphragm follower must be against diaphragm. Install emergency diaphragm retaining nut (fig. 145). Hold stem of emergency valve from turning with a screw driver and tighten nut securely.

(c) Position strainer in emergency valve cover and install supply cap nut. Tighten securely.

(d) Position pressure-regulating diaphragm assembly in emergency valve cover being sure edges of diaphragm are beneath the end of the pin. Position diaphragm ring so that curved side is toward diaphragm and the notch in the ring engages the pin. Position the same number of shims and the same spring, as were removed during disassembly, in the pressure-regulating valve cap and screw cap into position. Tighten cap securely.

(e) Position emergency valve spring under emergency diaphragm retaining nut. Carefully line up holes in emergency diaphragm with holes in emergency body and emergency cover. Install and securely tighten the four cap screws and lock washers that hold cover to body.

(f) Before installing emergency valve cap nut, make sure that emergency valve can move up and down freely without binding. Install emergency valve cap nut; tighten securely.

(g) Using a new gasket, position relay valve and emergency valve and install and tighten four cap screws and lock washers attaching relay valve to emergency valve (fig. 143).

105. Test

The test below applies to the three types of relay-emergency valves. Prepare test bench (fig. 71 and par. 60b).

a. Connect line 1 (fig. 71) to emergency port. Connect line 2 to service port. Connect line 3 to reservoir port. Connect line 4 to one brake chamber port (figs. 135 and 136). Close valves 5 and 6 (fig. 71) and open valves 2 and 3 (par. 60b).

b. Open valve 1 (fig. 71) gradually and observe gages 1 and 3. Both gages should be rising in pressure at approximately the same rate to a

point between 70 and 80 pounds at which point an increased rate of rise must be noticed in gage 1. If the increased rate in rise occurs before gage 1 registers 70 pounds, install additional shims beneath the pressure-regulating valve spring. If the increased rate in rise does not occur before gage 1 registers 80 pounds, remove one or more shims from the pressure-regulating valve spring.

c. Operate valve 4 (fig. 71) from applied to released position several times to insure proper seating of the supply valve and relay diaphragm.

d. With valve 4 (fig. 71) in the released position, coat the exhaust port with soap suds to detect and evaluate (h below) leakage past the supply valve or lower emergency valve. Coat the vent hole in the pressure-regulating valve cap to detect and evaluate (h below) leakage past the pressure-regulating diaphragm.

e. With valve 4 (fig. 71) in the applied position, coat the exhaust port with soap suds to detect and evaluate (h below) leakage past the relay diaphragm and its seat.

f. Close valve 2 (fig. 71). Turn handle of valve 3 at right angles to the body of the valve (closing the valve). The relay emergency valve should go into emergency application. Gages 3 and 4 should read the same.

Note. A port in the (air supply) valve No. 3 (fig. 71) opens when the valve is closed (releasing the air from the emergency supply) and closes when the valve is opened.

g. Disconnect line 1 (fig. 71) and coat the emergency port with soap suds to detect and evaluate (h below) leakage past the pressure-regulating valve, emergency diaphragm, or check valve. Coat the exhaust port to detect and evaluate (h below) leakage past the upper emergency valve or supply valve.

h. Leakage in the above tests should not produce a 1-inch soap bubble in less than 1 second.

i. Connect line 1 (fig. 71) to emergency port. Turn handle of valve 3 parallel with the body of the valve (opening the valve, par. 60b). Move valve 4 to released position, open valve 2, and the relay-emergency valve should then be in the released position. Gage 4 should read zero.

j. Move valve 4 (fig. 71) to the applied position and coat the entire valve with soap suds to detect casting and gasket leakage. No leakage is permissible.

k. When valve 4 (fig. 71) is moved to its applied position, the relay-emergency valve must promptly deliver to the brake chamber, line 4 the same pressure received in the service line, line 2. Gages 2 and 4 should read approximately the same (within 3 pounds pressure).

l. Move handle of valve 4 to released position. Open valve 5 (fig. 71) and turn handle of valve 3 at right angles to the body of the valve closing the valve (par. 60b) and opening a port which discharges the emergency supply. Disconnect relay-emergency valve.

106. Adjustment

a. Type RE Valve.

- (1) If valve fails to meet requirements in paragraph 105k, too much clearance between top of supply valve stem and bottom of diaphragm screw is indicated. Replace supply valve to correct condition (par. 94c(2)(d)).
- (2) Leakage with brake valve lightly applied indicates insufficient clearance between top of supply valve stem and bottom of diaphragm screw. To correct, file top of supply valve stem to proper length (par. 94c(2)(d)).

b. Type RE-1C Valve.

- (1) If valve fails to meet requirements in paragraph 105k, top of diaphragm guide is too far below relay diaphragm seat. To correct, replace either the supply valve, the diaphragm guide, or both (par. 98c(4)).
- (2) Leakage with brake valve lightly applied indicates that diaphragm guide is too high in relation to relay diaphragm seat. To correct, grind top of supply valve stem to proper length (par. 98c(4)).

CHAPTER 8

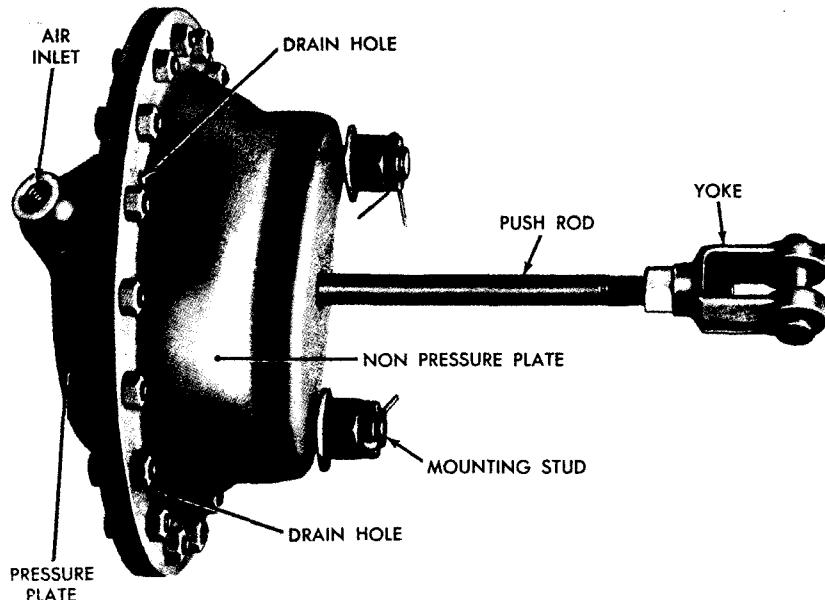
BRAKE CHAMBERS, ROTOCAMBERS, AND BRAKE CYLINDER

Section I. BRAKE CHAMBERS

107. Description and Operation

a. Description.

- (1) Brake chambers convert the energy of compressed air into the mechanical force and motion necessary to operate the brakes.
- (2) Conventional brake chambers (lettered types) are made in several different sizes. The over-all diameter of the smallest is $5\frac{1}{4}$ inches and the largest is 11 inches. Each of these sizes is made for several different mountings, such as the stud-type mounting (figs. 152 and 153), bracket-type mounting (fig. 155), and flange-type mounting (fig. 154). Brake chambers use either a dirt-seal washer (fig. 155) or a rubber boot (fig. 156) to prevent dirt from entering the chamber.
- (3) Clamp ring type brake chambers (numbered types) (fig. 157) have been developed to permit installation when clearances



RA PD 135074

Figure 152. Stud-type brake chamber.

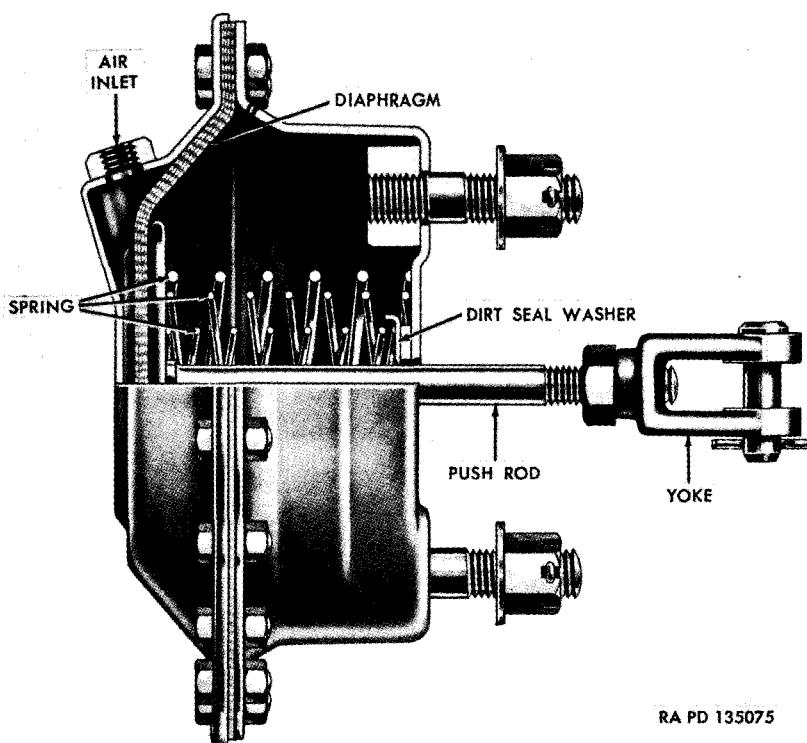
are not sufficient for conventional chambers with bolted flanges. This type is assembled with a clamping ring instead of bolts. Aside from differences in construction details, all brake chambers are alike in function and operation.

b. Operation. As air pressure enters the brake chamber behind the diaphragm, the diaphragm pushes the push rod outward. The higher the air pressure admitted to the brake chamber, the greater the force on the push rod. If all the air pressure is released from the brake chamber, the springs return the push rod and diaphragm to the released position.

108. Preliminary Examination

Inspect unit for broken or damaged parts. Perform leakage and operation tests (par. 112). No disassembly is necessary, if unit passes inspection.

Note. Unit is to be disassembled once a year or every 50,000 miles for cleaning and diaphragm replacement.



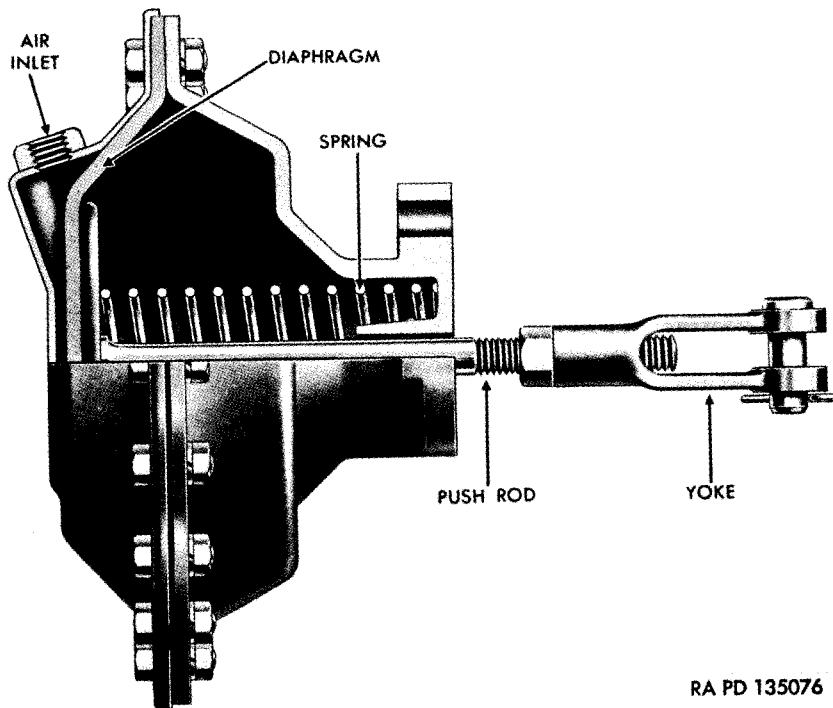
RA PD 135075

Figure 153. Sectional view stud-type brake chamber.

109. Disassembly

(fig. 158)

- a. Before disassembly, mark the pressure plate and nonpressure plate so that the air inlet opening in the pressure plate will be at correct angle with the mounting bolt or bracket when assembled.
- b. Remove bolts and nuts clamping outer edge of diaphragm between pressure plate and nonpressure plate. If unit is equipped with a clamping ring, remove two bolts and nuts clamping ring together and remove ring.
- c. Remove yoke and lock nut from push rod. If unit is equipped with rubber boot, remove boot from push rod and nonpressure plate. Remove pressure plate and diaphragm.
- d. Remove push rod assembly and springs from nonpressure plate. If unit is equipped with a dirt-seal washer or dirt-seal assembly, remove seal from push rod.



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Figure 154. Sectional view flange-type brake chamber.

110. Cleaning, Inspection, and Repair

a. *Cleaning.* Clean all metal parts in dry-cleaning solvent or volatile mineral spirits.

b. *Inspection.* Inspect push rod for signs of wear or damage. Inspect studs for damaged threads. Inspect diaphragm for signs of cracking or wear. Inspect yoke and pin for damage.

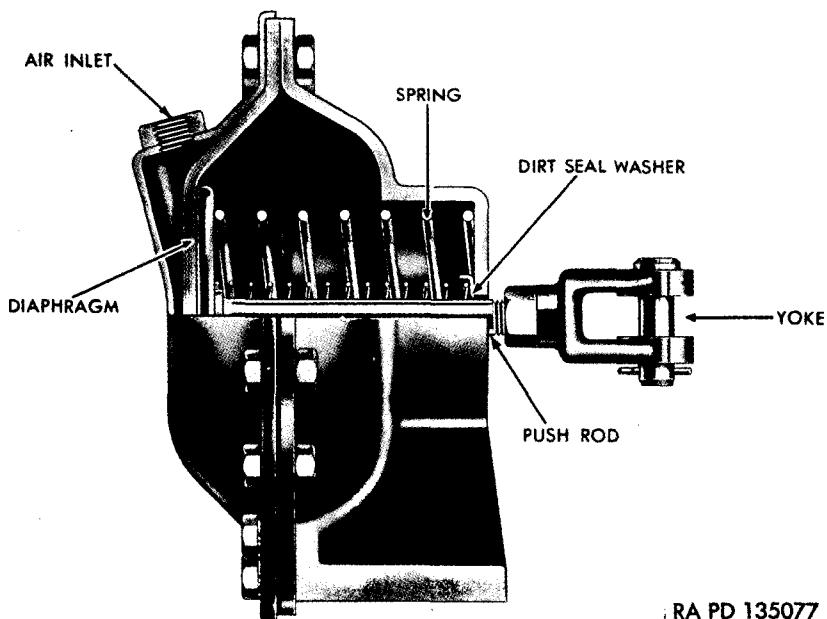
c. *Repair.* Minor damage to stud threads can be corrected with a standard thread chaser. Loose or bent studs must be replaced. Replace all defective parts.

Note. It is important, when replacing springs in brake chambers, to be sure the correct spring is used, otherwise unbalanced braking may result.

111. Assembly

(fig. 158)

a. Position dirt-seal washer or dirt-seal assembly, if one is used, in nonpressure plate. Position push rod assembly and springs in non-pressure plate. Pull push rod out and lock in the pulled out position with vise grip pliers or similar tool at the nonpressure plate. If unit is equipped with rubber boot, install boot on push rod and nonpressure plate. Install yoke lock nut and yoke.



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Figure 155. Sectional view bracket-type brake chamber.

b. Position diaphragm and pressure plate on nonpressure plate. Be sure the air inlet opening in the pressure plate is in proper relation to the mounting bolt or bracket as marked before disassembly (par. 109a).

c. Install bolts and nuts holding diaphragm between pressure plate and nonpressure plate. It is important that all bolts be tightened evenly and sufficiently to insure an airtight seal between pressure plate and diaphragm. Do not distort the diaphragm.

d. If unit is equipped with a clamping ring, position pressure plate and diaphragm to nonpressure plate with push rod, spring, and seal in place. Place clamping ring over the outer edge of the pressure and non-pressure plates. Use a clamp or long bolt to bring ends of clamping ring as close together as possible and install one bolt and nut to the clamp ring. Install other bolt and nut to clamping ring and tighten both nuts and bolts securely.

112. Test

a. Prepare test bench as described under test preparation (fig. 71 and par. 60b).

b. Connect line 2 (fig. 71) to air inlet port of brake chamber.

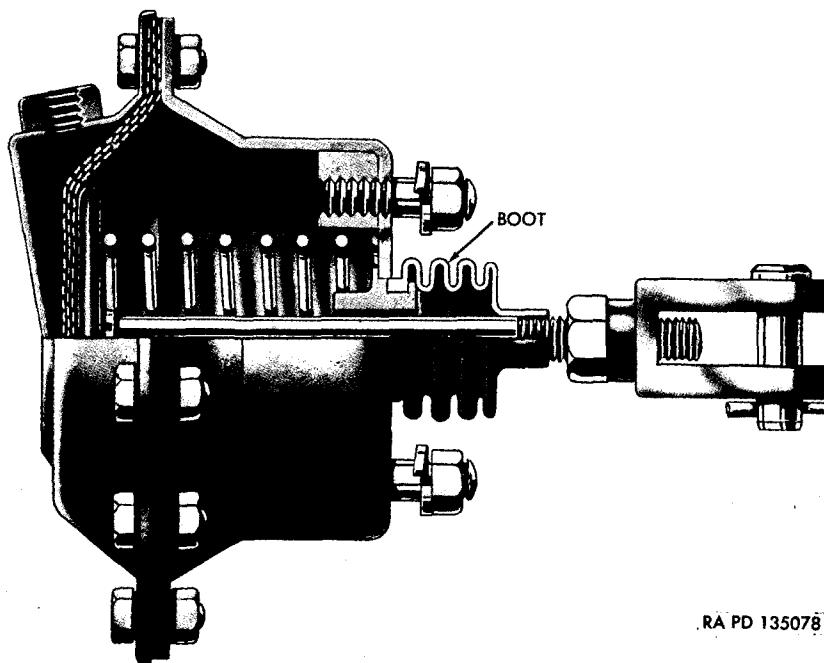


Figure 156. Brake chamber with boot.

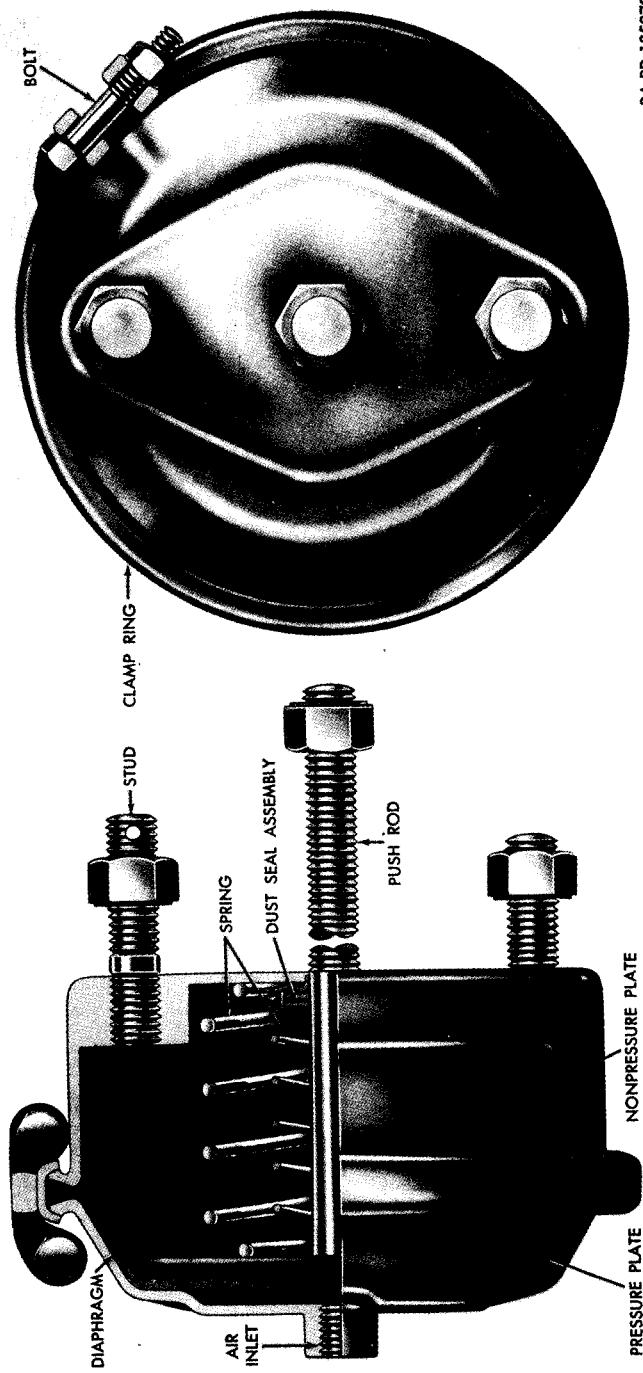


Figure 167. Brake chamber with clamping ring.

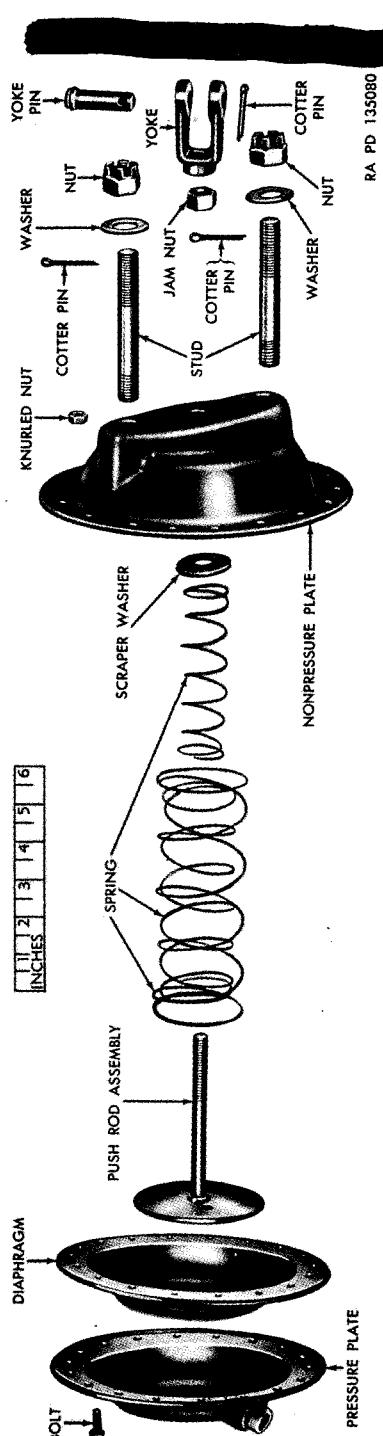


Figure 168. Typical conventional brake chamber—exploded view.

c. With normal air pressure in the system, move valve 4 (fig. 71) slowly to the fully applied position. Coat the brake chamber bolting flanges (of the pressure plate and nonpressure plate) with soap suds to detect leakage. Coat the clearance hole around push rod and drain hole in nonpressure plate with soap suds to detect leakage. No leakage is permissible. Move valve 4 to released position.

d. Move valve 4 (fig. 71) until gage 2 reads 5 pounds and note that push rod begins to move "out". Move valve 4 slowly to fully applied position and note that push rod moves out promptly and without binding. Move valve 4 to released position and note that push rod returns to released position promptly and without binding.

e. Disconnect line 2 (fig. 71) and remove brake chamber.

113. Tabulated Data

a. Conventional Type Brake Chambers (Lettered Types).

Type	Outside diameter	Effective area (sq. in.)	Normal working stroke	Maximum working stroke	Maximum stroke
A	6 $\frac{15}{16}$	12	$\frac{5}{8}$	1 $\frac{1}{8}$	1 $\frac{3}{4}$
B	9 $\frac{3}{16}$	24	$\frac{3}{4}$	1 $\frac{1}{4}$	2 $\frac{1}{4}$
C	8 $\frac{1}{16}$	16	$\frac{3}{4}$	1 $\frac{1}{4}$	2 $\frac{1}{4}$
D	5 $\frac{1}{4}$	6	$\frac{1}{2}$	1 $\frac{1}{4}$	1 $\frac{5}{8}$
E	6	9	$\frac{5}{8}$	1 $\frac{1}{8}$	1 $\frac{3}{4}$
F	11	36	$\frac{3}{4}$	2 $\frac{1}{4}$	3
G	9 $\frac{7}{8}$	30	$\frac{3}{4}$	1 $\frac{1}{4}$	2 $\frac{1}{2}$

b. Clamp Ring Type Brake Chambers (Numbered Types).

Type	Outside diameter (in.)	Effective area (sq. in.)	Maximum stroke (in.)
9	4 $\frac{5}{16}$	9	1 $\frac{1}{4}$
12	5 $\frac{1}{16}$	12	1 $\frac{1}{4}$
16	6 $\frac{3}{8}$	16	2 $\frac{1}{4}$
20	6 $\frac{13}{16}$	20	2 $\frac{1}{4}$
24	7 $\frac{1}{4}$	24	2 $\frac{1}{4}$
30	8 $\frac{1}{8}$	30	2 $\frac{1}{2}$
36	9	36	3

Section II. ROTOCAMBERS

114. Description and Operation

a. *Description* (fig. 159). Rotochambers consist of a cylindrical body, housing a push rod and attached parts. A tubular diaphragm, attached to both body and push rod assembly permits reciprocal motion of push rod. Type numbers signify the effective pressure area.

b. *Operation* (fig. 160). As air pressure enters rotochamber behind the diaphragm it moves the diaphragm forward. The diaphragm moves

along the inside wall of the cylinder body with a rolling motion. This forward motion of the diaphragm forces the push rod forward. The higher the air pressure admitted to the rotochamber, the greater the force on the push rod. If all the air pressure is released from the rotochamber, the spring returns the push rod and diaphragm to the released position.

115. Preliminary Examination

Inspect unit for broken or damaged parts. Perform leakage and operation tests (par. 119). No disassembly is necessary if unit passes inspection.

Note. Unit is to be disassembled once a year or after every 50,000 miles for cleaning and diaphragm replacement.

116. Disassembly

(fig. 161)

a. Remove yoke, lock nut, and rubber boot from push rod. Remove cap screws and lock washers holding cover to the body (fig. 160). Remove cover and spring. Remove nuts holding outer diaphragm clamp to body. Discard rubber boot.

b. Remove push rod assembly consisting of push rod, push plate, diaphragm guide, diaphragm, and inner diaphragm clamp from body. Straighten the rolled diaphragm and remove outer diaphragm clamp. Remove the nuts inside diaphragm guide. Remove inner diaphragm

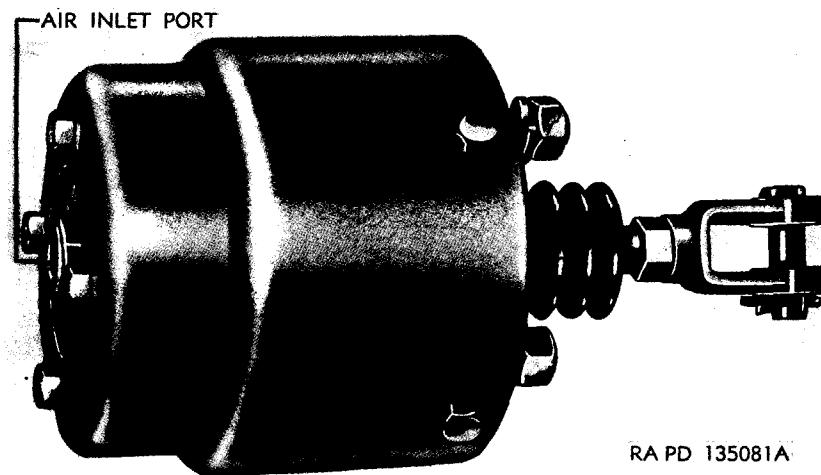


Figure 159. Typical rotochamber.

clamp, diaphragm, and diaphragm guide from push rod assembly. Discard rubber diaphragm.

117. Cleaning and Inspection

a. *Cleaning.* Clean all metal parts in dry-cleaning solvent or volatile mineral spirits.

b. *Inspection.* Inspect body, diaphragm clamps, and diaphragm guide for damage. Be sure the push rod is not bent. Inspect spring for damage. Inspect studs for damaged threads. Replace damaged parts.

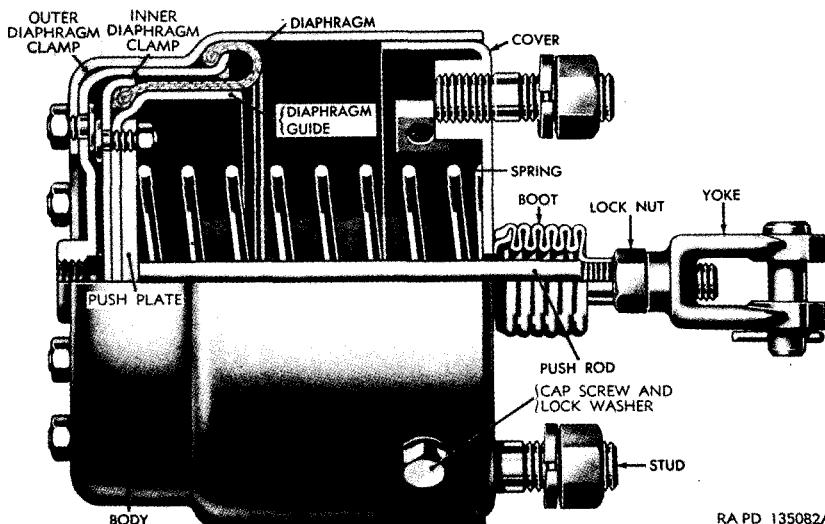
Note. It is important, when replacing springs in rotochamber, to be sure the correct spring is used, otherwise unbalanced braking may result.

118. Assembly

(fig. 161)

a. Stand a new diaphragm on end in the inner diaphragm clamp. Small end of diaphragm must be against inner diaphragm clamp. Position diaphragm guide within diaphragm over inner diaphragm clamp studs. Position push rod assembly within diaphragm guide and over studs. Install nuts on studs and tighten securely.

b. Place the outer diaphragm clamp over the inner diaphragm clamp. Roll the free end of the diaphragm back and over the end of the outer diaphragm clamp. Apply a light coat of automotive and artillery



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Figure 160. Sectional view of rotochamber.

grease (GAA) to the inside of the body and the rolling surface of the diaphragm.

c. Slide the above partial assembly into the body, making sure the end of the diaphragm fits snugly against the shoulder in the body by positioning the outer diaphragm clamp studs through the holes at the end of the body. Screw nuts on the outer diaphragm clamp studs and tighten securely.

d. Place spring over push rod. Place the cover over push rod and into body. Install cap screws and lock washers holding cover to body. Position a new rubber boot over push rod and attach to cover. Install lock nut and yoke on push rod.

119. Test

a. Prepare test bench (fig. 71 and par. 60b).

b. Connect line 2 (fig. 71) to air inlet port (fig. 159) of rotochamber. With normal air pressure in the system move valve 4 (fig. 71) slowly to the fully applied position. Coat the outer edge of the cover where it meets the body with soap suds to detect leakage. Coat the rubber boot with soap suds to detect leakage. No leakage is permissible. Move valve 4 (fig. 71) to released position.

c. Move valve 4 (fig. 71) until gage 2 reads 5 pounds and note that push rod begins to move out. Move valve slowly to fully applied posi-

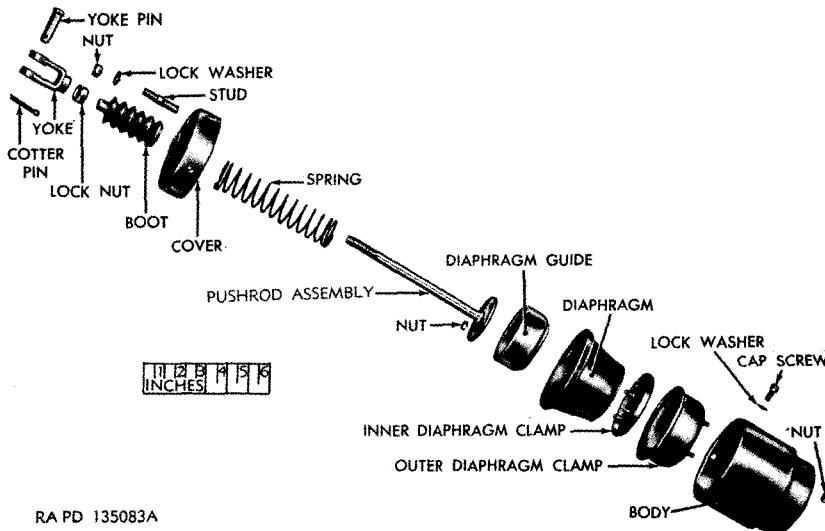


Figure 161. Typical rotochamber—exploded view.

tion and note that push rod moves out promptly and without binding. Move valve 4 to the released position and note that push rod returns to the released position promptly and without binding.

d. Disconnect line 2 (fig. 71) and remove rotochamber.

120. Tabulated Data

Type	Effective area (sq. in.)	Overall diameter (in.)	Stroke (in.)
9	9	4 ¹³ / ₁₆	2
12	12	5 ¹¹ / ₃₂	2
16	16	5 ¹⁵ / ₁₆	2 ¹ / ₂
20	20	6 ¹⁵ / ₃₂	2 ¹ / ₂
24	24	7 ¹ / ₃₂	2 ¹ / ₂
30	30	7 ¹⁹ / ₃₂	3
36	36	8 ¹ / ₄	3 ¹ / ₂
50	50	9 ¹ / ₂	4

Section III. BRAKE CYLINDERS

121. Description and Operation

a. *Description.* Brake cylinders serve the same basic purpose as brake chambers and rotochambers. They consist of a single acting cylinder fitted with an air piston and push rod. Brake cylinders are made with two different mountings and with several different diameters and strokes. Refer to tabulated data (par. 127). The smaller sizes (figs. 162 and 163) are usually trunnion mounted which permits lateral displacement of push rod yoke during operation. Larger sizes are usually rigidly mounted and are fitted with hollow piston guides. A ball point connection of push rod to piston permits some lateral deflection of push rod yoke (fig. 164).

b. *Operation.* When air pressure is admitted back of piston, the push rod is forced forward. When air pressure is released, the piston spring returns piston and push rod to original position.

122. Preliminary Examination

Inspect unit for broken or damaged parts. Perform leakage and operation tests (par. 126). No disassembly is necessary if unit passes inspection.

Note. Unit will be disassembled once a year or after every 50,000 miles for cleaning and piston cup replacement.

123. Disassembly

a. *Trunnion Mounted Cylinder* (fig. 163). Remove cap screws and lock washers holding cylinder head in place and pull out cylinder head

and push-rod-and-piston assembly. Remove yoke, lock nut, cylinder head, and piston return spring from push rod. Remove nut holding piston on push rod and remove piston follower, grommet, spacer, piston cup, and piston. Remove air strainer and felt oil seal from cylinder head.

b. Rigidly Mounted Cylinder (fig. 164). With the exception of push-rod-and-piston assembly, disassembly of this cylinder is same as for trunnion mounted type (*a* above). To disassemble piston, remove yoke, lock nut, cylinder head, and piston return spring from push rod. Unscrew piston follower and remove piston cup. Remove piston felt oil seal. Loosen lock nut on piston guide and unscrew guide from piston. Push rod and push rod retainer are removed from guide and shim from piston. Remove air strainer, retaining ring, felt oil seal, and washers from cylinder head.

124. Cleaning, Inspection, and Repair

a. Cleaning. Wash all parts except piston cup with dry-cleaning solvent or volatile mineral spirits.

b. Inspection and Repair. Check piston cup. If cup is worn thin or if edges are damaged, replace cup. Check fit of push rod, or piston guide in cylinder head bushing (figs. 163 and 164). These must be a sliding fit. Check condition of push rod or piston guide, and cylinder

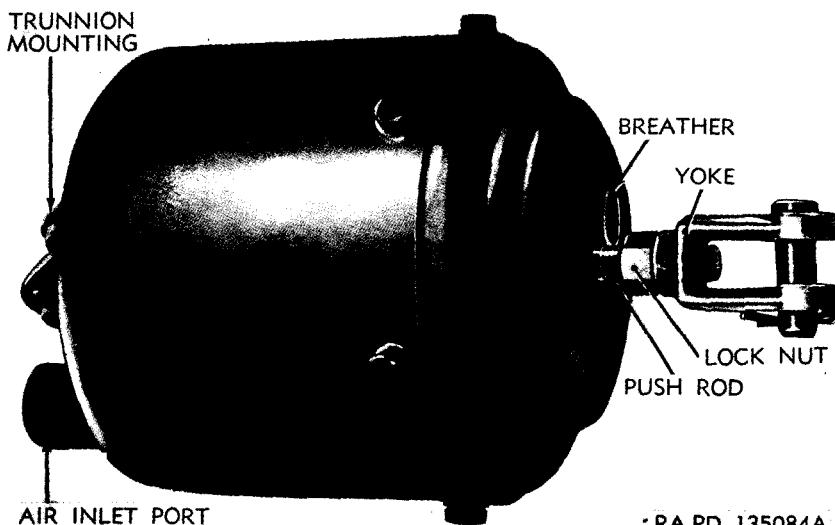


Figure 162. Typical brake cylinder—trunnion mounting.

head bushing. Replace worn or damaged parts. Internal cylinder walls must be smooth. If cylinder is dented it must be replaced.

125. Assembly

a. Trunnion Mounted Cylinder (fig. 163).

- (1) Place piston on push rod, install piston cup and piston spacer. Cup lip must face away from piston. Place new grommet in spacer recess, install piston follower and nut. Tighten nut securely. Place piston return spring over push rod.
- (2) Install air strainer in cylinder head. Fill grease groove in cylinder head bushing with automotive and artillery grease (GAA), and install felt oil seal in groove. Also use this grease to coat inside of cylinder and piston cup.
- (3) Place cylinder head on push rod and install lock nut and yoke. Carefully insert piston-and-push-rod assembly into cylinder. Guard against damage to piston cup. Secure cylinder head with cap screws and lock washers.

b. Rigidly Mounted Cylinder (fig. 164).

- (1) Place push rod retainer over rod with spherical recess seated against ball. Insert push rod into piston guide and seat retainer against shoulder. Place lock nut on piston guide and run on to end of threads. Fill cavity around push rod ball with automotive and artillery grease (GAA), place shim in

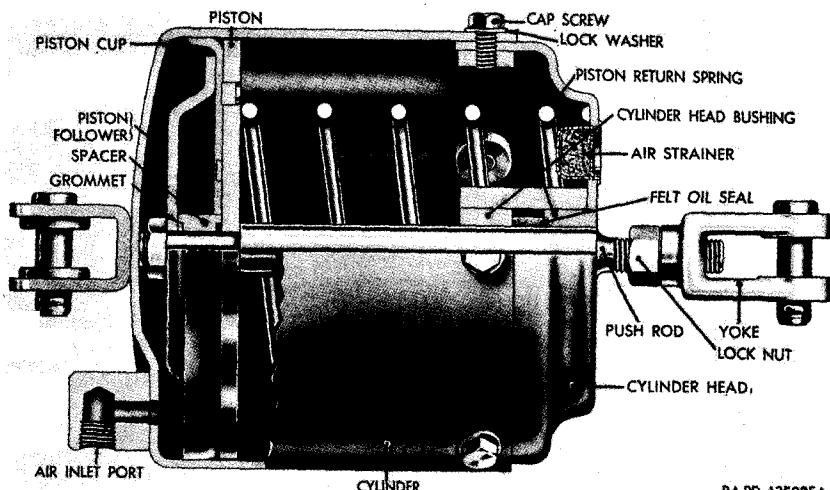


Figure 163. Sectional view of brake cylinder—trunnion mounting.

center recess of piston, install guide in piston, and seat solidly against shim. Tighten lock nut against piston.

- (2) Install felt oil seal in piston groove and position piston cup with lip away from piston. Install piston follower and turn down tight against cup. Use suitable spanner wrench or a drift to tighten follower.
- (3) Place piston return spring over piston guide and slip cylinder head on piston guide. Install yoke and lock nut on push rod.
- (4) Coat inside of cylinder, piston cup, and oil seal with automotive and artillery grease (GAA) and carefully insert piston into cylinder. Guard against damage to piston cup. Seat cylinder head and secure with cap screws and lock washers.
- (5) Fill cavity in cylinder head with automotive and artillery grease and install felt oil seal, washers, and retaining ring. Install air strainer.

126. Test

- a. Prepare test bench (fig. 71 and par. 60b).
- b. Connect line 2 (fig. 71) to air inlet port of brake cylinder. With normal air pressure in the system move valve 4 slowly to the fully applied position. Coat the air strainer with soap suds to detect leakage. No leakage is permissible. Move valve 4 to released position.
- c. Move valve 4 (fig. 71) until gage 2 reads 5 pounds and note that brake-cylinder-push rod begins to move out. Move valve 4 slowly to

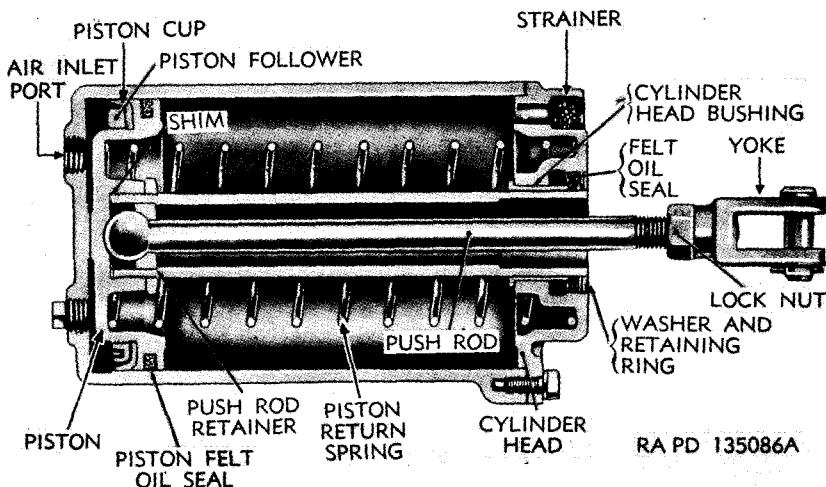


Figure 164. Typical brake cylinder—rigid mounting.

[REDACTED]

the fully applied position and note that push rod moves out promptly and without binding. Move valve 4 to the released position and note that push rod returns to the released position promptly and without binding.

d. Disconnect line 2 (fig. 71) and remove brake cylinder.

127. Tabulated Data

Diameter cylinder (in.)	Stroke (in.)
4½	2½
5	6
5½	3
6	3
6	3½
6	4
6	6
6	8

CHAPTER 9

SLACK ADJUSTERS

128. Description and Operation

a. Description. The slack adjuster provides a quick and easy method of adjusting brakes to compensate for brake lining wear. Fundamentally, all slack adjusters are alike, the different types differing only in torque capacity. They consist essentially of a worm and gear housed in a body having an extended lever arm. The worm gears are splined to fit S.A.E. standard 10-spline shafts of $1\frac{1}{8}$ -, $1\frac{1}{4}$ -, and $1\frac{1}{2}$ -inch diameters. Adjustment is obtained by rotation of worm shaft which alters the angular relation of lever to brake camshaft. A locking device holds the adjustment in position.

b. Types. Slack adjusters are classified by types according to their torque capacities. In the past, the types were identified by the letters G, K, L, R, and RB, all of which except the L type have been superseded in recent years by numbered types. The L type is still infrequently used for very light service where maximum torque is 8,000 inch-pounds. The numbered types differ from the lettered types mainly by having an improved locking device which is not subject to wear or accidental displacement of the adjustment. The torque capacity in thousands of inch-pounds, of the numbered types is indicated by the type numbers. Thus type 15 has maximum torque capacity of 15,000 inch-pounds, type 25 a maximum torque capacity of 25,000 inch-pounds, etc. Because the older types are still in service, types K, R, and RB are illustrated in this manual. All slack adjusters are made with straight, bent, or offset arms to meet installation requirements. Straight and offset arms are shown in figure 165.

c. Operation.

- (1) In normal braking, the entire slack adjuster remains as a rigid unit and acts as a simple lever to transmit brake chamber force to brake camshaft as brakes are applied or released.
- (2) All adjustments are made by turning the worm shaft, thus rotating the worm gear and changing the angular relation of lever arm to brake camshaft. The extended ends of all worm shafts on lettered type adjusters are either flattened or squared for wrench fit. Spring-loaded ball detents, or plungers, engaging indentations in worm shafts, lock adjusted positions.
- (3) On numbered type adjusters (fig. 166) a hex head is formed on

extended end of worm shaft. A sleeve, or worm lock, having a double hex recess and keyed to body of adjuster to prevent turning, normally is held in outward position by a spring. In this position the hex recess engages hex head of worm shaft and prevents its rotation. To adjust, a wrench is positioned

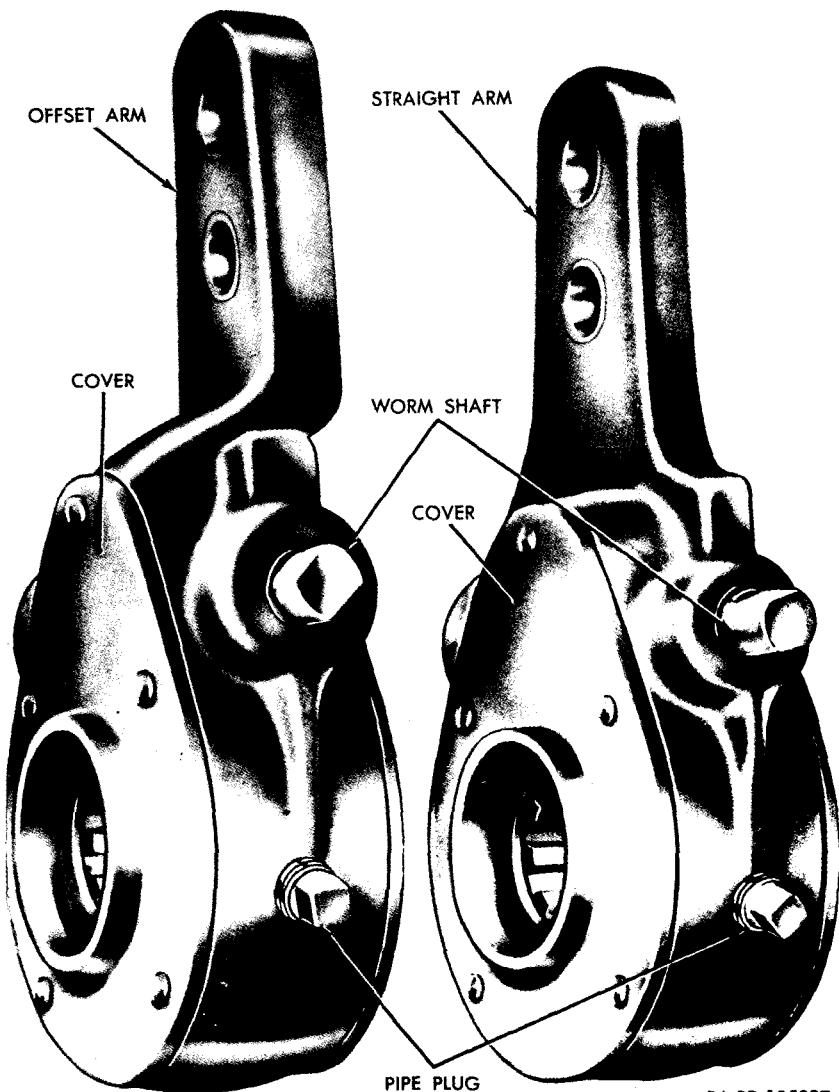


Figure 165. Type K slack adjuster—straight and offset arm.

over end of worm shaft and pushed on hex head until worm shaft lock recess is disengaged from head. Adjustment is made in usual manner and lock engaged with worm shaft head when wrench is withdrawn.

129. Inspection Before Rebuild

- a. Slack adjusters may be inspected for serviceability while mounted on vehicle or after removal. Because numerous defects may be corrected without disassembly, inspection and repair are treated together when possible.
- b. Due to the construction and function of slack adjusters, only breakage of body will necessitate replacement.

130. Inspection and Repair

- a. *Breakage.* Carefully inspect body for evidence of cracks or distortion. Replace adjuster, if any defect is found.

b. Wear.

- (1) *Lever arms.* With few exceptions or special adjusters, all yoke pin holes are provided with replaceable bushings.

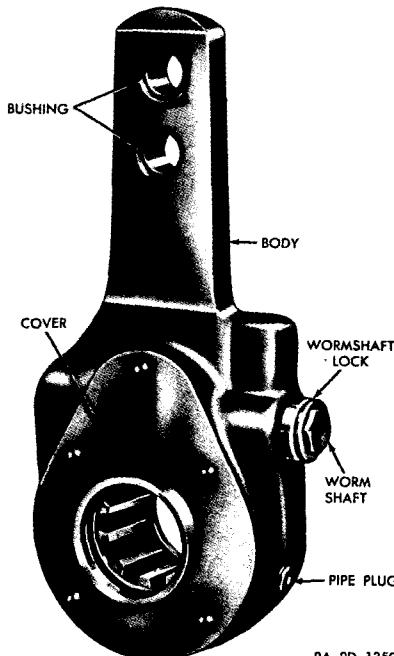
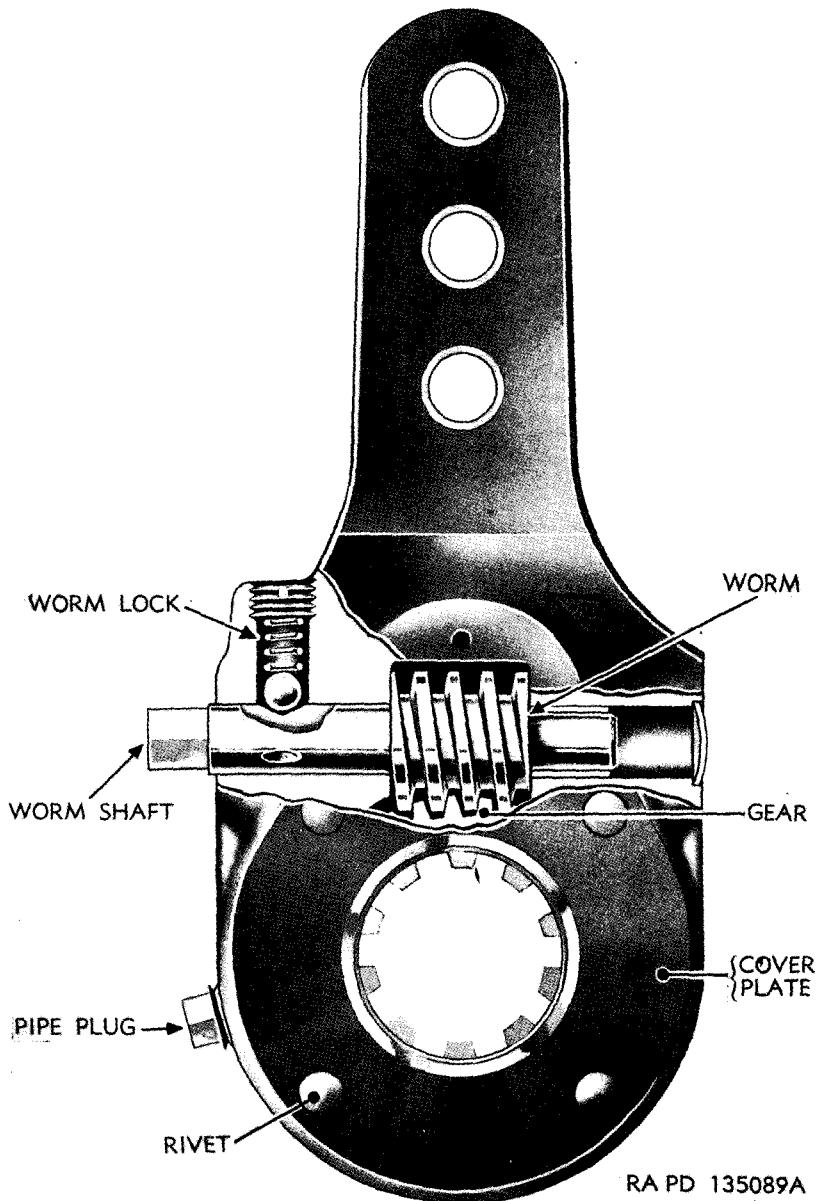


Figure 166. Typical numbered type slack adjuster.

Check play in holes. If yoke pin is loose in hole or if hole is out-of-round, press bushing out and press in replacement. Ream bushing after pressing in place.



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Figure 167. Sectional view—type K slack adjuster.

(2) *Backlash.* Check movement of lever arm while holding worm gear stationary. Although there is no relative movement of slack adjuster parts during brake application, the entire torque load is confined to one section of gear teeth. Continued application will result in ultimate wear. If lever movement is $\frac{1}{4}$ inch or more at approximately 6 inches from spline center, change gear position. Slack adjuster must be removed from brake camshaft for this correction. Turn worm shaft six revolutions to engage unworn gear teeth with worm.

(3) *Worm shaft.* Worm shaft replacement because of wear is required on lettered types of adjusters only. The locking device on this type consists of a ball plunger engaging detents in worm shaft. Check by turning worm shaft in both directions. Resistance to turning in either direction should be same. A great difference in one direction indicates that locking device has been set too tight and that worm shaft is damaged and must be replaced.

(a) *Types K and RB.* Disassembly necessary (par. 131).

(b) *Type R.* Unscrew worm stop nut from body and remove worm.

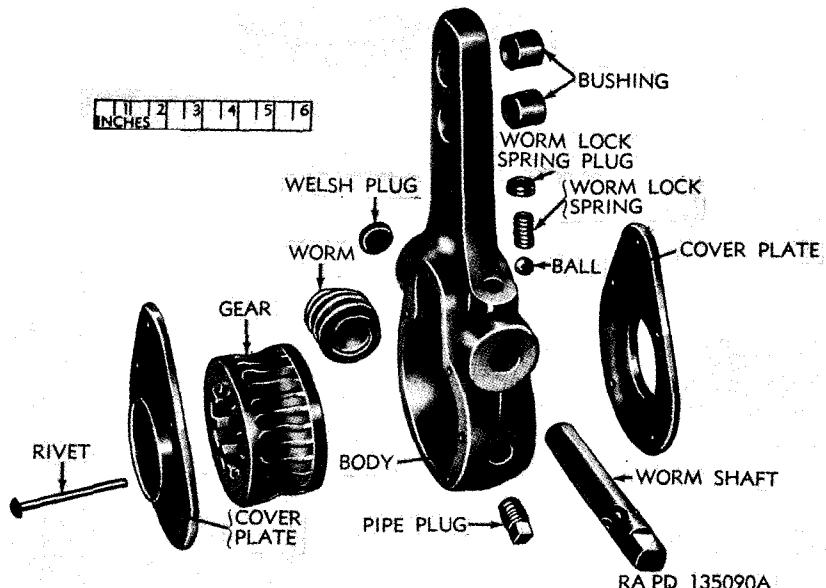


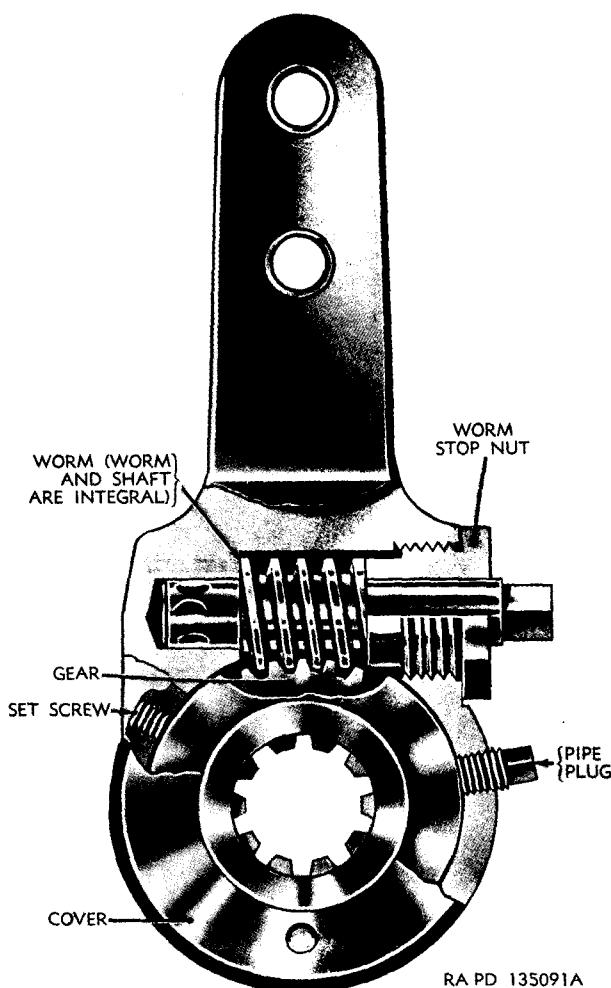
Figure 168. Type K slack adjuster—exploded view.

(c) All numbered types. Disassembly necessary (par. 132).

(4) Locking device.

(a) Types K and R. Replace without disassembly. Remove worm lock spring plug, spring, and ball (or plunger) from body.

(b) Type RB and all numbered types. Disassembly necessary (pars. 131 and 132).



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Figure 169. Sectional view—type R slack adjuster.

131. Disassembly of Lettered Types

a. Type K (figs. 167 and 168).

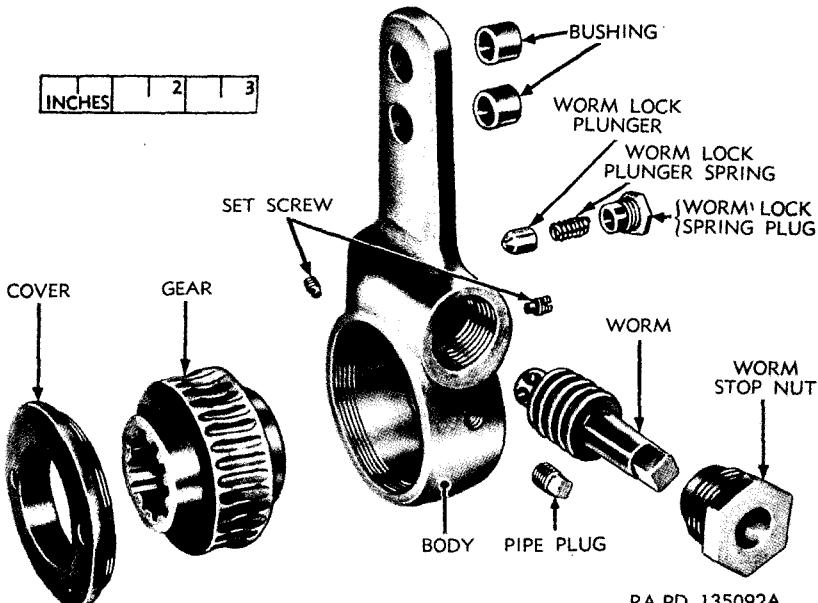
- (1) Drive out rivets and remove cover plates.
- (2) Remove worm lock spring plug, spring, and ball from body.
- (3) Remove welsh plug at end of worm shaft.
- (4) Insert drift against end of worm shaft under plug and press shaft out of worm. Remove worm and gear from body.

b. Type R (figs. 169 and 170).

- (1) Remove set screw locking cover in place and unscrew cover.
- (2) Remove set screw holding worm stop nut in place and remove worm stop nut.
- (3) Remove worm and lift gear from body.

c. Type RB (figs. 171 and 172).

- (1) Drive out rivets and remove cover plates.
- (2) Remove worm lock springs and plungers from body.
- (3) Remove welsh plug at end of worm shaft.
- (4) Insert drift against end of worm shaft under welsh plug and press shaft out of worm. Remove worm and gear from body.



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Figure 170. Type R slack adjuster—exploded view.

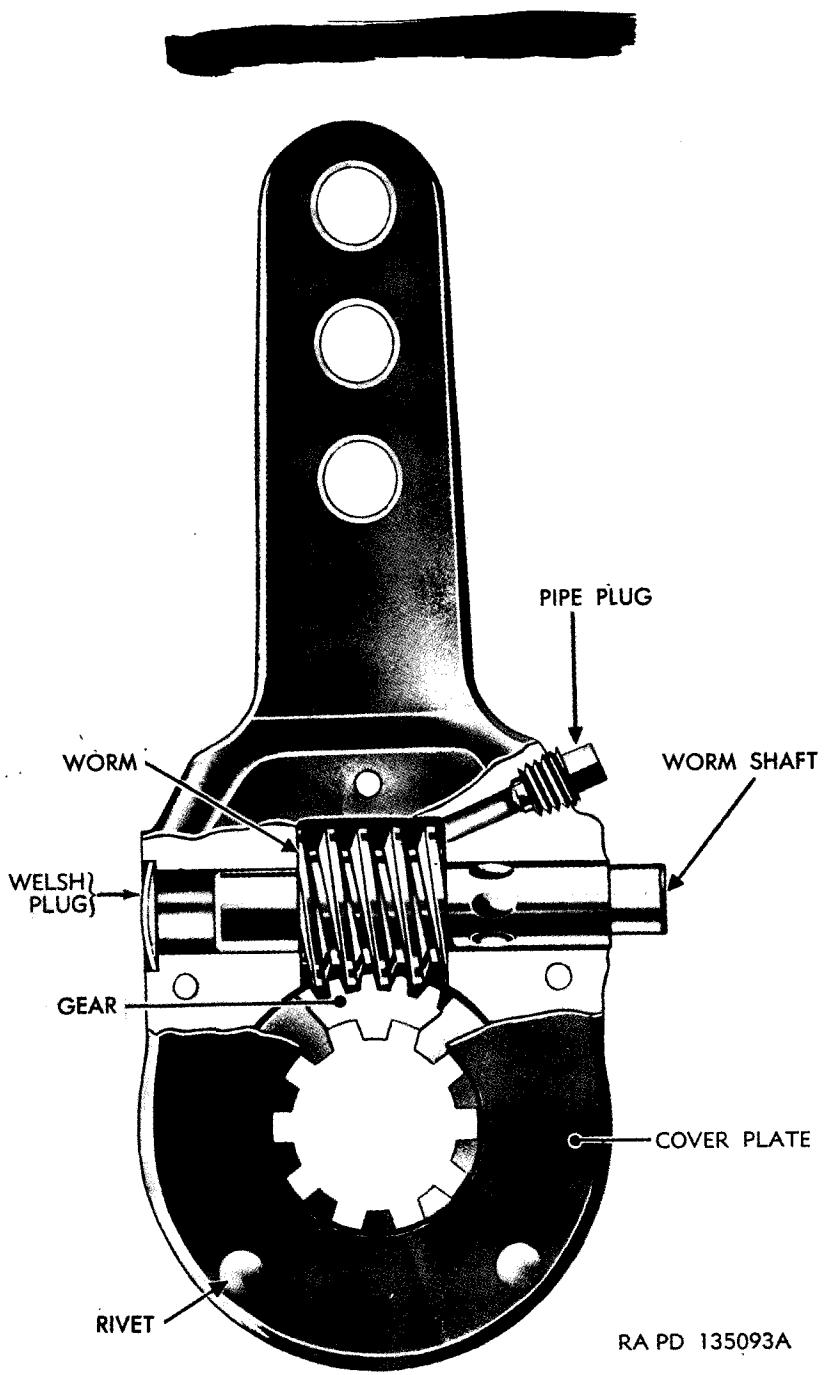


Figure 171. Sectional view—type RB slack adjusters.

132. Disassembly of Numbered Types

a. *Types 15, 16, 20, 22, 23, and 25* (figs. 173 and 174). Construction of the numbered type slack adjusters is identical except in strength of parts. Disassembly procedure is same for each type.

- (1) Remove rivets holding cover plates and remove cover plates.
- (2) Remove welsh plug, insert drift, and press worm shaft from worm.
- (3) Remove worm shaft lock spring and worm shaft lock from shaft.
- (4) Remove worm and gear from body.

133. Cleaning, Inspection, and Repair

a. *Cleaning*. Wash all parts with dry-cleaning solvent or volatile mineral spirits.

b. Inspection and Repair.

- (1) *Body*. Inspect body for cracks or distortion. Check condition of pin holes in arm. If out-of-round or worn, replace bushings. Drive or press out bushing and install replacement. Ream bushing to proper size after replacement.
- (2) *Worm gear*. Inspect gear for broken teeth or damaged splines. Replace gear if either are found. After considerable service,

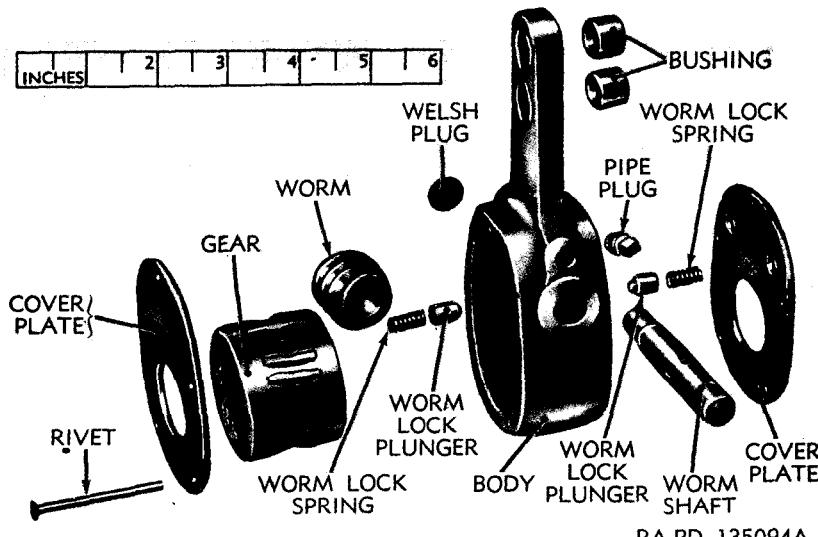
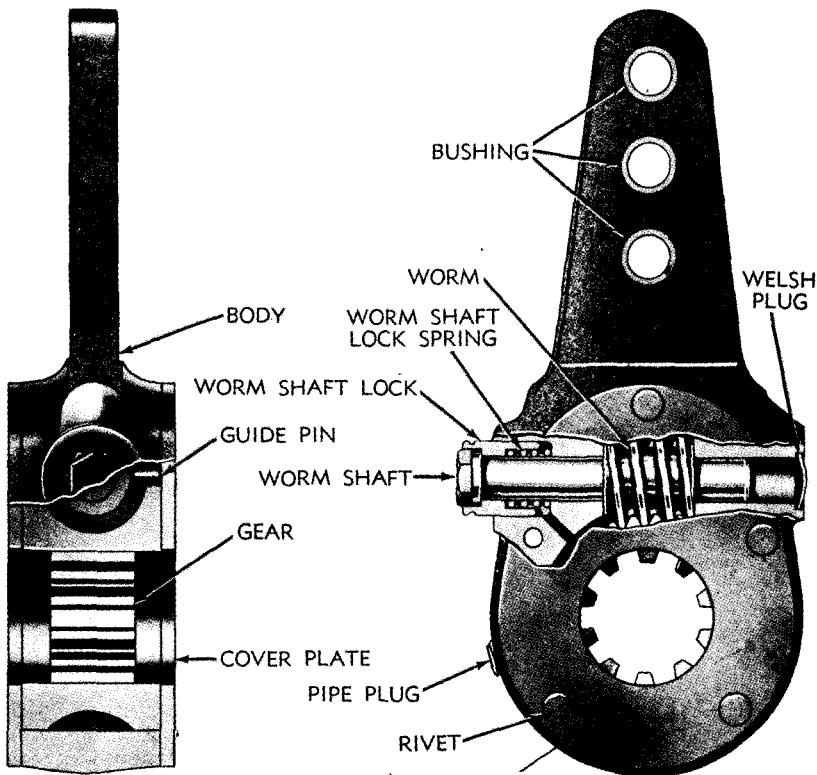


Figure 172. Type RB slack adjuster—exploded view

gear may show wear on one section of teeth. Such gear is serviceable if installed with good teeth in contact with worm.

- (3) *Worm.* Check worm for bent or deeply scored threads and replace, if such are found.
- (4) *Worm shaft.* Check edges of indents engaged by worm lock (lettered types only). With the exception of the type R, all shafts are pressed into serrated bores of worms. Type R worms and shafts are integral. Replace shaft, if edges of indents are damaged. The bores of all worms are serrated to assure a rigid assembly with shaft. Repeated removal and installation of a shaft in a serrated bore may impair firmness of fit and require the use of a new shaft in the assembly.
- (5) Check worm lock springs and replace broken or distorted springs.



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Figure 173. Sectional view—numbered type slack adjuster.

134. Assembly of Lettered Types

(figs. 167, 168, 171, and 172)

a. *Types K and RB.* Place worm and gear in body. Insert shaft in worm and press in place. While pressing shaft, check position of indents and press shaft just far enough to aline these with worm lock. An alternative method of locating worm shafts can be used if desired. Place short piece of round stock, of correct length to serve as a stop for the shaft, in shaft bore under worm shaft and press worm shaft in until it bottoms against the piece of round stock. (For type K adjusters use $\frac{7}{16}$ -inch round stock, $\frac{5}{8}$ -inch long. For type RB adjusters use $\frac{1}{16}$ -inch round stock, $\frac{37}{64}$ -inch long.) Install welsh plug.

b. Install Worm Lock.

- (1) *Type K.* Insert ball and worm lock spring in hole over worm shaft and install worm lock spring plug. Do not tighten plug on spring until assembly is complete.

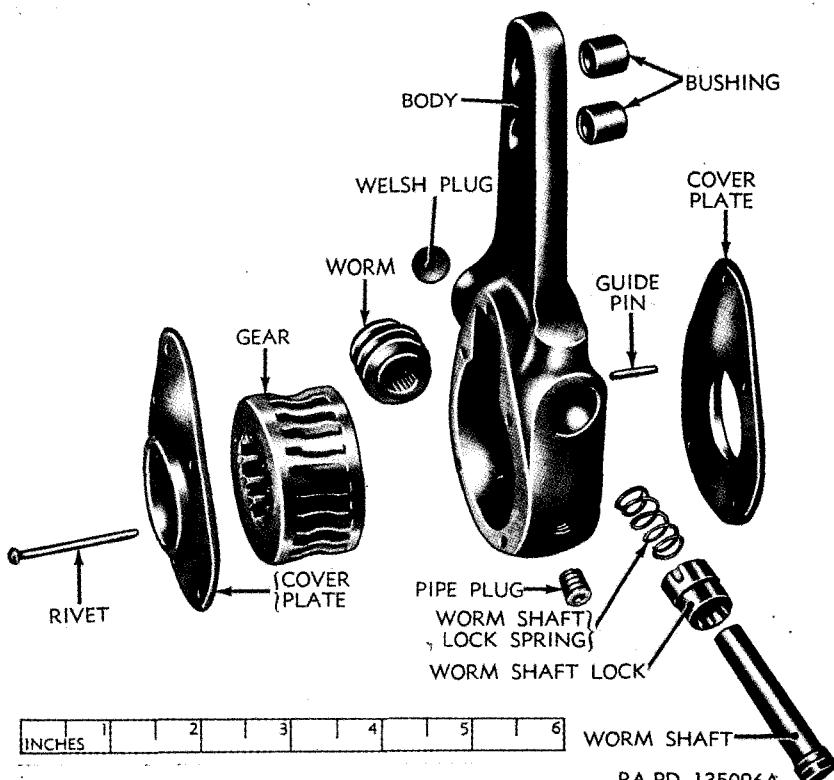


Figure 174. Numbered type slack adjuster—exploded view.

(2) *Type RB.* Place a worm lock plunger in the hole on each side of worm shaft and insert a worm lock spring in each hole.

c. *Install Cover Plates.* Place cover plates in position and rivet securely. Tighten worm lock spring plug on type K slack adjusters until worm lock offers some resistance to turning worm shaft.

Note. Guard against tightening worm lock spring plug so far that ball will not clear indents in shaft.

d. *Type R* (figs. 169 and 170). Place worm and gear in body. Install worm stop nut in body and tighten. Aline hole in stop nut with tapped hole in body and install set screw locking stop nut in place. Install cover and tighten. Aline hole in cover with tapped hole in body and install set screw locking cover in place.

e. *Lubricate.* Remove pipe plug. Fill slack adjusters with automotive and artillery grease (GAA) through tapped hole in body. Install pipe plug.

135. Assembly of Numbered Types

(figs. 173 and 174)

a. Place worm and gear in body.

b. Place worm shaft lock and spring over worm shaft with the 12-point socket next to hexagon on worm shaft. Insert shaft into worm, aline slot in worm lock with guide pin in body and press shaft into worm a short distance to hold assembly together.

c. The distance worm is pressed into shaft is important. When properly assembled, worm lock must depress until it clears hex head of shaft and when lock is released it must engage hex head. To position shaft, place a short piece of round stock in end of shaft bore as a stop against which to press shaft. Sizes of stock to use for each slack adjuster are given in the following table:

Type	Diam. stroke (in.)	Length (in.)
15	$\frac{7}{16}$	$\frac{5}{8}$
16	$\frac{1}{2}$	$\frac{7}{16}$
20	$\frac{1}{2}$	$\frac{9}{16}$
22	$\frac{1}{2}$	$\frac{9}{16}$
23	$\frac{1}{2}$	$\frac{9}{16}$
25	$\frac{1}{2}$	$\frac{9}{16}$

As an alternative method, worm shafts can be positioned by use of spacers over the hex head. Plain washers are placed over the hex head and against worm shaft lock. Select washers to get a total thickness

slightly greater than thickness of hex head. Press shaft into worm until worm shaft lock bottoms in adjuster body. Install welsh plug.

- d. Place cover plates in position and rivet securely.
- e. Remove pipe plug. Fill slack adjuster with automotive and artillery grease (GAA) through tapped hole in body and install pipe plug.

136. Test

Turn worm shaft until gear makes one complete revolution. There must be no evidence of binding. Check backlash; it should be no more than just perceptible.

CHAPTER 10

CHECK VALVES

Section I. SINGLE CHECK VALVE

137. Description and Operation

The single check valve (figs. 175 and 176) is a small device placed in an air line when it is important to allow air passage in one direction and prevent passage in reverse direction. They are most frequently used in the front emergency line on trucks or tractors having front hose connections. Check valves contain a spring-loaded ball or disk which normally seats against air inlet in one end of inner chamber. Air flow in normal direction raises the check from seat and flow is unobstructed. Flow in reverse direction is prevented by the seating of ball or disk by spring load assisted by air pressure.

138. Preliminary Examination

Inspect unit for broken or damaged parts. Perform leakage and operation tests (par. 142). No disassembly is necessary, if unit passes inspection.

Note. Unit will be disassembled once each year or after every 50,000 miles for cleaning.

139. Disassembly

a. *Ball Type* (fig. 175). Unscrew cap nut from body and discard gasket. Remove steel ball, spring, and spring seat from body and cap nut.

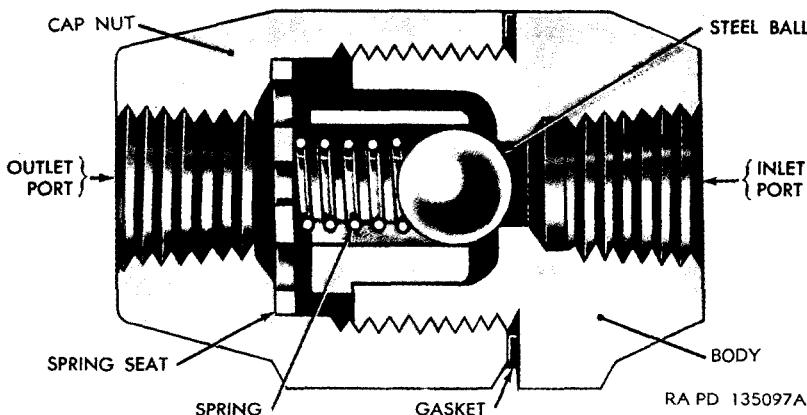


Figure 175. Sectional view—ball type single check valve.

b. *Disk Type* (fig. 176). Unscrew cap nut from body and remove grommet. Remove disk valve, valve stop bushing, and spring from body.

140. Cleaning and Inspection

a. *Cleaning*. Clean all parts in dry-cleaning solvent or volatile mineral spirits.

b. *Inspection*. Inspect ball or disk valve and seat for pitting or corrosion. Inspect body and cap nut for wear or damage. Replace damaged parts.

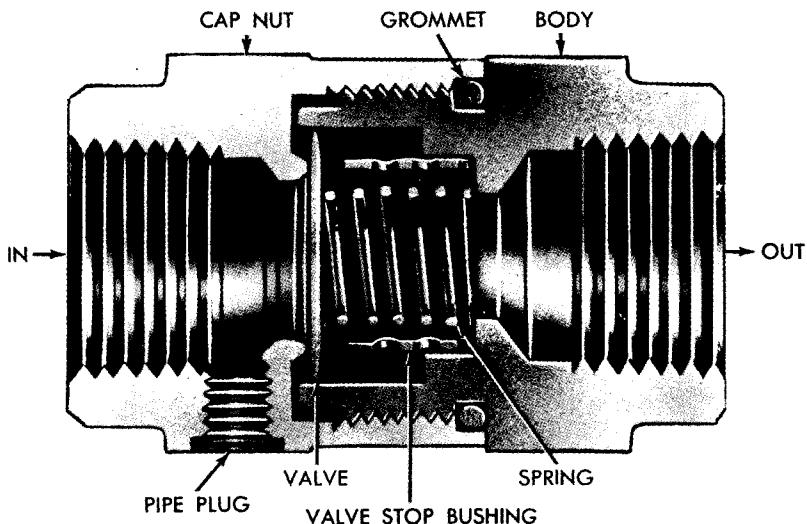
141. Assembly

a. *Ball Type* (fig. 175). Place spring seat in cap nut and position steel ball and spring in body. Install a new gasket on body and screw cap nut onto body. Tighten securely.

b. *Disk Type* (fig. 176). Position valve stop bushing, spring, and disk valve in body. Install grommet on body and screw cap nut onto body. Tighten securely.

142. Test

a. Apply air pressure to the end of the check valve through which



RA PD 135098

Figure 176. Sectional view—disk type single check valve.

the ball can be seen (fig. 175) or in the direction of the arrow cast on the body of the disk type valve. Air must flow through check valve freely.

b. Apply 100 psi air pressure to the opposite end of the check valve and coat the open end with soap suds to detect leakage. No leakage is permissible.

Section II. DOUBLE CHECK VALVES

143. Description and Operation

a. Description. Double check valves are used when it is necessary to automatically direct the flow of air into a common line from either of two other lines. These valves are used in air brake systems having two brake valves, such as systems having independently controlled trailer brakes.

b. Types. Two types of double check valves are in use—shuttle type and disk type.

(1) *Shuttle type* (figs. 177, 179, and 181). The shuttle type consists of a die-cast body inclosing a closed end cylinder or shuttle valve, which is free to move in body. Ends of body are closed by rubber gaskets and bolted end covers. Both end covers are tapped for air line inlet connections. A tapped outlet connection in body is located midway between the ends.

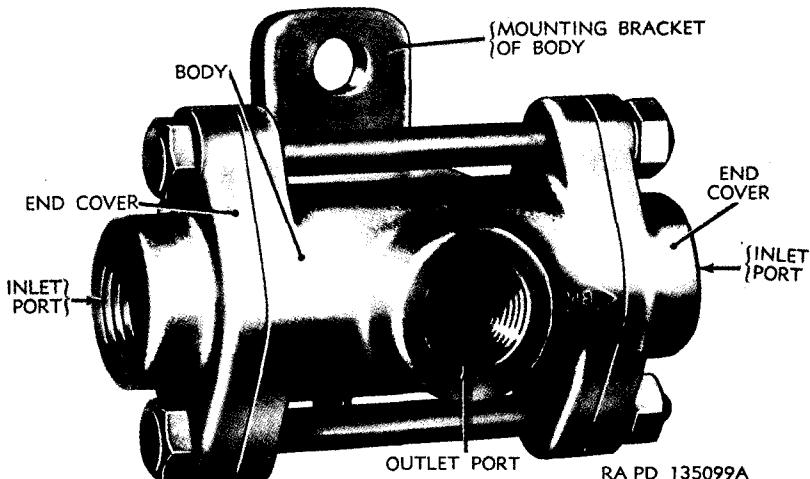


Figure 177. Shuttle type double check valve.

(2) *Disk type* (figs. 178, 180 and 182). The disk type consists of a cast body closed by one cap held in place by cap screws. The valve is a free rubber disk (or a rubber disk fastened to a free plug that serves to prevent the valve from tilting in the valve guide) inclosed in a perforated valve guide which is positioned centrally in valve body. Four tapped connections for air lines are provided; two inlet connections, one in cap and one in end of body, and two outlet connections in the body, diametrically opposite each other from the central chamber.

c. *Operation* (figs. 179 and 180). The operation of both type valves is similar. As air enters either inlet, the pressure moves the shuttle or disk valve to the opposite end where it seals that inlet opening. The center outlet is always clear permitting unobstructed air flow to the common line. Even in the event that some air pressure may exist in

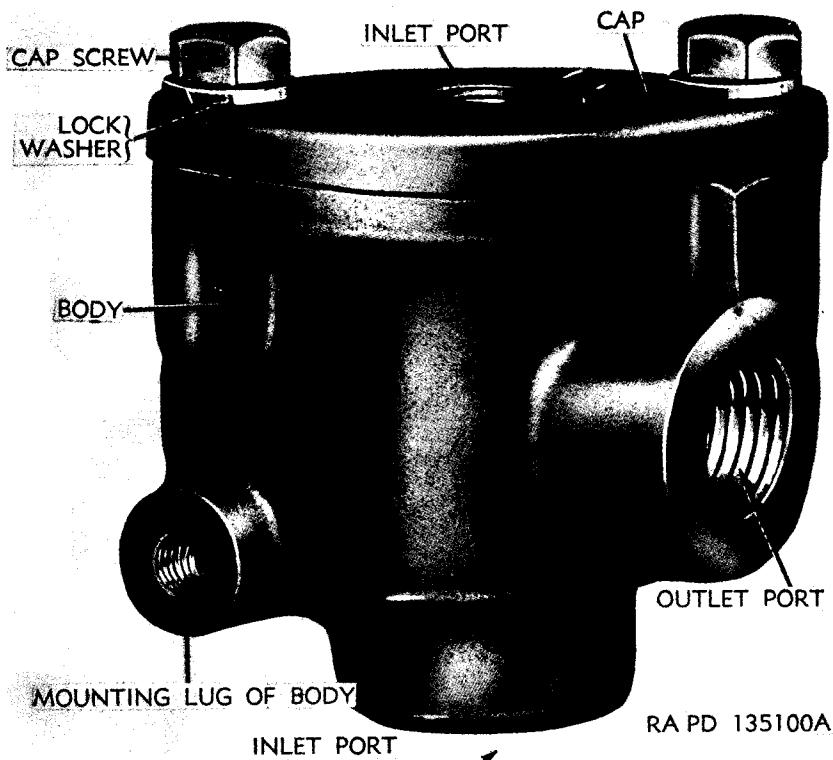


Figure 178. Disk type double check valve.

the inactive line, the line having the higher pressure will prevail and valve will function in normal manner.

144. Preliminary Examination

Inspect unit for broken or damaged parts. Perform leakage and operation test (par. 148). No disassembly is necessary if valve passes test and it should be returned to service.

Note. Valve must be completely disassembled and cleaned once each year or after every 50,000 miles.

145. Disassembly

a. *Shuttle Type* (fig. 181). Remove the two bolts holding end covers in place. Remove and discard gaskets. Remove shuttle valve.

b. *Disk Type* (fig. 182). Remove the two cap screws and lock washers holding the cap in place. Lift off cap and discard grommet. Withdraw valve guide and valve from body.

146. Cleaning, Inspection, and Repair

a. *Cleaning.* Clean all metal parts in dry-cleaning solvent or volatile mineral spirits.

b. *Inspection.*

(1) *Shuttle type.* Inspect inside bore of body for scores or ridges. Inspect shuttle valve for wear or damage, particularly the end surfaces.

(2) *Disk type.* Inspect valve seat on end cap and in body for signs of pitting or damage. Inspect valve guide for damage.

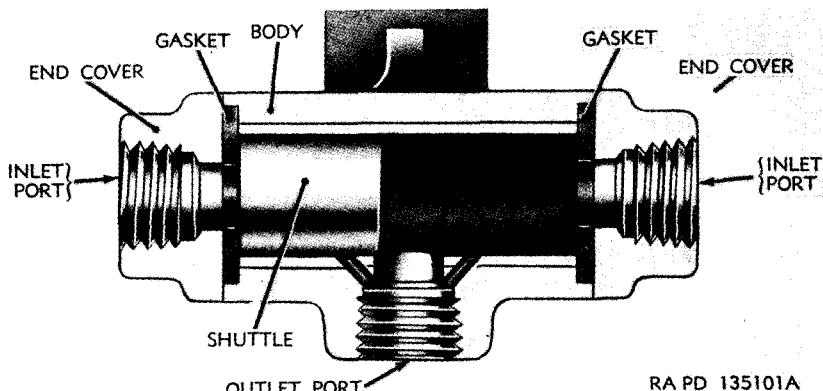


Figure 179. Sectional view—shuttle type double check valve.

c. *Repair.*

- (1) *Shuttle type.* Slight scratches on the bore of the body or on the shuttle valve may be corrected by polishing with crocus cloth. If either part is badly scratched or scored, it must be replaced.
- (2) *Disk type.* If valve seats are pitted or damaged, the part must be replaced. If valve is grooved or worn, it must be replaced.

147. Assembly

a. *Shuttle Type* (fig. 181). Place shuttle valve in body. Use new gaskets and position them and end caps on body with the smooth surface of the gasket against the body. Install bolts and secure with lock washers and nuts. Tighten bolts evenly.

b. *Disk Type* (fig. 182). Insert valve guide in body and center it over machined boss. Place valve in guide. Use a new grommet and position it in recess and install valve cap. Secure cap with cap screws and lock washers.

148. Test

a. *Shuttle Type* (fig. 179). Plug outlet. Connect air line to one inlet port and apply 100 psi air pressure. Coat other inlet with soap suds to detect and evaluate leakage. Repeat test on other inlet. Leakage that produces a 1-inch soap bubble in less than 3 seconds is not permissible. Coat entire valve with soap suds and check for leakage at end covers. No leakage is permissible.

b. *Disk Type* (fig. 180). Plug both outlets and test as in a above.

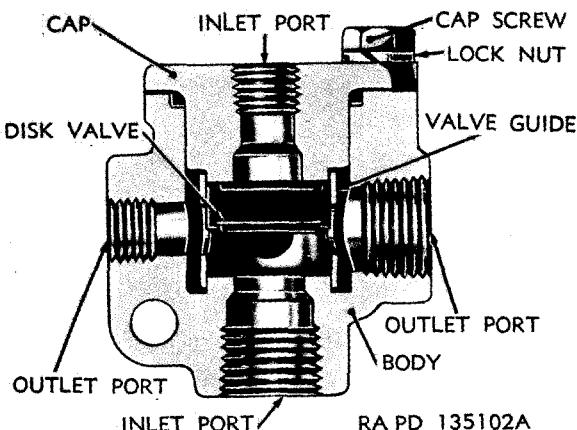


Figure 180. Sectional view—disk type double check valve.

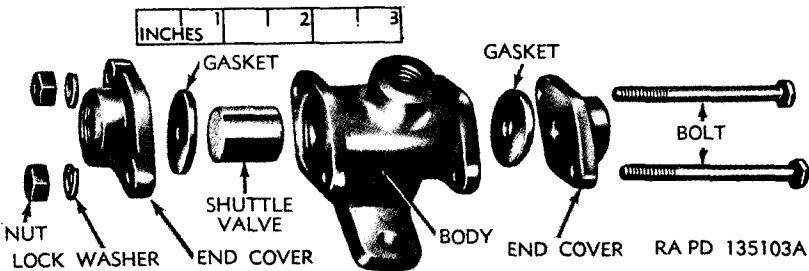


Figure 181. Shuttle type double check valve—exploded view.

Section III. EXHAUST CHECK VALVE

149. Description and Operation

a. *Description* (fig. 183). The exhaust check valve is a rubber diaphragm check valve used in the exhaust port of relay-emergency valves to prevent dirt or water from entering the valve through exhaust port.

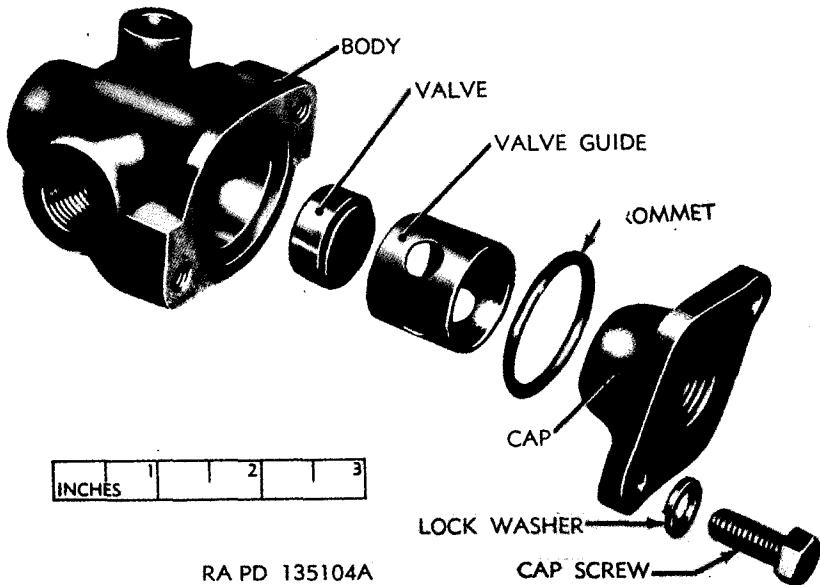


Figure 182. Disk type double check valve—exploded view.

b. *Operation.* Air pressure passes through the exhaust check valve by deflecting the rubber diaphragm. With no pressure, sufficient tension is placed on the rubber diaphragm by the washer to seal the valve.

150. Preliminary Examination

Inspect unit for broken or damaged parts. Perform leakage and operation test (par. 154). No disassembly is necessary if unit passes inspection.

Note. Unit is to be disassembled once a year or after every 50,000 miles for cleaning.

151. Disassembly

(fig. 184)

Remove screw and lock washer holding diaphragm in body. Lift out washer and diaphragm.

152. Cleaning and Inspection

a. *Cleaning.* Clean all metal parts in dry-cleaning solvent or volatile mineral spirits.

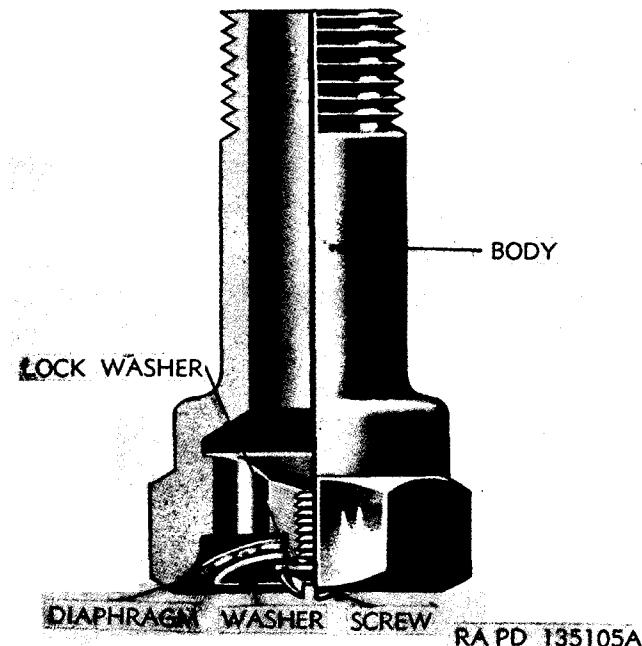


Figure 183. Sectional view—exhaust check valve.

b. Inspection. Inspect diaphragm seat of body, diaphragm, and washer for wear or damage. Replace if necessary.

153. Assembly

(fig. 184)

Position rubber diaphragm and washer in body. Install lock washer and screw and tighten.

154. Test

a. Apply air pressure to the exhaust check valve and see that the air passes through freely.

b. Immerse the diaphragm end of the exhaust check valve in water. Check for leakage of water past the diaphragm. No leakage is permissible.

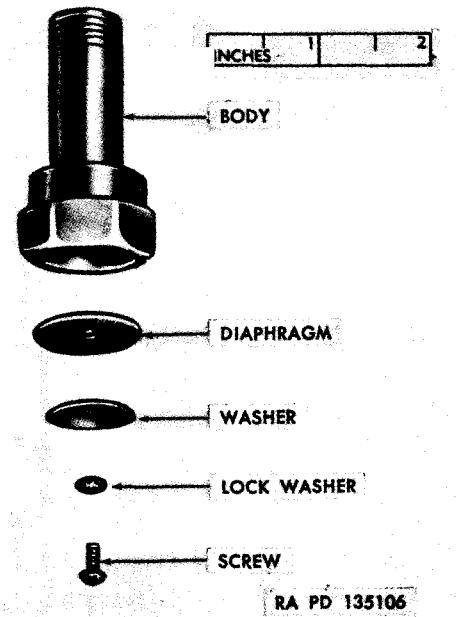


Figure 184. Exhaust check valve—exploded view.

CHAPTER 11

COCKS

Section I. CUT-OUT-COCKS

155. Description and Operation

(fig. 185)

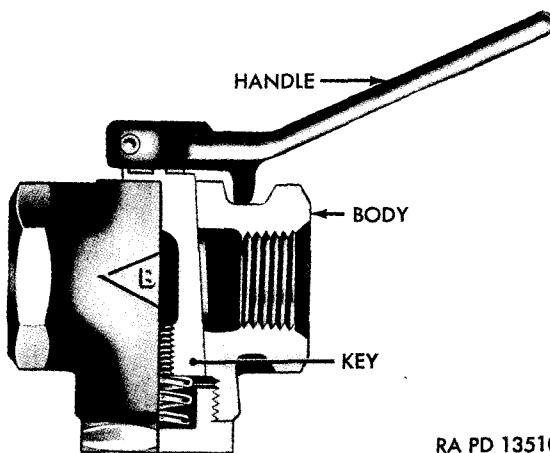
a. Cut-out cocks (fig. 185) usually are used in the service line and emergency line on trucks and tractors to provide a method of closing off these lines when they are not being used.

b. The cut-out cock is open when the handle is at a 90° angle with body of the cock. The cut-out cock is closed when the handle is parallel with the body of the cock. Stops are provided so that the handle cannot be turned beyond its normal open and closed positions.

c. Always open and close cut-out cocks by hand. Never strike the handle with a hammer or any heavy instrument, otherwise the cock may be damaged and leakage may develop.

156. Preliminary Inspection

Inspect unit for broken or damaged parts and test for leakage (par. 160). If no defect is found, cock will be returned to service.



RA PD 135107

Figure 185. Sectional view—cut-out cock in closed position.

157. Disassembly

(fig. 186)

Drive out rivet pin attaching the handle to the key and lift off handle. Remove cap nut covering the lower end of the key and lift out spring and key.

158. Cleaning, Inspection, and Repair

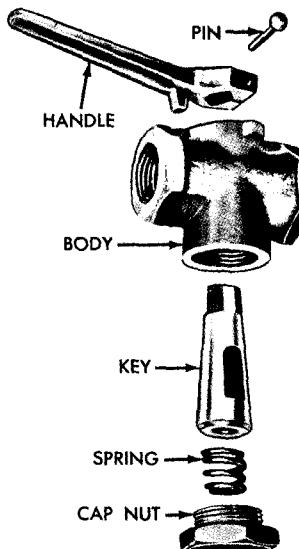
a. *Cleaning.* Wash all parts with dry-cleaning solvent or volatile mineral spirits.

b. *Inspection and Repair.* Inspect the outside of the key and inside bore of the body for ridges and scoring. Leakage due to slight ridges and scoring is corrected by grinding (lapping) key to body using fine grinding compound. If leakage has been caused by scoring, replace the complete cut-out cock. Do not attempt to fit or grind a new key to an old body or vice versa.

159. Assembly

(fig. 186)

Be sure all parts are thoroughly cleaned, apply a thin coating of automotive and artillery grease (GAA) with the fingers on the outside.



INCHES | 1 | 2

RA PD 135108

Figure 186. Cut-out cock—exploded view.

of the key and on the inside bore of the body. Place the key in position in the body. Install spring and cap nut putting a thin layer of automotive and artillery grease under the head of the cap nut where it contacts the body. Tighten cap nut securely. Place handle in position on key being sure the key is positioned so that with the handle installed, the projection on the bottom of the handle will properly engage the stops on the top of body in open and closed positions. Tap handle down on key so that rivet hole in key is in line with the rivet hole in the handle. Drive rivet into place and peen over the end.

160. Test

With cock in closed position, connect 100 psi air pressure to cock. Plug open end of cock and turn handle to open position. Coat all over with soap suds. No leakage is permissible in either position.

Section II. DRAIN COCKS

161. Description and Operation

(fig. 187)

a. The drain cock is open when the handle is parallel to the body and is closed when the handle is at right angles to the body. Drain cocks are installed in the bottom of each reservoir in the air brake system. Their purpose is to provide a convenient means of draining the condensation which normally collects in the reservoirs.

b. Open the drain cock by hand and never strike the handle with a hammer or any other heavy instrument, as the cock may be damaged, causing leakage.

162. Disassembly

(fig. 188)

Remove the cotter pin from the end of the key, lift off small washer, spring, large washer, and remove key from body.

163. Cleaning, Inspection, and Repair

a. *Cleaning.* Wash all parts with dry-cleaning solvent or volatile mineral spirits.

b. Inspect the key and bore of body for ridges and scoring. Slight leakage due to scoring is corrected by grinding (lapping) the key to the body using valve grinding compound (fine).

c. Leakage due to severe scoring cannot be corrected and the com-

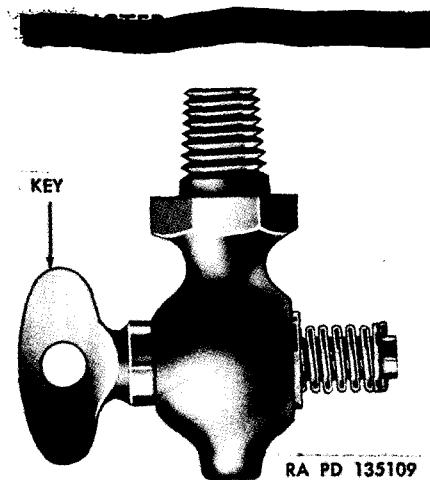


Figure 187. Drain cock in open position.

plete drain cock assembly must be replaced. Do not attempt to fit or grind a new key to an old body or vice versa.

164. Assembly

(fig. 188)

Put a thin coating of automotive and artillery grease on the outside of the key, and place the key in the body. Place the large washer, spring, and small washer, in this order over the end of the key and with the spring compressed, put the cotter pin in place through the end of the key. Spread the ends of the cotter pin.

165. Test

With drain cock in closed position, connect 100 psi air pressure to cock. Coat all over with soap suds to detect leakage. No leakage is permissible.

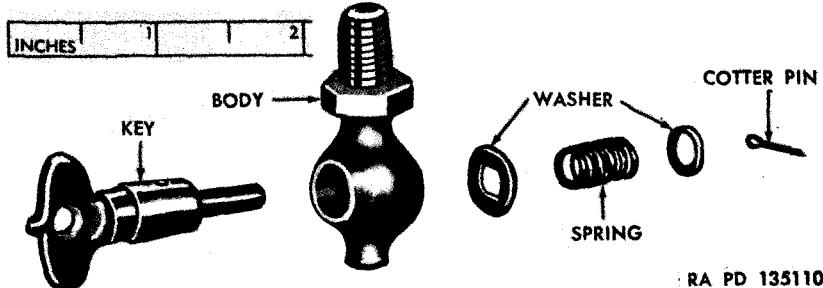


Figure 188. Drain cock—exploded view.

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CHAPTER 12

AIR LINES

Section I. HOSE AND HOSE ASSEMBLIES

166. Description

- a. Air hose and air hose fittings provide a means of making flexible air connections between points on a vehicle, which normally change their position in relation to each other, or between two vehicles.
- b. Air hose assemblies used to connect the air brake system of one vehicle to the air brake system of another vehicle are fitted with hose couplings (fig. 189). Identification tags (fig. 190) are used to identify the lines.
- c. All air hose assemblies include detachable type air hose fittings with spring guards (fig. 189). The hose illustrated is furnished in two grades—a standard, (identified as BW-101-M) for ordinary temperatures and a special type (identified as BW-170-M) which performs satisfactorily in temperatures as low as -65°F.
- d. When installing a hose assembly where both ends are permanently connected, use the air hose connector assembly at either end as a union, to permit tightening the hose connectors in place. Loosen the nut on one of the connector assemblies and then turn the hose in the loose connector assembly sufficient to avoid kinking the hose, before the nut is again tightened.

167. Disassembly

(fig. 191)

Remove nut from connector body and pull hose out of body. Do not remove sleeve from hose. If a new piece of hose is to be installed, use a new sleeve. Do not remove hose guide (fig. 193) from connector body.

168. Cleaning and Inspection

- a. Clean metal parts with dry-cleaning solvent or volatile mineral spirits.
- b. Inspect hose for abrasions, swelling, or other damage. If hose is damaged, replace with a new piece and discard sleeve.
- c. Springs, nuts, and bodies, may be used again unless they are damaged.

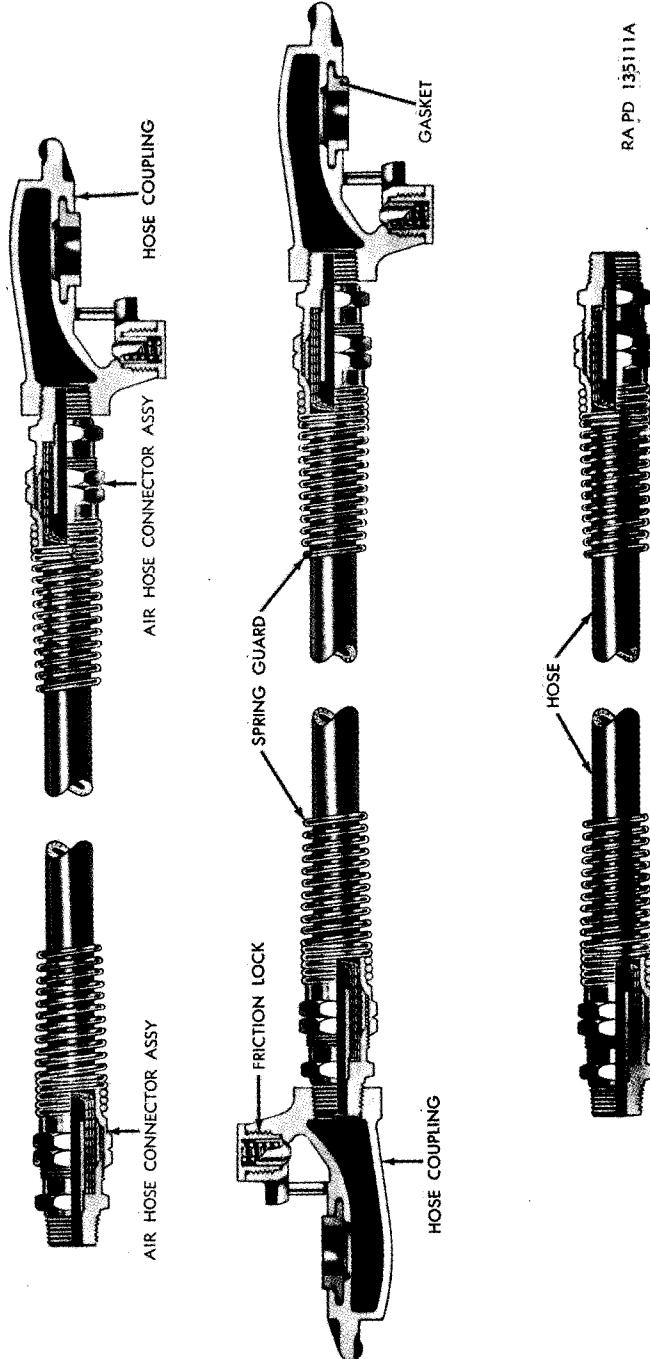
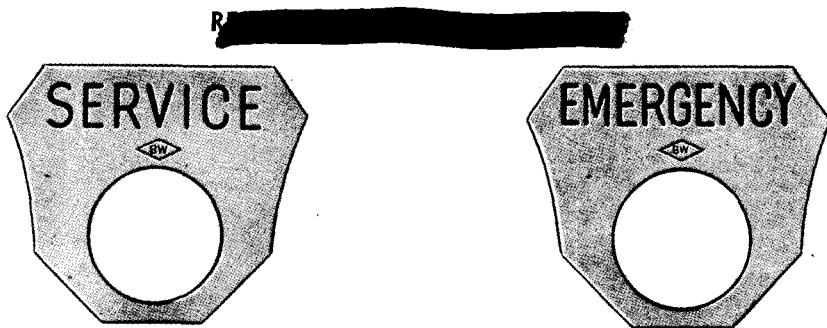


Figure 189. Air hose assemblies—sectional view.



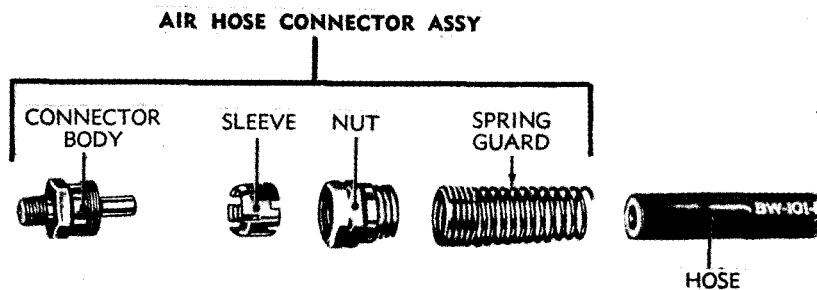
RA PD 135112

Figure 190. Service and emergency line identification tags.

169. Assembly

(fig. 191)

- a. Cut hose to desired length being sure the cut is made at right angles to the outside wall of the hose and that the end of the hose is smooth.
- b. Blow out the hose with an air line to remove all cuttings.
- c. Position connector nut and sleeve on hose (fig. 192) being sure the barbs on the inside of the sleeve point toward the end of the hose.
- d. Put the end of the hose in the connector body (fig. 193), making sure the end of the hose is against the bottom of the recess in the connector body.
- e. Move the sleeve, if necessary, until it is against the edge of the connector body. Then tighten the connector nut. It is only necessary to tighten the nut sufficiently to insure a good airtight joint.



INCHES | 1 | 2 | 3 | 4 | 5 | 6

RA PD 135113A

Figure 191. Air hose assembly—exploded view.

170. Test

Connect hose assembly to air line, plug open end and admit 100 psi air pressure. Coat entire connector assembly with soap suds to detect leakage. No leakage is permissible. Remove soap suds with a moist cloth and wipe dry.

Section II. HOSE COUPLINGS AND DUMMY COUPLINGS

171. Description and Operation

a. *Hose Couplings.* The design of the hose coupling is such that when two of them are coupled together, pressure is put on two rubber gaskets making an airtight seal and at the same time providing a joint which can be easily connected or disconnected by hand (fig. 195). Some types of hose couplings are fitted with friction locks while others do not have this feature. Some also are marked with the word service or emergency. Couplings of this type which are marked emergency have a knob on the back while those marked service do not have a knob. However, all types are interchangeable and any hose coupling of one type can always be connected to any coupling of another type.

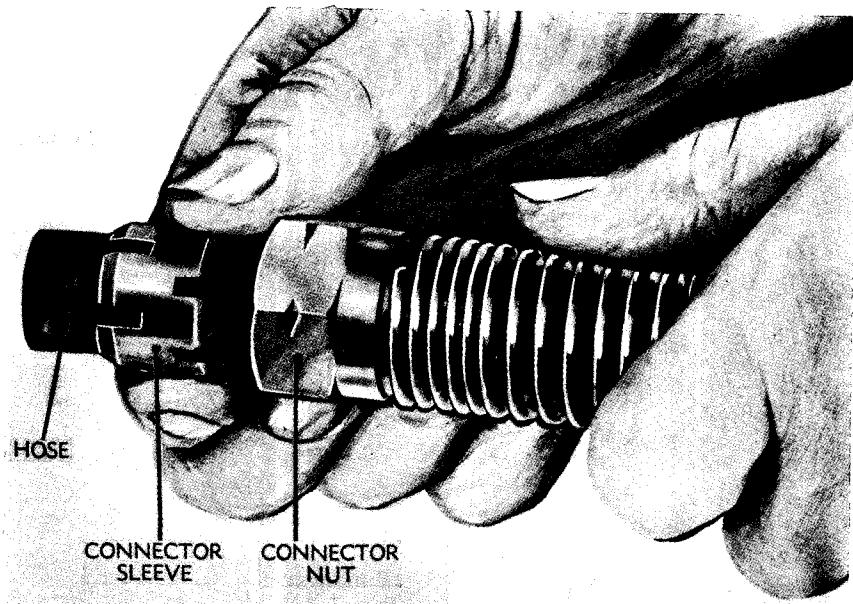


Figure 192. Connector nut and sleeve positioned on hose.

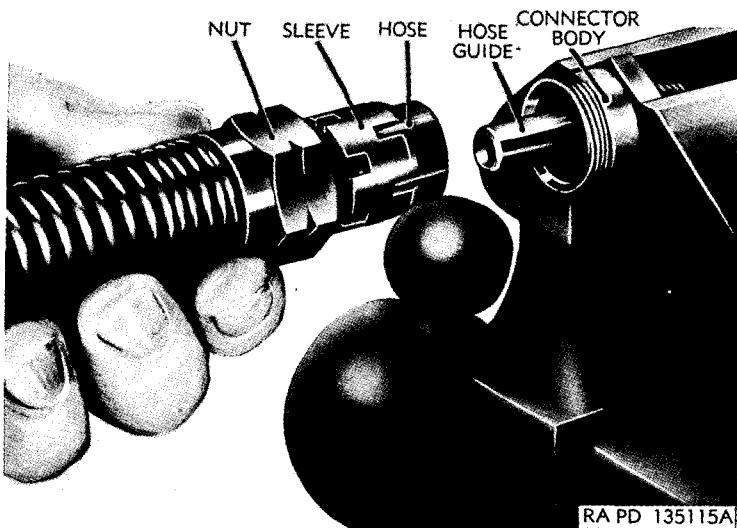


Figure 193. Placing hose in connector body.

b. Dummy couplings are made in two general designs, some being fitted with brackets to permit them to be rigidly mounted on the vehicle (fig. 196), while others are fitted with a chain (fig. 197). The bracket-type is used where the dummy coupling is to serve as a fastening for holding hose lines when not in use, whereas the type fitted with a chain

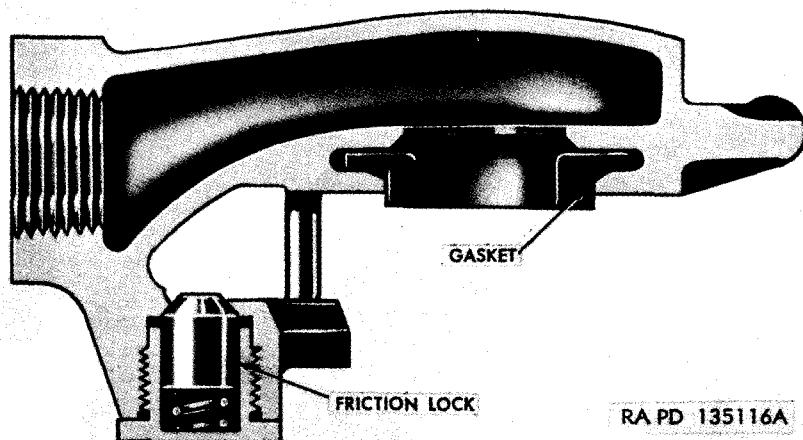


Figure 194. Hose coupling—sectional view.

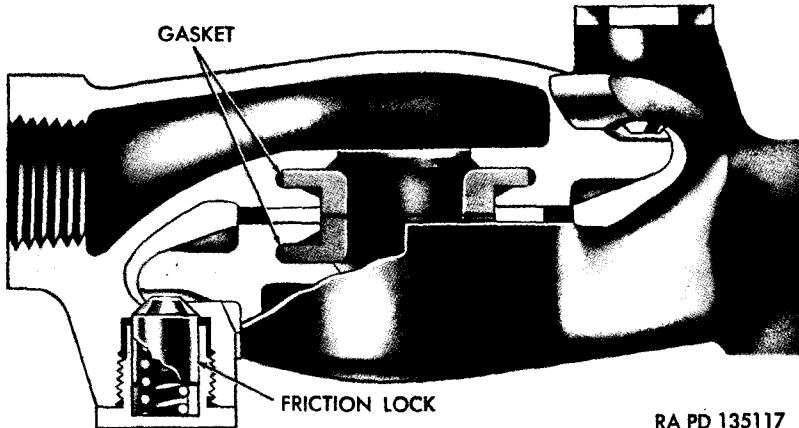


Figure 195. Hose coupling connected—sectional view.

is used for blanking off hose couplings rigidly mounted on the vehicle. The primary purpose of all dummy-couplings is to prevent the entrance of dirt or other foreign matter into the air brake lines when they are not being used. Dummy-couplings used to protect the service line coupling at the front of a truck or tractor are drilled with a small vent hole. This prevents air being trapped in this line, keeping brakes applied.

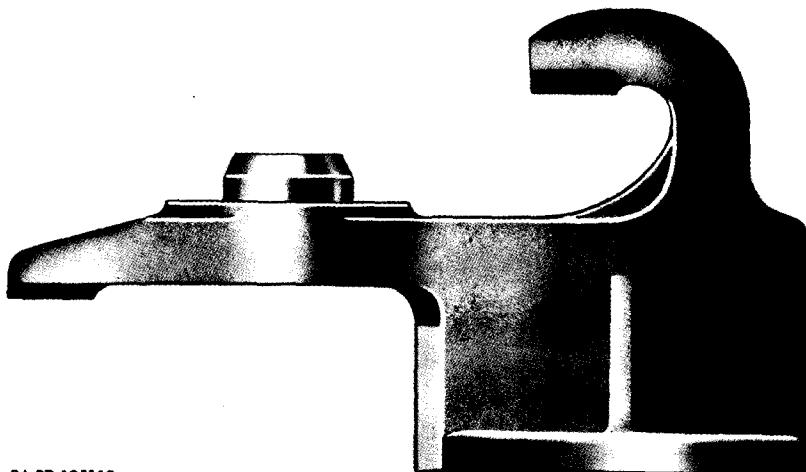


Figure 196. Bracket type dummy coupling.

172. Disassembly

(fig. 198)

- a. If the hose coupling is fitted with a friction lock, remove the spring plug, lock spring, and lock plug.
- b. Remove the gasket by prying it out with a screw driver.

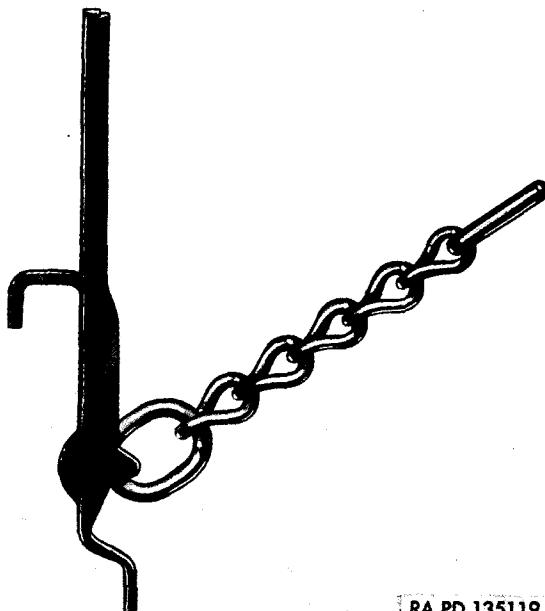
173. Cleaning and Inspection

Discard old gasket and clean all other parts in dry-cleaning solvent or volatile mineral spirits. Examine friction lock spring and lock plug for wear or damage and replace, if necessary. When cleaning the hose coupling body, give particular attention to the groove into which the flange of the hose coupling gasket fits. This groove must be scraped thoroughly clean, otherwise the new gasket will not fit properly.

174. Assembly

(fig. 198)

- a. To install a new gasket, partially collapse it with the fingers and enter one side of the gasket flange in the groove of the coupling



RA PD 135119

Figure 197. Dummy coupling with chain.

(fig. 199). Then use a blunt-nose screw driver or some similar instrument to complete pushing the gasket in place (fig. 200). When properly installed, the exposed face of the gasket will be flat and not twisted or bulged at any point.

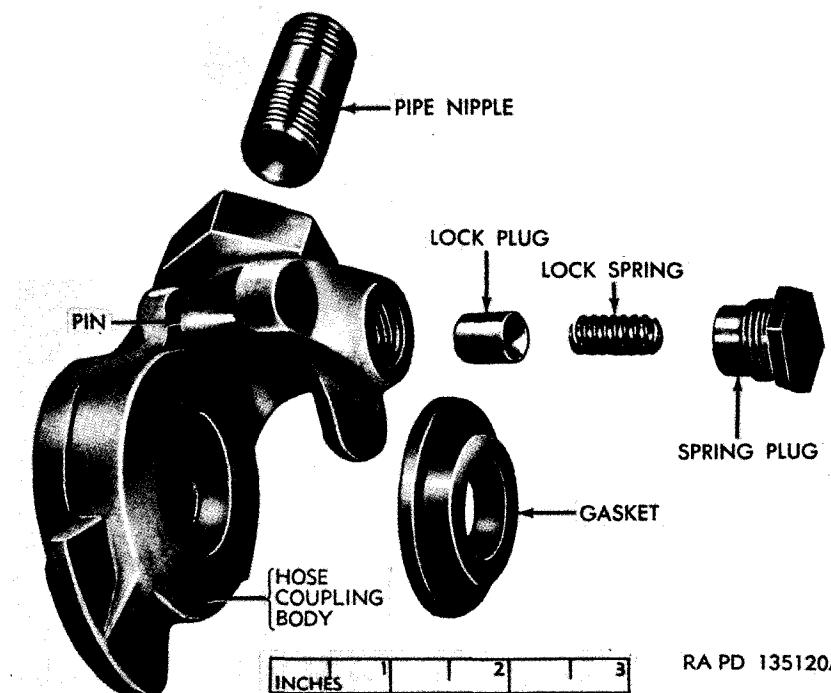
b. With a new gasket installed, the assembly of the hose coupling is completed by installing the friction lock parts when these parts are included in the assembly.

Section III. TUBING AND TUBING FITTINGS

175. Description

a. General. Tubing and fittings (figs. 201-205) are used to connect the various devices in the air brake system where it is not necessary to use flexible hose.

b. *Tubing Sizes.* Three sizes of copper tubing are used in air brake systems. The largest size has an outside diameter of three-quarters of an inch and is frequently used as the compressor discharge line.



RA PD 135120A

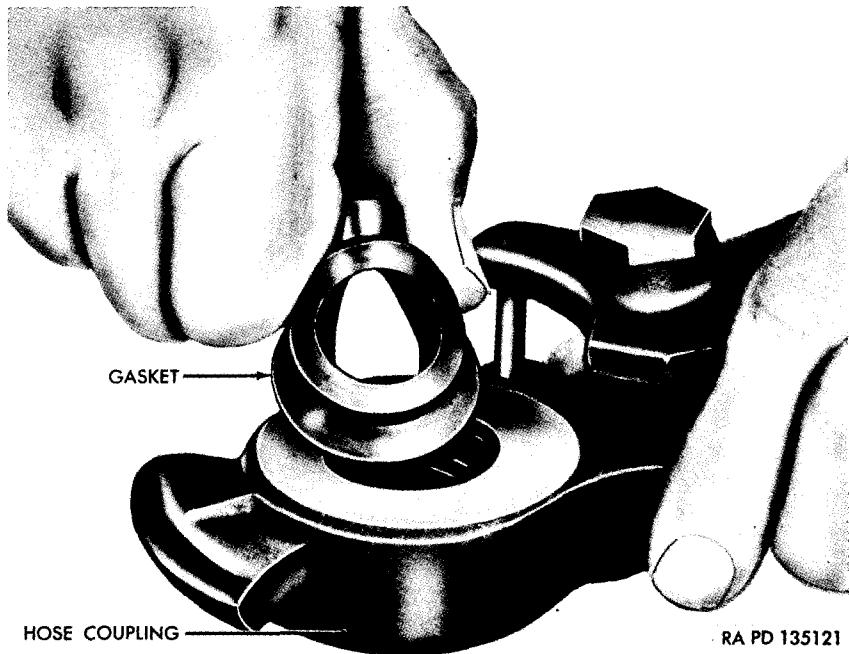
Figure 198. Hose coupling—exploded view.

Tubing used to carry the air supply to such devices as brake valves, relay valves, and emergency valves usually has an outside diameter of five-eighths or one-half inch. Lines which handle a comparatively small quantity of air or where the rate of flow is not important usually have an outside diameter of three-eighths of an inch. The inside diameter of these tubing lines is not the same as standard commercial tubing and it is important that tubing of the correct wall thickness be used (par. 178), otherwise operation of the air brake equipment will be seriously affected.

c. *Tubing Fittings.* Tubing fittings used in the air brake system are the three piece compression type (figs. 201-204). Flared type fittings such as are used in gasoline lines, etc. must not be used in the air brake system.

176. Cleaning and Inspection

All tubing must be clean and free from dents or kinks. All tubing fittings must be cleaned using dry-cleaning solvent or volatile mineral spirits, and must not be damaged in any way.



RA PD 135121

Figure 199. *Installing hose coupling gasket—first operation.*

177. Assembly

- a. When replacing tubing lines, cut tubing to required length with a hacksaw or tubing cutter. Make sure the end of the tubing is smooth and that it is cut squarely with the outside wall. Make sure the ends are not crimped or partially closed. Ream or file the ends of the tubing if necessary.
- b. Blow out tubing with an air line to remove all cuttings and filings.
- c. Place nut and sleeve on tubing and put the end of the tubing in the recess in the body. Always use a new sleeve when replacing tubing lines. Nuts and bodies of fittings and tubing may be used again provided they are in serviceable condition.

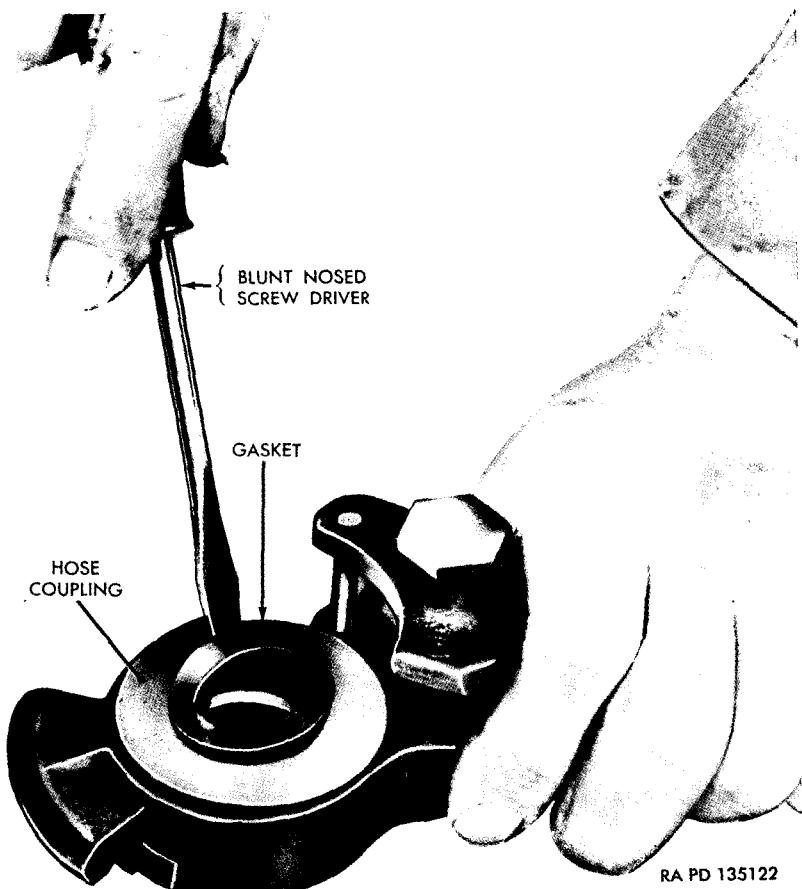
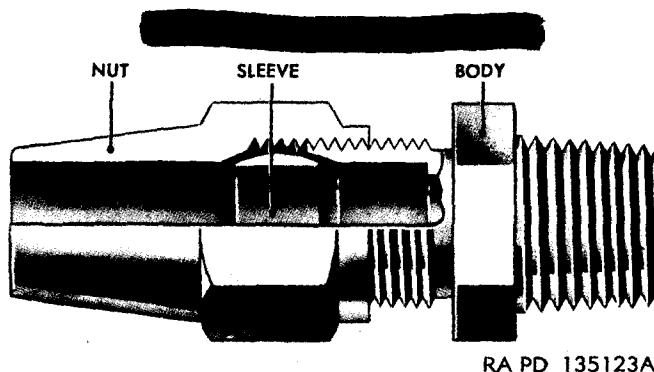


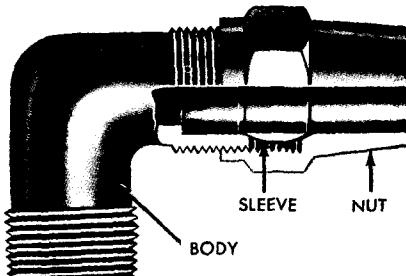
Figure 200. Installing hose coupling gasket—final operation.



RA PD 135123A

Figure 201. Tubing connection—sectional view.

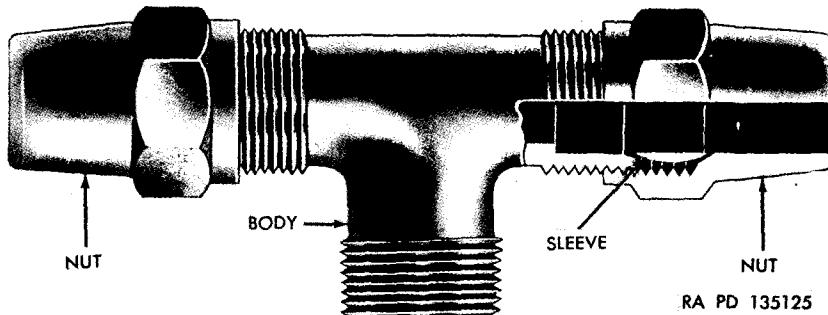
d. A common fault when making tubing connections is to tighten the fitting more than necessary. The practice of tightening a nut until it bottoms is definitely wrong. An airtight joint is all that is necessary



RA PD 135124

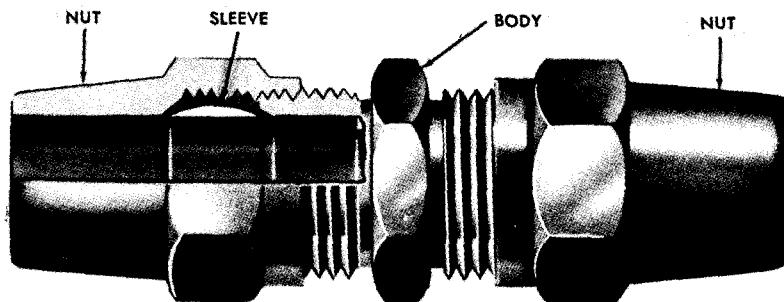
Figure 202. Tubing elbow—sectional view.

and it is better to retighten to stop air leaks than distort tubing and fittings. The following torques have been found satisfactory for 110 psi air pressure:



RA PD 135125

Figure 203. Tubing tee—sectional view.



RA PD 135126

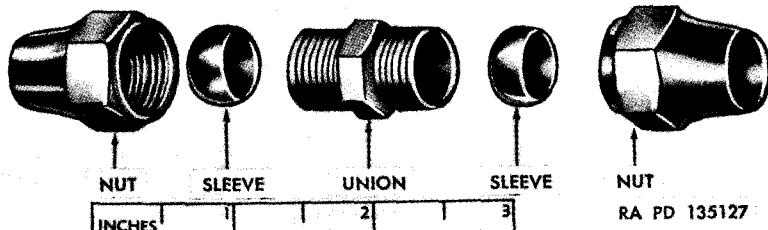
Figure 204. *Tubing union—sectional view.*

Tubing size	Inch-pounds torque	Pull on end of 10-inch wrench
$\frac{1}{4}$ inch	75 to 175	$7\frac{1}{2}$ to $17\frac{1}{2}$ pounds.
$\frac{3}{8}$ inch	100 to 200	10 to 20 pounds.
$\frac{1}{2}$ inch	150 to 250	15 to 25 pounds.
$\frac{5}{8}$ inch	150 to 250	15 to 25 pounds.
$\frac{3}{4}$ inch	300 to 400	30 to 40 pounds.

178. Tabulated Data

The wall thickness of the various tubing sizes is as follows:

OD	Wall size
$\frac{1}{4}$ inch	0.032 inch
$\frac{3}{8}$ inch	0.045 inch
$\frac{1}{2}$ inch	0.058 inch
$\frac{5}{8}$ inch	0.058 inch
$\frac{3}{4}$ inch	0.049 inch



RA PD 135127

Figure 205. *Tubing union—exploded view.*

CHAPTER 13

MISCELLANEOUS AIR BRAKE DEVICES

Section I. SAFETY VALVE

179. Description and Operation

a. *Description* (fig. 206). The safety valve consists of a spring-loaded ball check valve. It is usually mounted on a reservoir to protect the air brake system against excessive pressure. Valves are usually set for 150 pounds pressure but setting can be varied to suit requirements.

b. *Operation*. Reservoir pressure is always present below the ball valve and the force of the pressure-regulating spring keeps the ball valve on its seat unless the air pressure rises above 150 pounds. When this happens, the air pressure below the ball valve overcomes the spring force above it and the ball valve lifts off its seat. Reservoir pressure then escapes through the exhaust port until the pressure is lowered to the pressure setting of the valve. When this happens, the pressure-

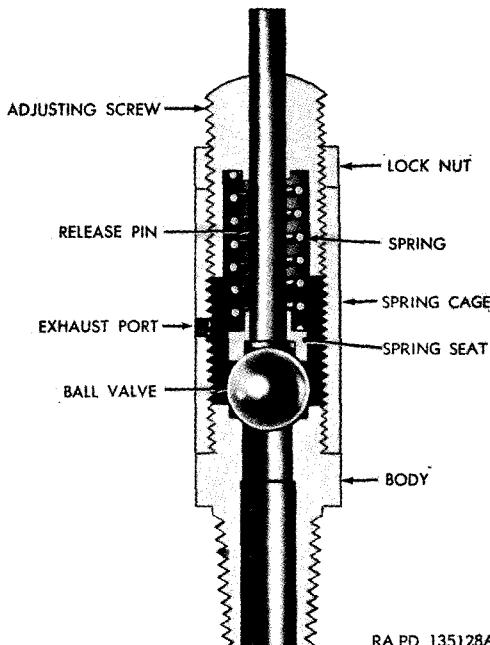


Figure 206. Sectional view of safety valve.

regulating spring forces the ball valve back to its seat, preventing further escape of reservoir pressure.

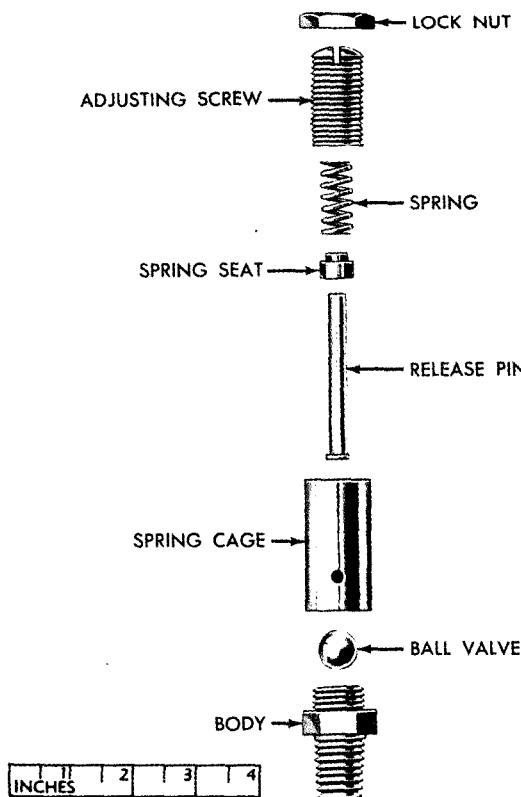
180. Disassembly

(fig. 207)

Loosen lock nut on adjusting screw. Remove adjusting screw, spring, spring seat, release pin, and ball valve. *Do not remove spring cage from body unless one of these parts is to be replaced.*

181. Cleaning and Inspection

Clean all parts with dry-cleaning solvent or volatile mineral spirits. Inspect all parts for wear or damage, particularly the ball valve and seat for corrosive action and pitting. Be sure release pin is not bent. Check fit of release pin in adjusting screw. It should be a free sliding fit.



RA PD 135129

Figure 207. Safety valve—exploded view.

182. Assembly

(fig. 207)

With the spring cage and body assembled, position spring seat on release pin with head of pin in the recess of the spring seat. Drop ball valve into spring cage. Position release pin and spring seat in place with large end of spring seat contacting the ball valve. Place spring in position being sure lower end of spring properly engages the spring seat. Install adjusting screw and lock nut.

183. Test

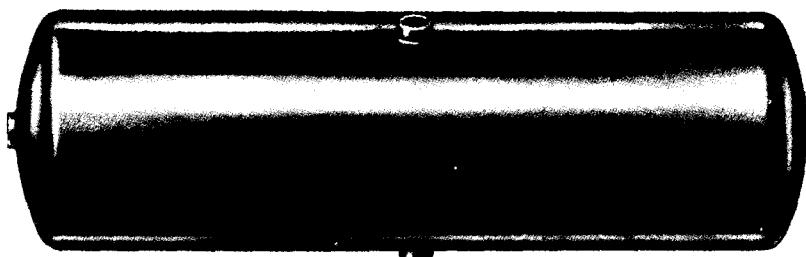
- a. Prepare test bench (fig. 71 and par. 60b)
- b. Connect line 1 (fig. 71) to safety valve.
- c. Open valves 1, 2, and 3 (fig. 71 and par. 54b(2)) until gage 1 shows the desired 150-pound setting of the safety valve. Then close valve 1.
- d. If safety valve does not exhaust, loosen the adjusting screw until exhaust starts. Turn adjusting screw counterclockwise until exhaust stops then tighten lock nut.
- e. Reduce the pressure in the system 15 pounds below the setting of the safety valve by operating valve 3 (fig. 71 and par. 197). Coat the safety valve with soap suds to detect leakage. No leakage is permissible. Small leakage can be corrected by lightly tapping the release pin seating the ball valve.
- f. Turn the handle of valve 3 (fig. 71) at right angles to the body of the valve (par. 197) and disconnect safety valve after gage 1 reads zero.

Section II. RESERVOIRS

184. Description

(fig. 208)

- a. The reservoir provides a place to store compressed air until re-



RA PD 135130

Figure 208. Reservoir.

quired for brake operation. The amount of air stored is sufficient to permit several brake applications after the motor has stopped. The reservoir also provides a place where the air (heated during compression) may cool and oil and water vapors condense.

b. Cylindrical reservoirs are made of sheet steel with electrically welded seams. The heads or ends are steel stampings welded to the body. Pipe tapped ferrules are used at the openings and are welded in place. Some reservoirs used on gun mounts are fitted with mounting flanges.

c. The total reservoir volume is based on the quantity of compressed air required and the size of the compressor being used.

185. Cleaning and Inspection

a. *Cleaning.* Clean reservoir inside and out with steam and hot water.

b. *Inspection.* Inspect inside and outside surfaces for damage or corrosion. A small flashlight is helpful when inspecting the interior. If corrosion or other damage makes condition doubtful, subject it to test.

186. Test

If there is any doubt as to the serviceability of the reservoir, subject it to a water pressure of 200 pounds.

Warning: Do not use air pressure when making pressure tests of reservoirs.

187. Tabulated Data

Diameter (in.)	Length (in.)	Volume (cu. in.)
7	18	634
7	24	846
7	28	995
7	36	1,268
7	48	1,692
8	26	1,240
8	41½	1,975
9½	27	1,790
9½	36	2,490

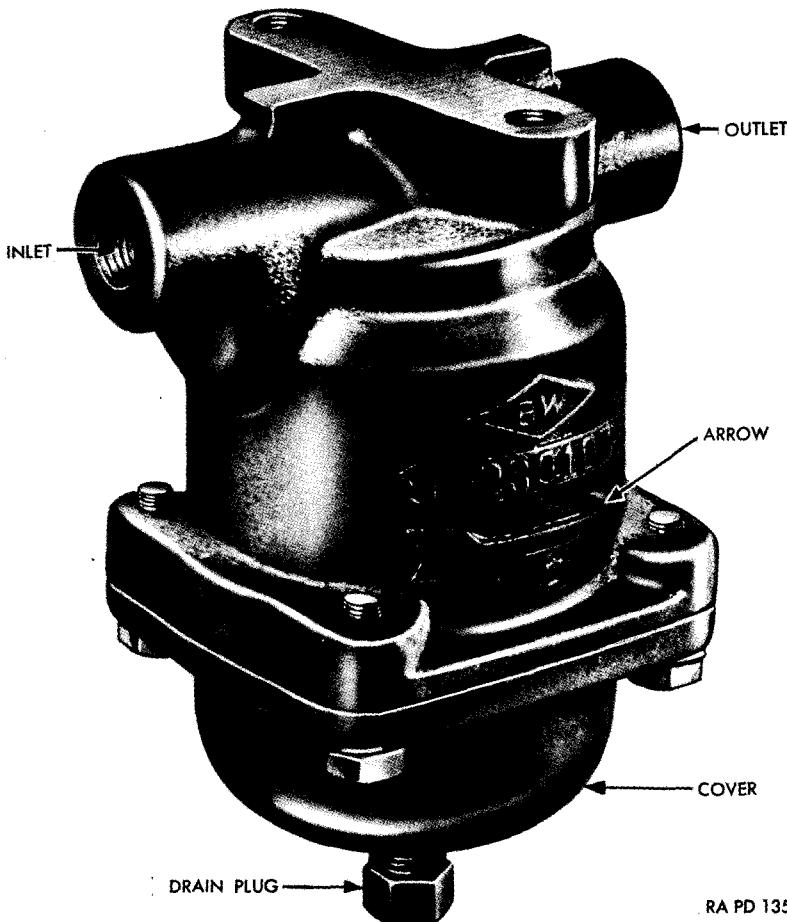
Section III. AIR FILTERS

188. Description and Operation

a. *Description* (fig. 209). Air filters are used in the service line and the emergency line on trailers to trap any dirt or foreign matter which

might get into these lines when the trailer is not connected to a towing vehicle. Two very similar types will be found in service. The older style includes flange type connections and a curled hair strainer. The new style does not include flange type connections and uses a wound cotton strainer. The cotton type strainer is used as a replacement element in either style of filter. Both styles of filters have removable dirt chambers or covers and these covers are fitted with drain plugs.

b. Operation (fig. 210). The correct direction of the air flow through the filter is indicated by an arrow cast on the body. Air flowing from the truck or tractor to the trailer must pass through the filter in the direction indicated by the arrow. Air flowing through the filter readily



RA PD 135131

Figure 209. Air filter.

passes through the strainer but any dirt which might be present in the air stream is stopped by the strainer. Moisture or dirt which may collect in the filter is eliminated by removing the drain plug.

189. Preliminary Examination

- a. Examine filter for broken or damaged parts. Connect air line to filter inlet and admit air pressure slowly. If there is any time delay between air admission and air leaving outlet, strainer element should be replaced.
- b. Plug outlet and admit 100 psi air pressure. Coat entire filter with soap suds to detect leakage. No leakage is permissible.
- c. If filter passes above examination it will be returned to service.

Note. Unit must be disassembled and cleaned once each year or after every 50,000 miles of service.

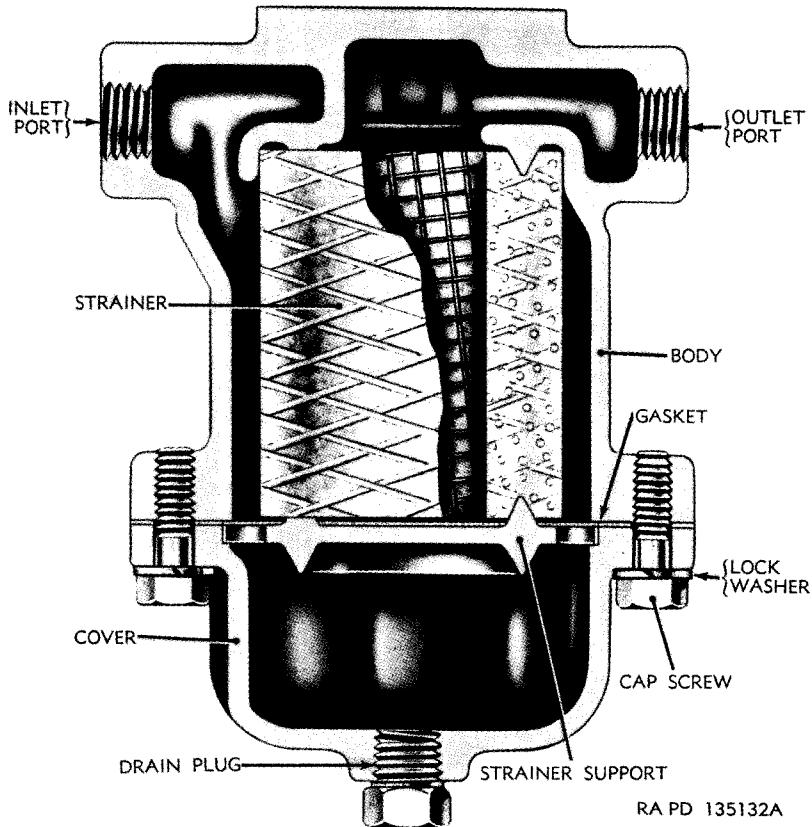


Figure 210. Air filter—sectional view.

190. Disassembly

(fig. 211)

- a. Remove cap screws and lock washers attaching cover to body. Remove gasket, strainer support, and strainer.
- b. On old style filters, remove bolting flanges and gaskets.

191. Cleaning and Inspection

- a. Clean all metal parts using dry-cleaning solvent or volatile mineral spirits.
- b. If strainer is merely dusty, clean by brushing. If an oily or gummy deposit is found, the strainer must be replaced. Curled hair type strainers are washed in dry-cleaning solvent or volatile mineral spirits.
- c. Replace gasket.

192. Assembly

(fig. 211)

- a. Place strainer in body. Place strainer support and gasket on cover and install cover.
- b. On old style filters, install flange type connections using new gaskets.

193. Test

Refer to paragraph 189.

Section IV. AIR PRESSURE GAGES

194. Description and Operation

- a. Two types of air pressure gages are used in connection with air brake systems.
- b. The most common types are frequently referred to as dash gages because they are usually installed on the dash (instrument panel) to tell the driver the air pressure in the air brake system. The appearance and style of dash gages often vary with the design of the instrument panel used on the vehicle. A common type is illustrated in figure 212.
- c. While air gages of this type are commercially accurate, they should never be confused with or substituted for test type air gages

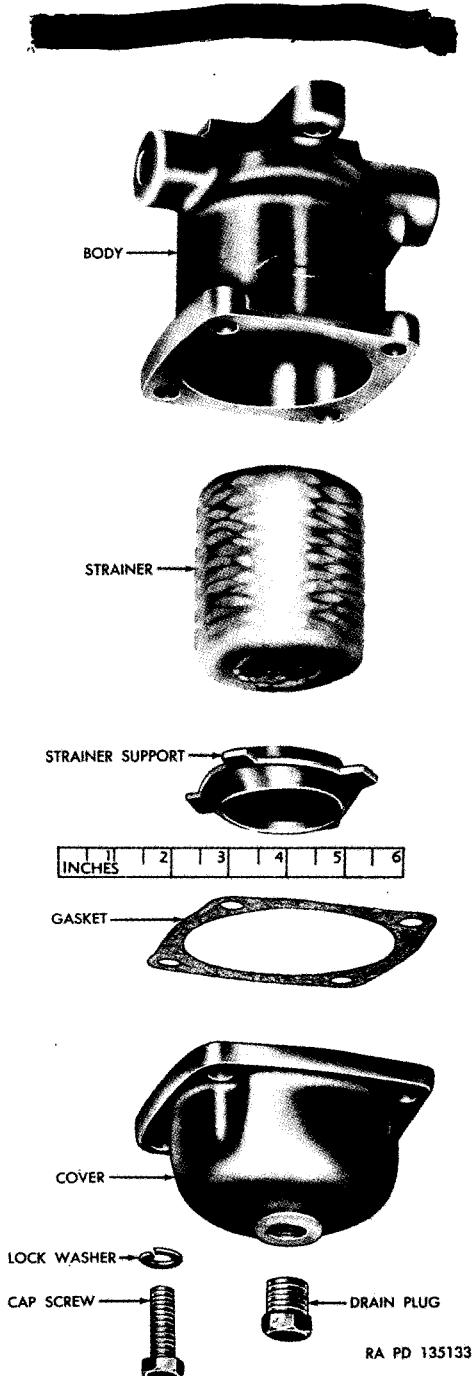


Figure 211. Air filter—exploded view.

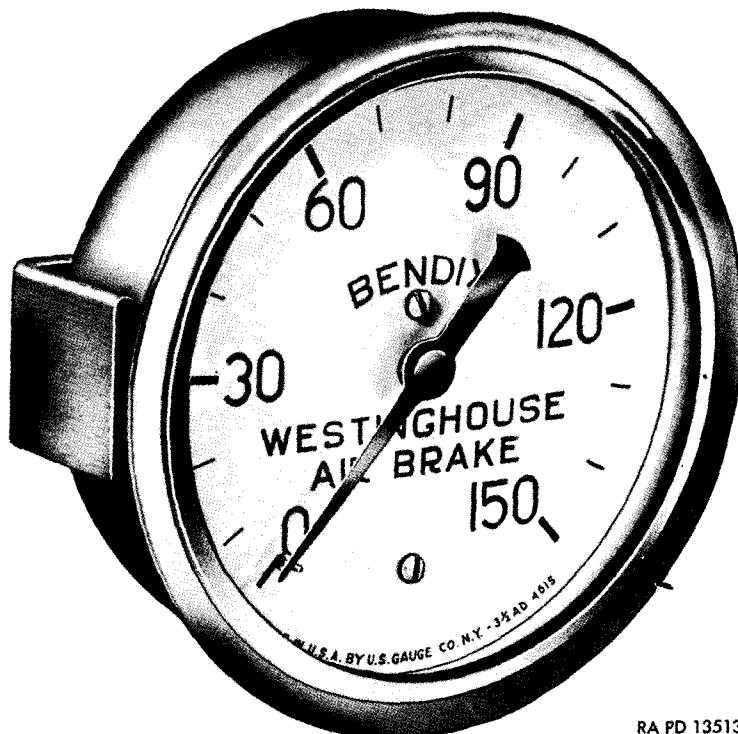
intended primarily for accurately checking air pressures in an air brake system. Only test gages known to be accurate are used for checking brake valve delivery pressures, governor pressure settings, etc.

d. Test gages merely differ from ordinary dash gages in that they are more accurate over their entire range and maintain their accuracy over longer periods. A typical test gage is illustrated in figure 213.

e. Extreme care must be used when attaching air connections to air gages because if they are strained during this operation, their rather delicate mechanism will be disturbed and their accuracy impaired.

195. Inspection

a. Periodically it is advisable to check the accuracy of any air gage. The simplest way to do this is to compare the pressure registered by the gage over its normal pressure range with the pressure registered by another gage known to be accurate.



RA PD 135134

Figure 212. Dash gage.

b. Dash gages may lose their accuracy after long periods of service and may require replacing. The continued use of dash gages showing an error of more than 5 pounds high or low is not recommended.

c. The mechanism of most air pressure gages is contained in a sealed case which makes adjustment impossible; therefore, when they lose

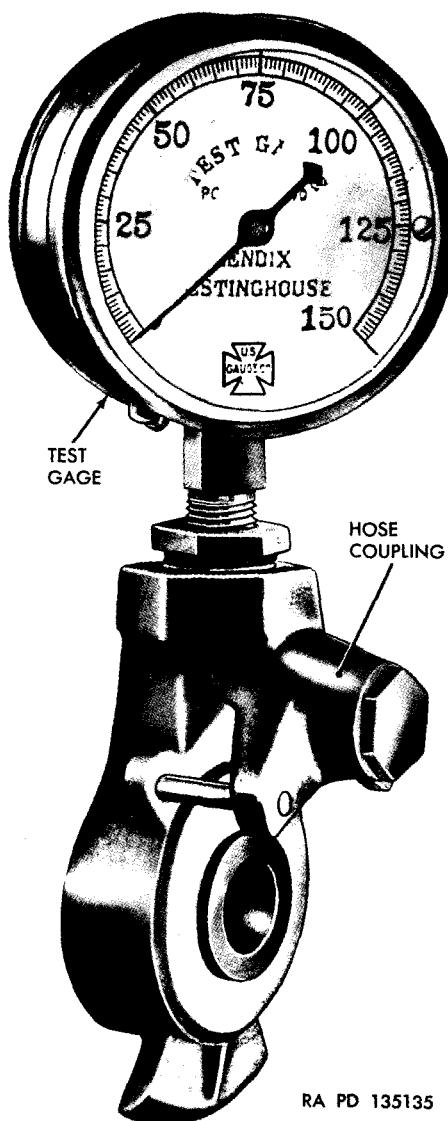


Figure 213. Test gage.

[REDACTED]

their accuracy beyond the permissible limit, they must be replaced. Test gages usually can be recalibrated but this work must not be attempted by anyone who is not qualified or who does not have the necessary special equipment.

196. Test

Prepare test bench (fig. 71 and par. 60b). Operate valve 1 (fig. 71) to maintain a reading of 150 lbs on gage 1 during test. Attach gage to line 2 and open valve 4 in steps of 10 pounds, as registered on gage 2 until entire range of gage being tested is covered. Dash gages must register within 5 pounds of gage 2 in all steps. Replace gage if inaccuracy exceeds 5 pounds. Test gages must be accurate within 1 pound over their entire range.

CHAPTER 14

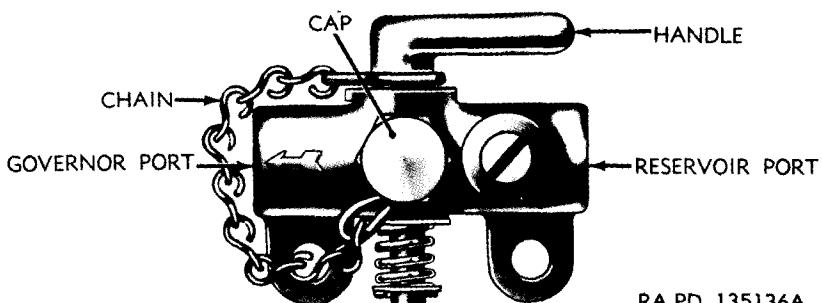
AUXILIARY AIR DEVICES

Section I. AIR SUPPLY VALVE

197. Description and Operation

a. The air supply valve (fig. 214) is installed in the line between the compressor governor and the reservoir and is used to supply air to an air supply connection at the side of the valve or to shut off the air from the air supply connection. When air is supplied to the air supply connection, the valve disconnects the compressor governor from the air brake system but connects the compressor governor to the air brake system when the air supply connection is shut off. A cap is used to protect the male threads of the supply connection and to keep out dirt when the supply connection is not in use. To avoid the possibility of losing the cap when the supply connection is in use, the cap is chained to the valve.

b. The handle of the air supply valve under normal conditions must be turned so as to be parallel with the body of the valve. With the handle in this position, the air pressure of the air brake system is applied to the governor and the air supply connection is shut off. When the handle of the air supply valve is turned to its air supply position, that is, at right angles to the body of the valve, air pressure from the reservoir will flow out the side connection (air supply connection). At the same time, any air pressure in the governor is permitted to exhaust through the small vent port in the key of the air supply valve. When the handle of the air supply valve is turned to its air supply position, the governor cannot operate and air pressures as high as the setting of



RA PD 135136A

Figure 214. Air supply valve.

the safety valve (150 psi) can be obtained through the air supply connection.

c. Turn the valve handle by hand. Never strike it with a hammer or any other tool, otherwise the body of the valve may be distorted and leakage will result.

198. Disassembly

(fig. 215)

Remove cotter pin from end of key. Lift off small washer, spring, large washer, and remove key. Remove cap from air supply connection of valve.

199. Cleaning, Inspection, and Repair

a. *Cleaning.* Wash all parts in dry-cleaning solvent or volatile mineral spirits.

b. *Inspection.* Check key and bore in body for grooving or scoring. Be sure small drilled passage through center of key is not blocked.

c. *Repair.* If the key and body are only slightly scored, leakage is corrected by carefully grinding (lapping) the key to the body using valve grinding compound (fine). If the key and body are badly scored, the complete assembly must be replaced. Do not attempt to grind a new key to an old body or vice versa.

200. Assembly

(fig. 215)

Put a thin coating of automotive and artillery grease (GAA) on the key and in the bore of the body. Position key in body and install large

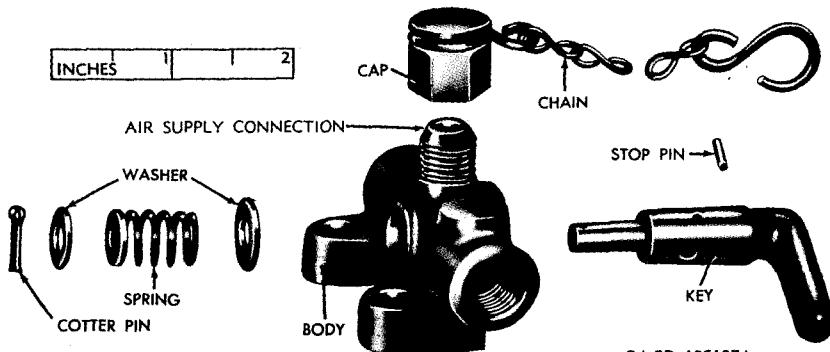
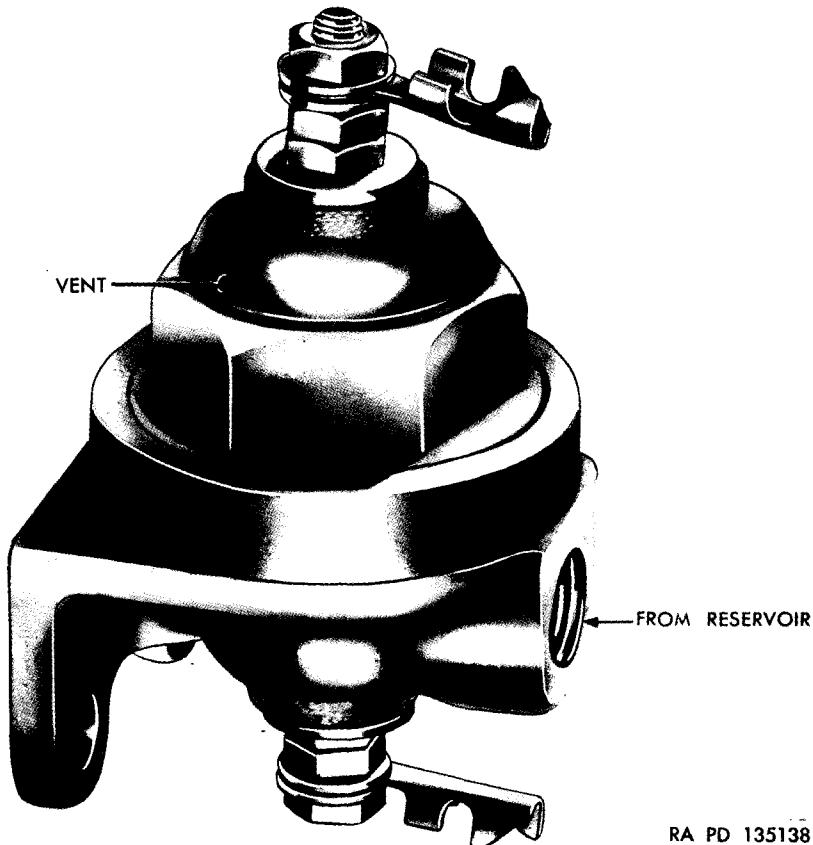


Figure 215. Air supply valve—exploded view.

washer, spring, and small washer. Install cotter pin in key. Install cap at side connection.

201. Test

- a. Connect air line to reservoir port, plug governor port, and admit 100 psi air pressure. Coat entire valve with soap suds and turn handle back and forth to detect leakage. Leakage which will produce a 1-inch soap bubble in less than 5 seconds is not permissible.
- b. Remove plug, connect air line to governor port, turn handle 90° to body, and admit air pressure. Air should discharge freely from small passage in key. If port is plugged, clear it.



RA PD 135138

Figure 216. Type LP-1 low pressure warning switch.

Section II. LOW PRESSURE WARNING SWITCH

202. Description and Operation

a. *General.* The low pressure warning switch is a safety device designated to give an automatic warning when the air pressure in the air brake system is dangerously low. The low pressure warning switch is actuated at approximately 60 pounds. Operating as an air controlled switch of an electrical circuit, the low pressure indicator automatically lights a warning light or sounds a buzzer when the air pressure drops below safe operating pressure and automatically opens the electrical circuit to the light or buzzer when the air pressure rises above this point. The low pressure switch and warning device are connected in series through the ignition switch on a vehicle to prevent the warning signal from operating while the ignition switch is turned off.

b. *Types.* Two general types will be found in service; an older type, LP-1, in which the plastic cover is threaded into the body (fig. 216) and the later type, LP-2, in which cover is secured to body by a threaded retainer (fig. 217). This later type is available in two styles; the standard and the waterproof (fig. 218). The waterproof style dif-

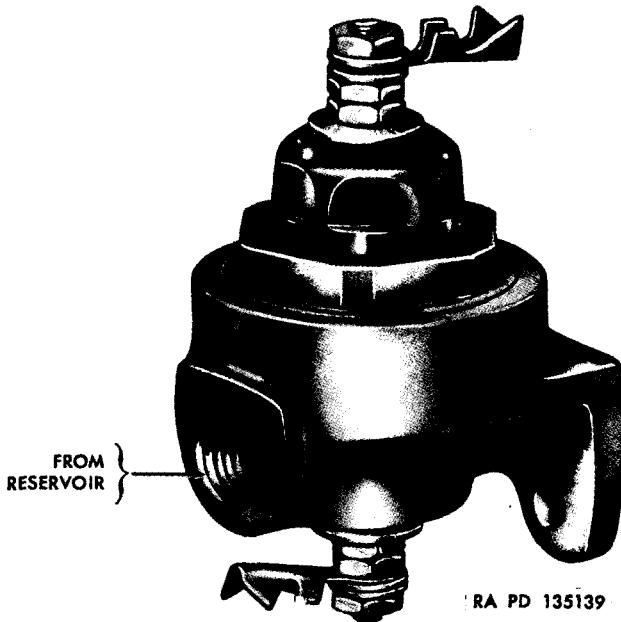


Figure 217. Type LP-2 low pressure warning switch.

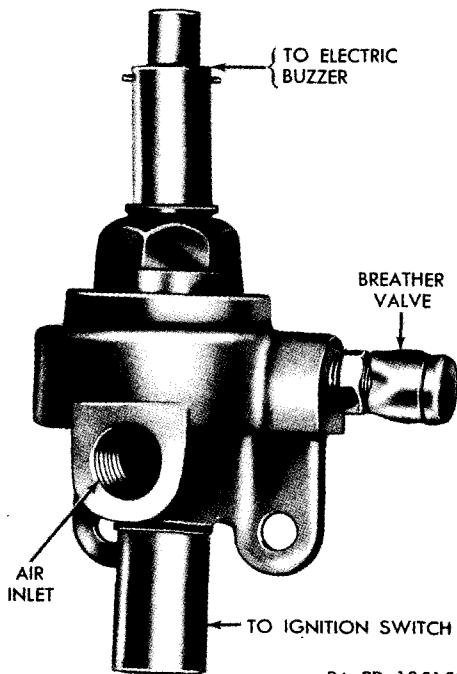
fers from the standard only in the terminal connections, and the provision for a breather valve.

c. *Operation* (figs. 219, 220, and 221). When reservoir pressure below the diaphragm is below approximately 60 psi, the spring keeps the electrical contacts closed and the circuit to warning buzzer or light is completed through the spring to upper terminal. When reservoir pressure rises above approximately 60 psi, the spring load on diaphragm is overcome, separating contacts, and circuit is open. The normal pressure setting of 60 psi is subject to a tolerance of plus or minus 6 pounds so that the actual operating point may vary between a maximum of 66 pounds and a minimum of 54 pounds.

203. Preliminary Examination

Inspect unit for broken or damaged parts. Perform leakage and operating tests (par. 207). If switch passes tests it will be returned to service.

Note. The low pressure warning switch will be disassembled for cleaning once each year or after every 50,000 miles.



RA PD 135158

Figure 218. Type LP-2 low pressure warning switch (waterproof).

204. Disassembly

(figs. 222 and 223)

- a. Unscrew cover from body or unscrew cover retainer (fig. 220). Remove cover and lift out spring and diaphragm assembly.

Note. If shims are used between spring and diaphragm ring, same shims must be used in assembly.

- b. Remove nut and washer from contact screw (or diaphragm screw) and remove diaphragm.

- c. Remove sleeve, nuts, washers, terminal, insulating washers, and connector shell from terminal screws and remove terminal screws.

Note. Parts such as sleeve, insulating washers, and connector shell appear only on waterproof switches.

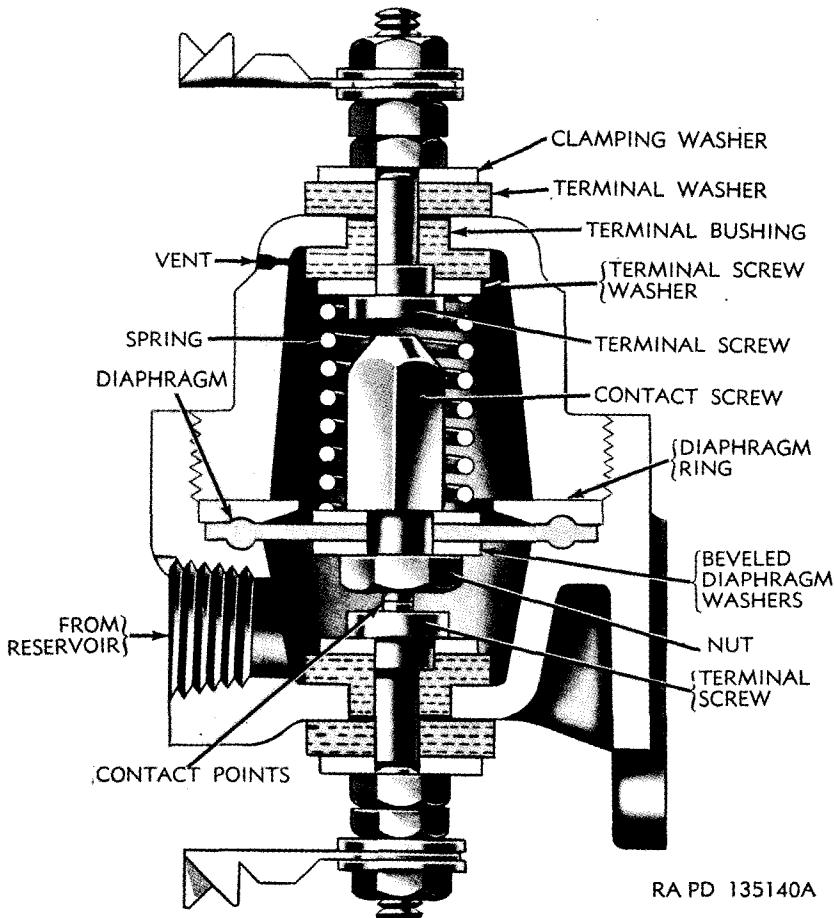


Figure 219. Type LP-1 10-in pressure warning switch—sectional view.

d. Remove terminal bushing and grommets.

205. Cleaning, Inspection, and Repair

a. *Cleaning.* Wash all metal parts with dry-cleaning solvent or volatile mineral spirits.

b. *Inspection.* Inspect diaphragm for signs of wear or cracks and replace if defects are evident. Check contact points for pitting or corrosion.

c. *Repair.* If contact points are only slightly pitted or corroded, they can be reclaimed by carefully filing them with a fine distributor-point file. If badly corroded or pitted, replace screws.

206. Assembly

a. Body.

(1) *Type LP-1* (figs. 219 and 222). Select lower terminal screw having contact point. Install special washer with **D** shaped hole on contact screw. Then install fiber terminal bushing on contact screw with **D** shaped hole positioned to fit over the **D** shaped shoulder under the head of the screw. Place terminal screw with washer in place in the body, positioning the square shoulder of the terminal bushing to fit in the square

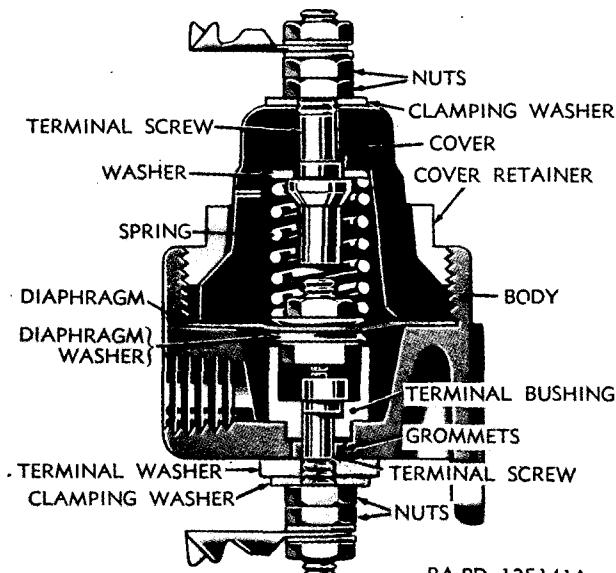


Figure 220. Type LP-2 low pressure warning switch—sectional view.

hole in the body. Install a new soft rubber seal washer. Then install fiber terminal washer and metal clamping washer. Hold the head of the terminal screw in place in the body with the fingers and install terminal nut and tighten securely. Install a second terminal nut as a lock nut and tighten.

- (2) *Type LP-2* (figs. 220 and 223). Place terminal bushing over **D** shaped shoulder on lower terminal. Position terminal and bushing in body and install grommets. Install terminal washer, clamping washer, nut, another nut as a lock nut, and tighten.
- (3) *Type LP-2 (waterproof)* (fig. 221). Place terminal bushing on lower terminal screw and seat bushing over **D** shaped shoulder on screw. Position screw and bushing in body and install grommet. Insert insulator in hole in bottom of connector shell and place assembly over screw. Install insulating and plain washer, nut, and a second nut as a lock nut. Install insulating washer in shell after nuts are tightened.

b. *Cover.*

- (1) *Type LP-1* (fig. 222). Select terminal screw without contact point and position special flat terminal screw washer and fiber

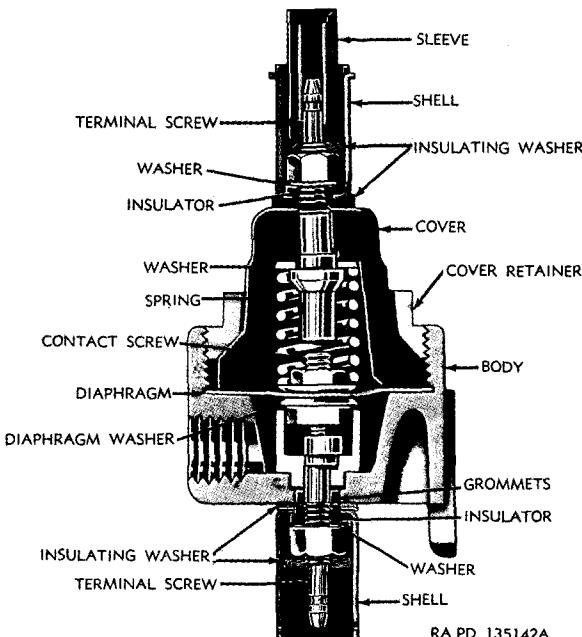


Figure 221. *Type LP-2 low pressure warning switch (waterproof)—sectional view.*

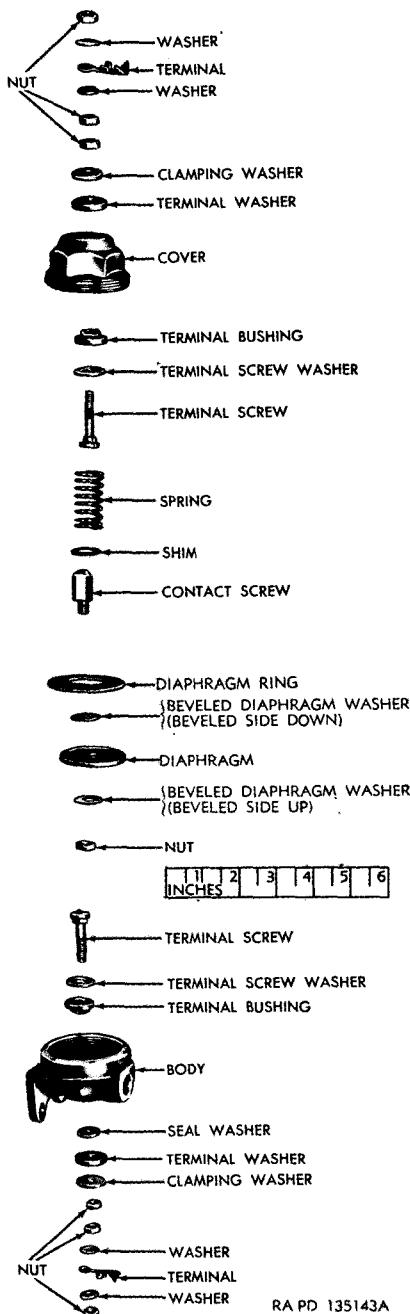


Figure 222. Type LP-1 low pressure warning switch—exploded view.

terminal bushing in place so that the **D** shaped hole in washer and bushing fit over the **D** shaped shoulder on the terminal screw. Place screw with washer and bushing in cover positioning the square shoulder of the bushing so it fits the square hole in the cover. Holding the head of the terminal screw with the fingers, install fiber terminal washer and metal clamping washer. Install and tighten terminal screw nut. Install second terminal screw nut as a lock nut and tighten.

- (2) *Type LP-2* (fig. 220). Place plain washer over upper terminal screw and insert screw in cover. Install clamping washer, nut, and tighten. Install another nut as lock nut and tighten.
- (3) *Type LP-2 (waterproof)* (fig. 223). Place plain washer over upper terminal screw and insert screw through cover. Place insulating washer over screw and install connector shell. Place insulator over screw and insert in hole in bottom of shell. Place plain washer over screw and secure shell with nut and a second nut as lock nut. Place insulating washer on lock nut and install sleeve

c. *Diaphragm*.

- (1) *Type LP-1* (figs. 219 and 222). Place beveled diaphragm washer on contact screw so that the flat side of the washer is against the shoulder of the screw. Place diaphragm on screw and then install other beveled diaphragm washer so the beveled side is next to the diaphragm. Install nut on contact screw and tighten nut sufficiently to make an airtight seal between the washers and the diaphragm. If the contact screw nut is tightened too tightly, the diaphragm will be distorted. Prick punch the threads of the screw to lock the nut in place.
- (2) *Type LP-2* (figs. 220 and 223). Place diaphragm on diaphragm screw. Install diaphragm washer with rounded edge next to diaphragm and secure with nut. Tighten nut just enough to make an airtight seal. If this nut is too tight, diaphragm will be distorted.

d. *Install Diaphragm Assembly*.

- (1) *Type LP-1*. Place diaphragm assembly in position in body so the contact point in the contact screw is in line with the contact point on the lower terminal screw. Press the edges of the diaphragm down with the fingers so the ridge on the bottom of the diaphragm engages the groove in the body. This will help prevent the diaphragm assembly from getting out of position when the cover is being installed. Install diaphragm ring so

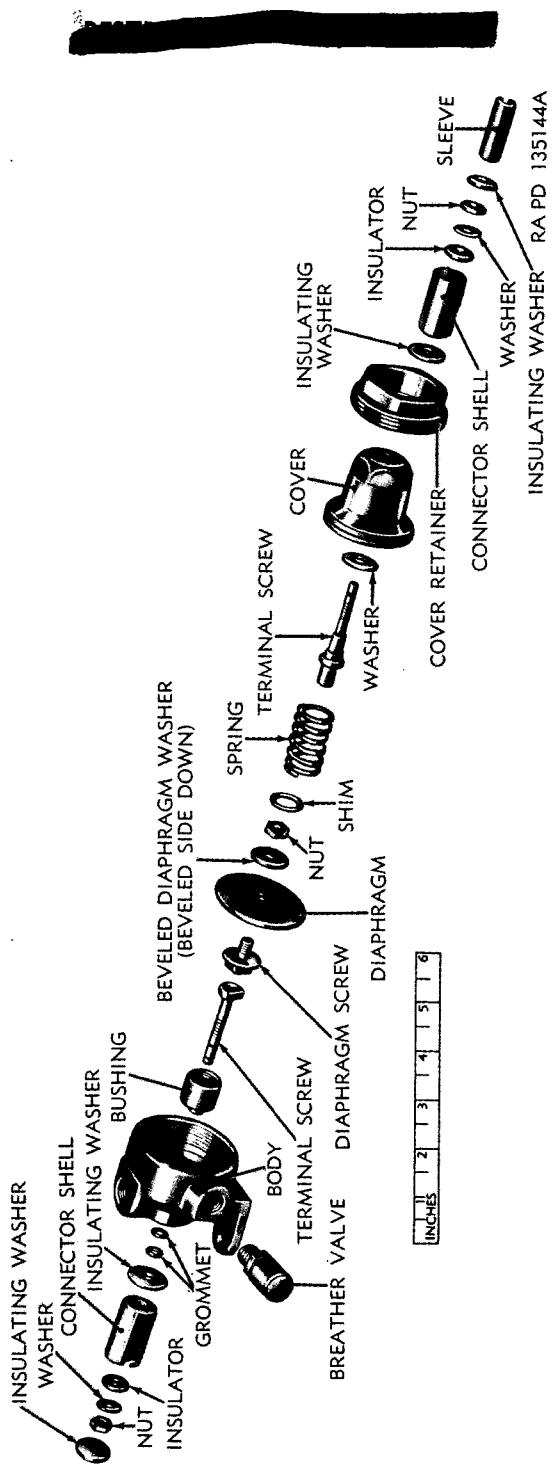


Figure 223. Type LP-2 low pressure warning switch (waterproof)—exploded view.

that the beveled and grooved side is next to the diaphragm. Press the diaphragm ring down on the diaphragm with the fingers to be sure the groove in the lower side engages the ridge on the top of the diaphragm. Place spring in position over the hexagon portion of the contact screw. Place cover assembly in position, compress the spring with hands, screw cover in place, and tighten securely. After tightening cover, check to be sure the contact points contact each other properly by making a visual inspection through the air connection port.

(2) *Type LP-2.* Place diaphragm assembly in body. If shims were removed in disassembly the same shims must be placed on diaphragm washer. Set spring in position on diaphragm and place cover assembly in position. Install cover retainer and tighten. Prevent cover from moving while tightening retainer or diaphragm may be distorted.

e. *Cable Terminal.* Install cable terminal, with washer on both sides, and secure with nut.

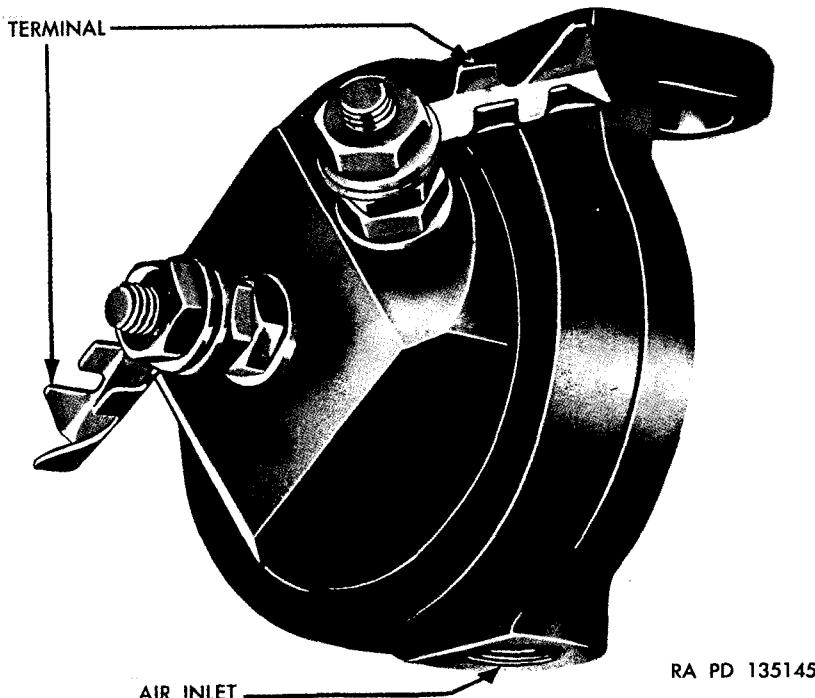


Figure 224. Type SL-1 stop light switch.

207. Test

- a. Prepare test bench (fig. 71 and par. 60b).
- b. Connect low pressure indicator to line 1 (fig. 71).
- c. Operate valve 1 (fig. 71) to obtain a reading of 105 pounds on gage 1. Open valves 2, and 3 (fig. 71 and par. 60b). Coat low pressure indicator all over with soap suds to detect leakage. No leakage is permissible.
- d. Connect low pressure indicator electrically. Connect one terminal of a 6-volt battery to the terminal clip in cover, connect one terminal of a 6-volt lamp to the terminal clip in body, and connect the other terminal of the lamp to the free terminal of the battery.
- e. Turn handle of valve 3 (fig. 71) at right angles to the body of the valve (par. 197b) and observe gage 1 and note at what pressure the electrical circuit is completed. This is indicated when the 6-volt lamp lights. The lamp should light when the pressure gage 1 is between 54 to 66 pounds. The pressure required to complete the circuit may be altered by removing cover from body and changing number of shims under the spring. Add shims to increase the pressure, remove shims to decrease the pressure.

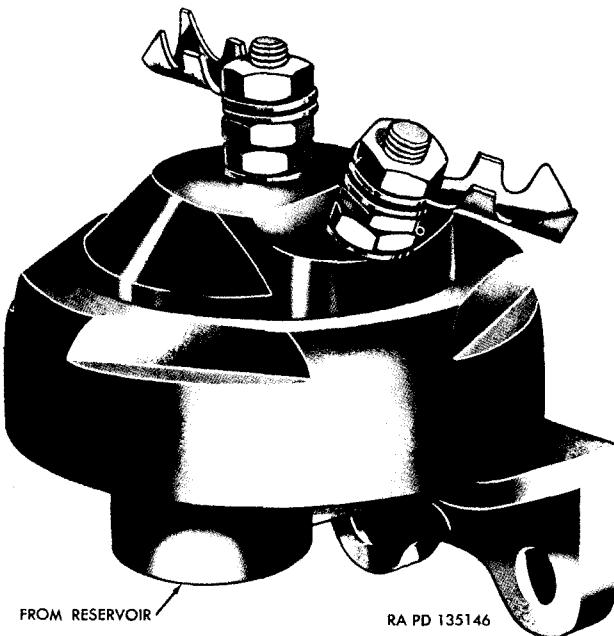


Figure 225. Type SL-2 stop light switch.

f. Turn handle of valve 3 (fig. 71) parallel with valve body and operate valve 1 to slowly raise the pressure in reservoir 1. Observe gage 1. If lamp does not become dark before gage 1 reads 70 pounds, disassemble the switch and inspect all the parts. Look for a short circuit. Replace all defective parts.

Section III. STOP LIGHT SWITCHES

208. Description and Operation

a. General. Stop light switches are electro-pneumatic devices which operate in conjunction with the brake valve to close the stop light electrical circuit when brakes are applied.

b. Types. Two types of switches may be found in service, type SL-1 and type SL-2. Both are identical in operation and differ only in construction details. The original type, SL-1 (fig. 224) has a threaded cover and the air inlet is in the side, opposite the mounting bracket. In the later type, SL-2 (fig. 225), the cover is clamped to body by a cover nut, and air inlet is in bottom of body. Type SL-2 is also available in waterproof construction (fig. 226). Waterproof terminal connections are used, and a breather valve is installed in cover. All other parts are the same.

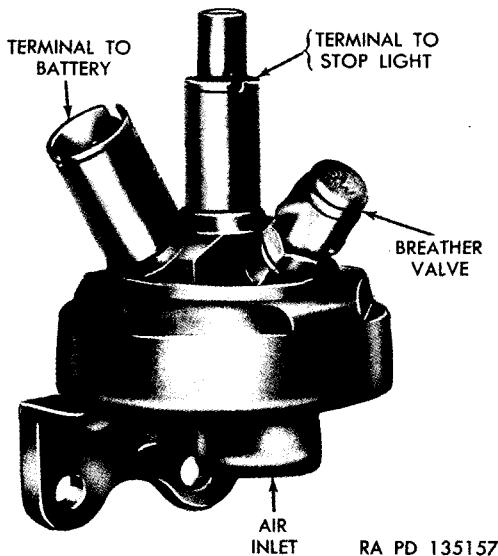


Figure 226. Type SL-2 stop light switch (waterproof).

c. Operation (figs. 227, 228, and 229).

- (1) Above the diaphragm inside the switch, a contact plunger fitted with a contact point makes contact with the contact point on one terminal screw when air pressure enters the switch below the diaphragm. The coil spring is in the electrical circuit and connects the contact plunger with one of the electrical terminals.
- (2) When air pressure from the brake valve enters the cavity on one side of the diaphragm, the diaphragm changes its position, overcomes the force of the spring and moves the contact plunger until the contacts close. This closes the stop light electrical circuit. The switch is designed to close as soon as 5 pounds air pressure is delivered to it. This means the stop light circuit closes immediately a brake application is made.
- (3) When air pressure acting on the diaphragm is exhausted by the brake valve, the spring forces the diaphragm and the contact plunger back to their normal position and the stop light circuit is opened.
- (4) Stop light switches are designed to handle a maximum electrical load of six 21-candlepower lamps at 12 volts or three 21-candlepower lamps at 6 volts.

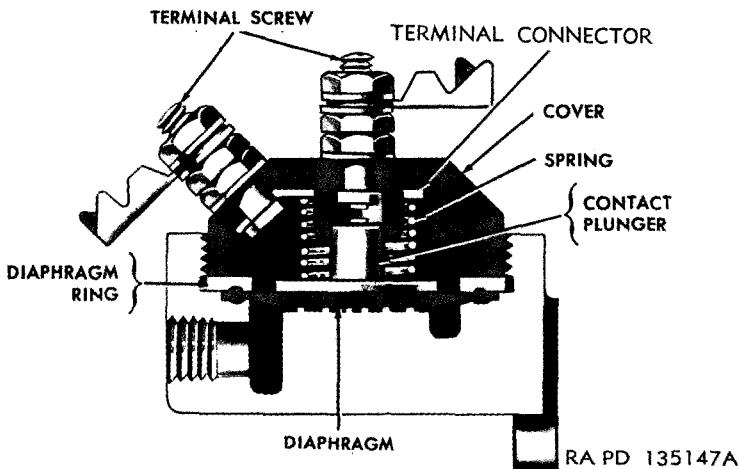


Figure 227. Type SL-1 stop light switch—sectional view.

209. Preliminary Examination

Inspect unit for broken or damaged parts. Perform leakage and operation tests (par. 213). If unit passes test, return to service.

Note. Disassemble for cleaning once a year or after every 50,000 miles.

210. Disassembly

- a. *Type SL-1* (fig. 227). Unscrew cover from body and lift out spring contact plunger, diaphragm ring, and diaphragm. Remove terminal screws, washers, nuts, and terminals.
- b. *Type SL-2* (fig. 228). Unscrew cover nut. Lift cover and remove spring, contact plunger, and diaphragm. Remove terminal screws, washers, nuts, and terminals. Lift terminal connector from cover.
- c. *Type SL-2 (waterproof)* (fig. 229). Construction of the waterproof switch is the same as the standard SL-2, with the exception that waterproof terminals are used. Disassembly of the stop light switch is the same as in b above. When removing terminal screws, remove sleeve, nuts, washers, terminal, insulating washers, and connector shell. Lift terminal connector from cover.

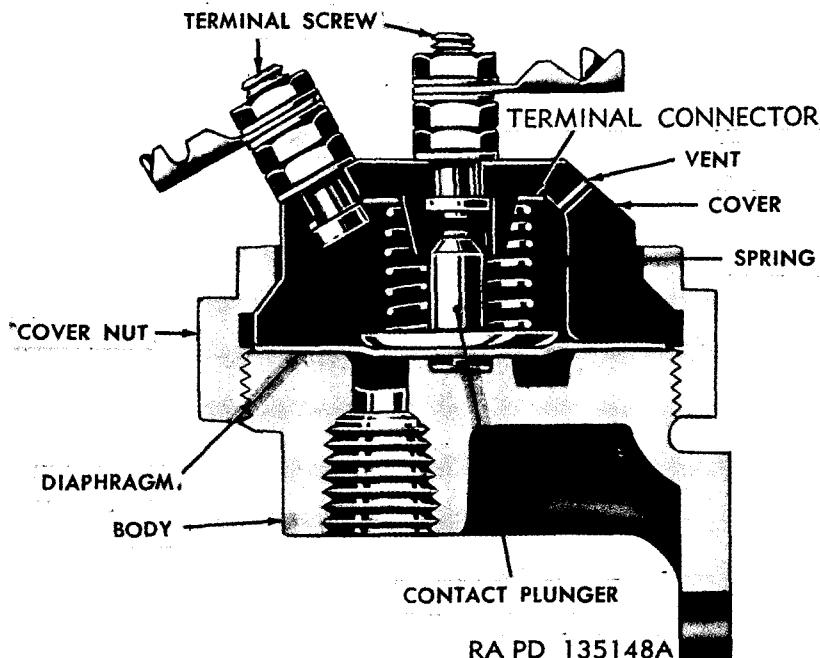


Figure 228. Type SL-2 stop light switch—sectional view.

211. Cleaning, Inspection, and Repair

a. *Cleaning.* Wash all parts, except diaphragms, with dry-cleaning solvent, or volatile mineral spirits.

b. *Inspection and Repair.*

- (1) Inspect condition of contact points in terminal screw and contact plunger. If points are only slightly burned or pitted, recondition them by carefully filing with a distributor point file. Replace terminal screw and contact plungers if points are badly burned or pitted.
- (2) Examine spring for evidence of heating or loss of tension. This is usually caused by a short in switch circuit. Replace spring if damaged in any way.
- (3) Replace diaphragm if cracked or damaged in any way.

212. Assembly

a. *Type SL-1* (figs. 227 and 230).

- (1) Install terminal screw having a contact point in center hole in cover and secure with washer, nut, and another nut as lock nut.
- (2) Position terminal connector in cover, install terminal screw and secure with washer, nut, and another nut as lock nut.
- (3) Position diaphragm and diaphragm ring in body. Set contact plunger and spring on diaphragm. Install cover and tighten.
- (4) Install cable terminals, with washers on each side, and secure with nut.

b. *Type SL-2* (figs. 228 and 231).

- (1) Install terminal screw having a contact point in center hole of cover, and secure with washer, nut, and another nut as lock nut.
- (2) Position terminal connector in cover, install terminal screw and secure with washer, nut, and another nut as lock nut.
- (3) Place diaphragm on switch body and set contact plunger and spring in position. Install cover nut. Hold cover to prevent turning while tightening cover nut. Install terminals with washer on each side and secure with nut.

c. *Type SL-2 (waterproof)* (fig. 229).

- (1) Place an insulator in the smaller of the two shells and press its small diameter into hole in bottom of shell. Install terminal screw having contact point in center hole in cover and install large insulating washer on terminal screw. Install shell and inserted insulator on terminal screw. Install washer and

nut and tighten. Place insulating washer over nut and install sleeve.

- (2) Position terminal connector in cover and install terminal screw and shell assembly as described in (1) above.
- (3) Position diaphragm on switch body and set contact plunger and spring in position. Install cover nut. Hold cover to prevent turning while tightening nut.

213. Test

- a. Prepare test bench (fig. 71 and par. 60b).
- b. Connect switch to line 2 (fig. 71).

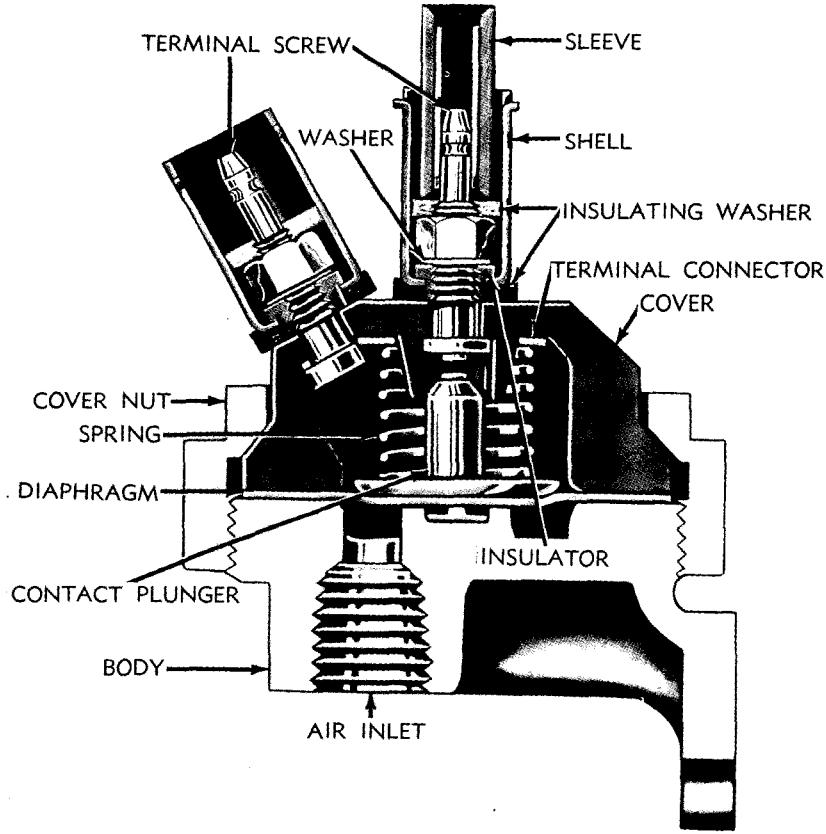


Figure 229. Type SL-2 stop light switch (waterproof)—sectional view.

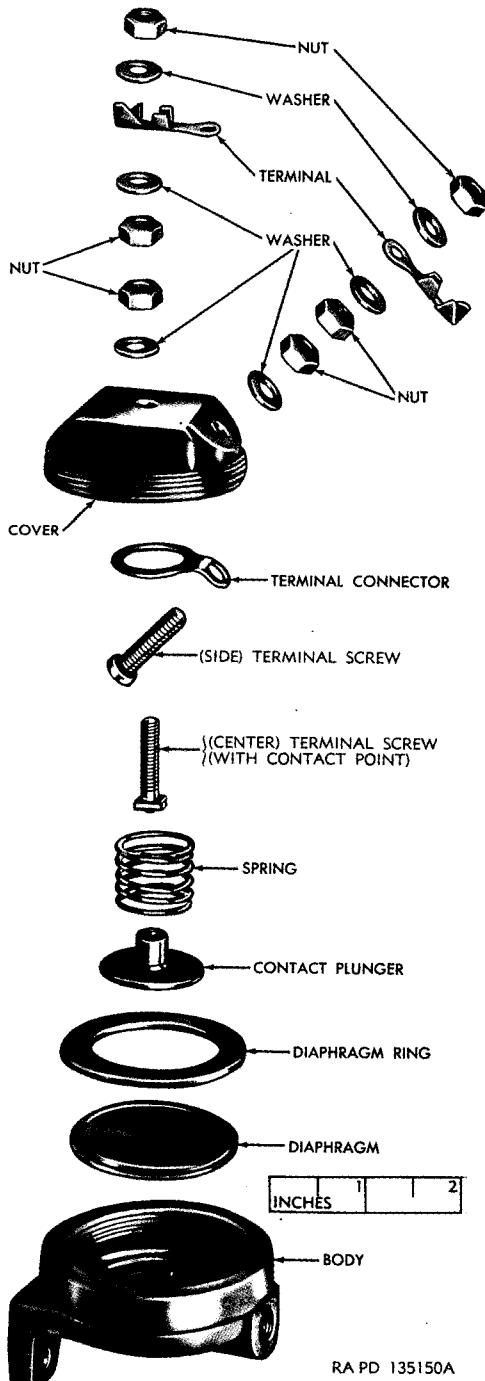


Figure 230. Type SL-1 stop light switch—exploded view.

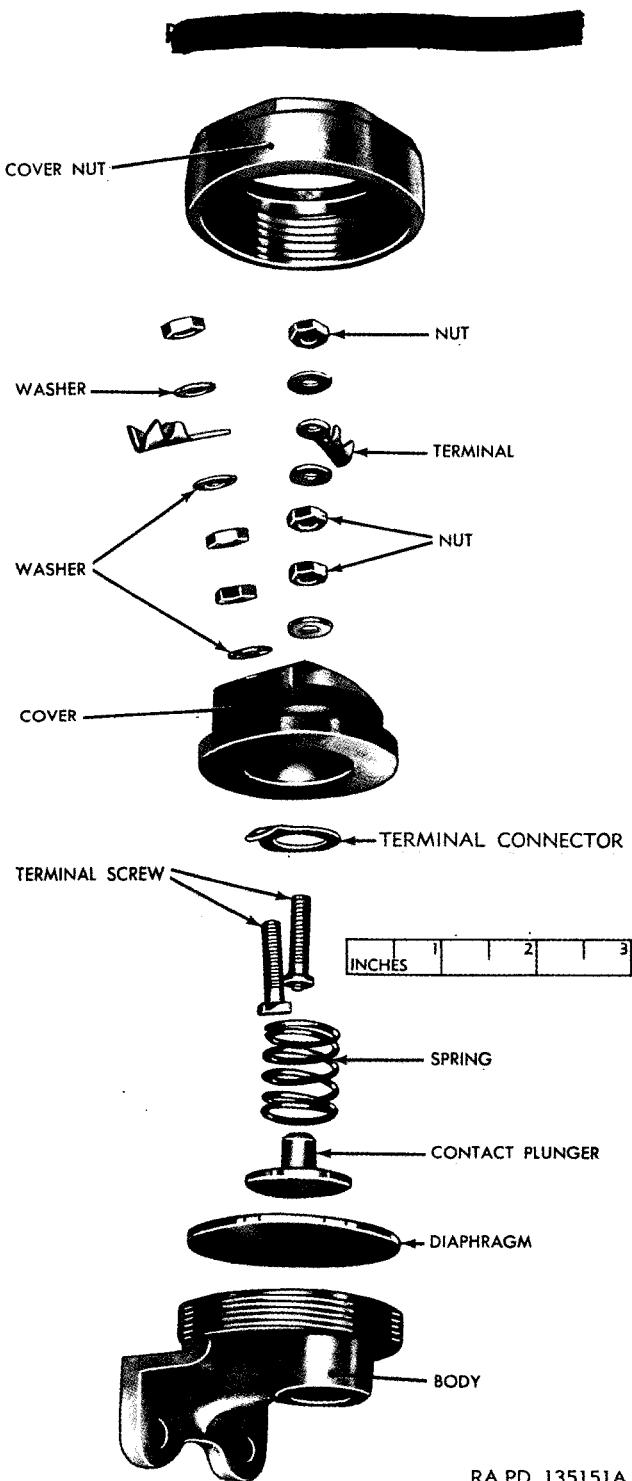


Figure 231. Type SL-2 stop light switch—exploded view.

RA PD 135151A

c. Operate valve 1 (fig. 71) to obtain a reading of 105 pounds on gage 1. Move valve 4 to applied position and coat entire switch with soap suds to detect leakage. No leakage is permissible. Move valve 4 to released position.

d. Connect stop light switch electrically. Connect one terminal of a 6-volt battery to the center terminal, connect one terminal of a 6-volt lamp to the terminal at the side of the cover, and connect the other terminal of the lamp to the free terminal of the battery.

e. The stop light switch requires 2 to 5 pounds air pressure to close contacts. Observe gage 2 (fig. 71) and apply valve 4 slowly until pressure causes lamp to light. If lamp fails to light at a maximum pressure of 6 pounds, disassemble switch and inspect contact points and spring. Replace defective parts.

f. Observe gage 2 (fig. 71) and slowly release valve 4. If lamp does not become dark before gage 2 reads zero, disassemble switch and inspect contact points and spring. Examine switch for a short circuit. Replace defective parts.

Section IV. AIR HORNS

214. Description and Operation

a. Description. Two types of air horns will be found in service. The two types are similar in construction and identical in operation and differ only in the mounting. Figure 232 shows the vertical mounting, the horizontal mounting is shown in figure 233.

b. Operation. Air pressure enters the horn, through the cavity in front of each diaphragm. The air pressure vibrates the diaphragm and allows air to escape through the horn bells causing the sound. The two different lengths of horn bells give the horn a dual tone.

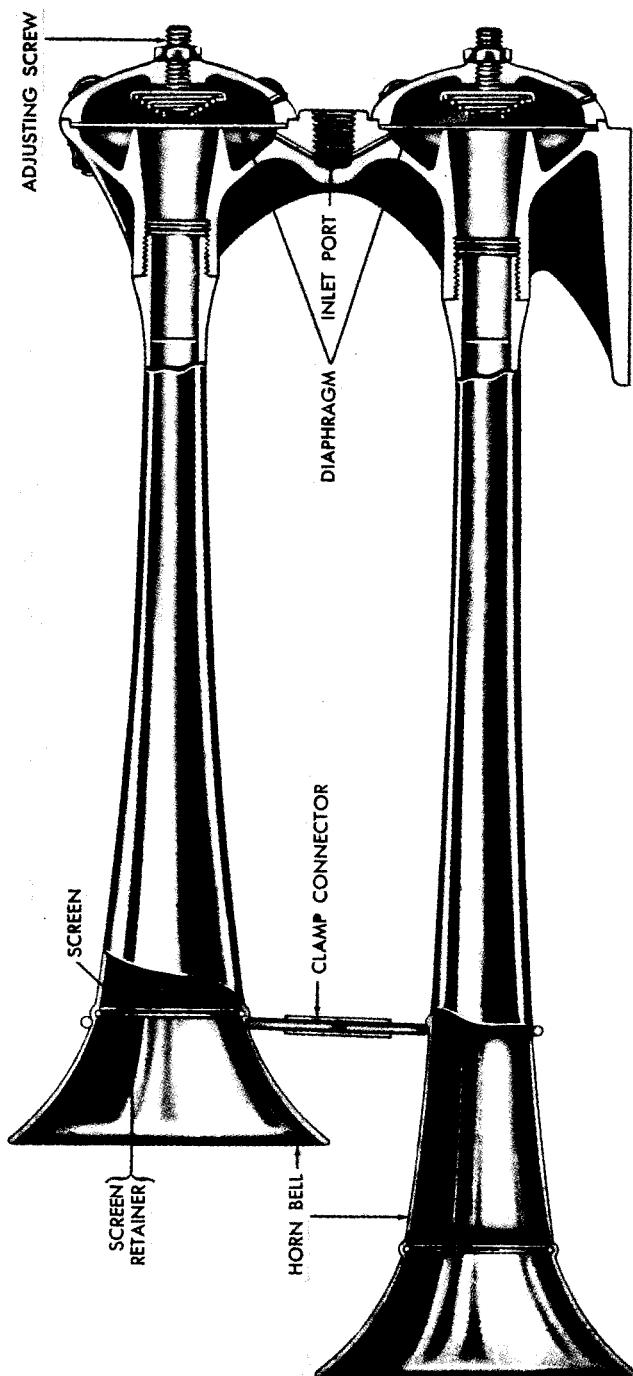
215. Disassembly

(fig. 233)

Remove the eight bolts and nuts fastening each cover to its body, separate the covers from the body, and lift out diaphragms. Remove springs, spring contacts, and spring seats from covers. Horn bells should not be removed from bodies unless replacement is necessary.

216. Cleaning, Inspection, and Repair

a. Cleaning. Wash all parts with dry-cleaning solvent or volatile mineral spirits.



RA PD 135152

Figure 232. Sectional view air horn—vertical mounting.

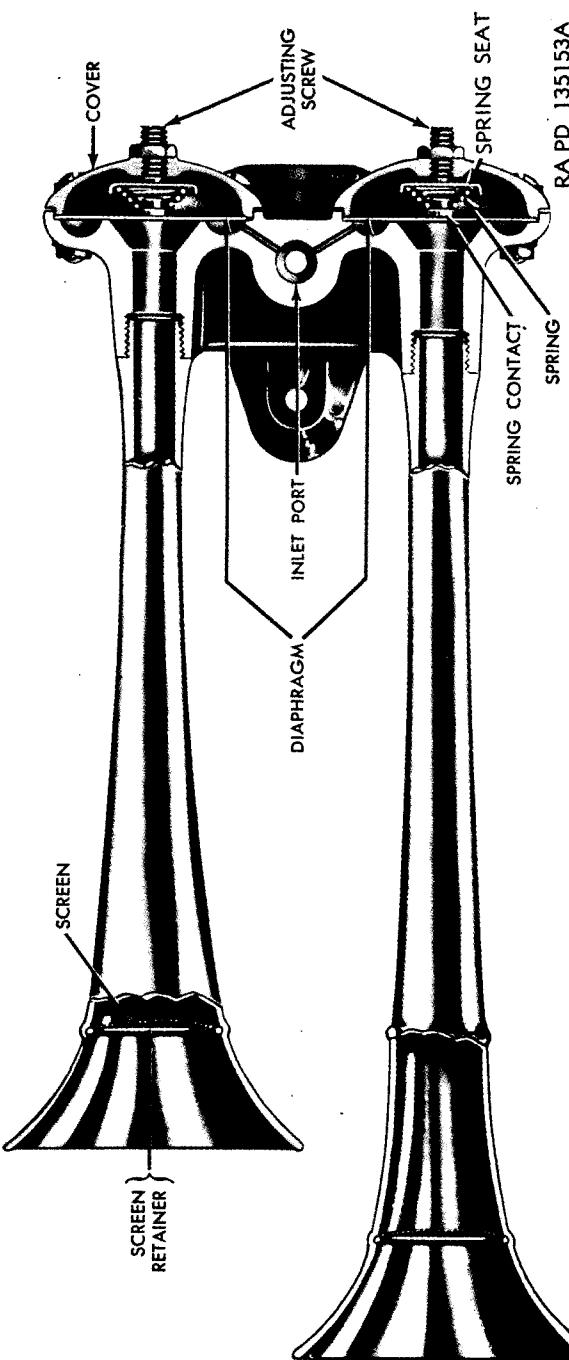


Figure 223. Sectional view air horn—horizontal mounting.

b. Inspection and Repair.

- (1) Inspect diaphragms. If ridges or cracks are apparent, or if they are damaged in any way, replace diaphragms.
- (2) Inspect diaphragm seats in body. If seats are chipped or damaged, or if any cracks are found in body, replace body.
- (3) Diaphragm seats in covers must not be chipped or damaged. Inspect covers for cracks. If any of these conditions are found, replace defective parts.
- (4) Replace cracked or broken horn bells.
- (5) Inspect springs, spring seats, and spring contacts. Replace broken parts.

217. Assembly

(fig. 233)

- a. Place the diaphragms in the body.
- b. Install the spring contacts, springs, and spring seats in covers.
- c. Install the eight bolts and nuts attaching the cover to the body. Care should be used to be sure equal pressure is exerted on all bolts holding the cover to the body.

d. Assemble the horn bells to the body if they were removed.

218. Adjustment

If horn does not operate satisfactorily, loosen lock nuts and adjust set screws in covers while operating the horn to determine best adjustment. Tighten lock nuts after adjustment.

Section V. ALCOHOL EVAPORATOR

219. Description and Operation

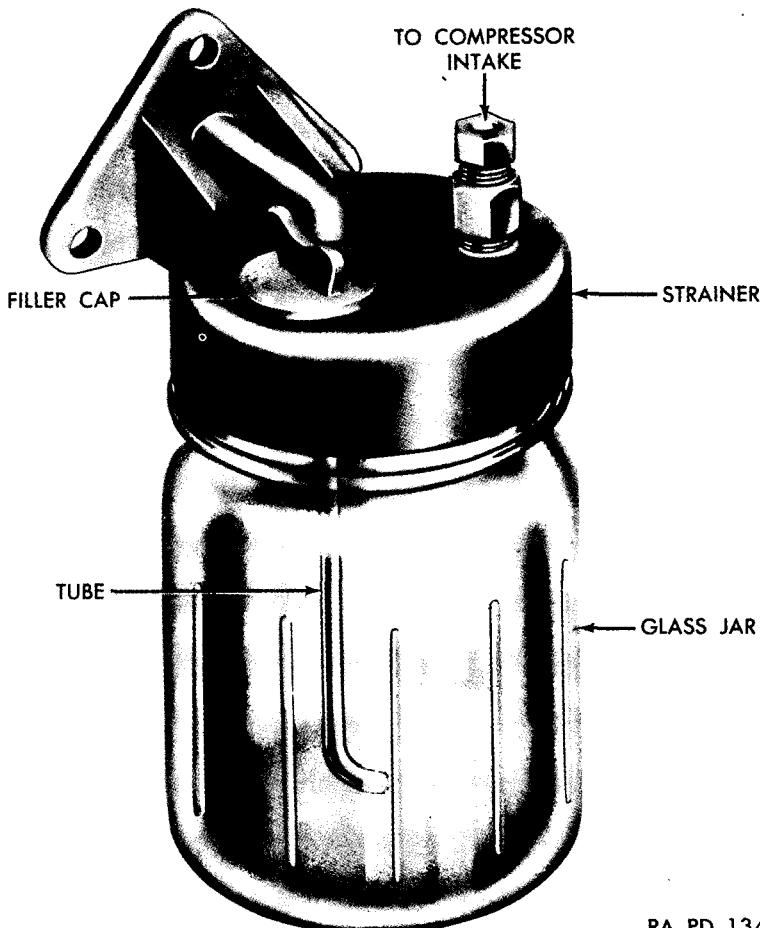
a. Description. The alcohol evaporator is used to protect an air brake system against freezing during service in below freezing temperatures. The alcohol evaporator permits vaporized alcohol to be drawn into the air brake system. The device consists of a casting forming a support for a glass receptacle for methyl alcohol (fig. 234).

b. Operation. While the compressor is compressing air, a partial vacuum is present in the compressor intake manifold. The alcohol evaporator is connected to the compressor intake manifold, therefore, a partial vacuum is created above the alcohol in the glass jar. Atmosphere then passes through the air strainer, through the cored passage in the cover, down the tube leading to the bottom of the jar, and then bubbles up through the alcohol and out through the tubing line to the

compressor intake manifold. The passing of the air bubbles through the alcohol causes some of the alcohol in the form of vapor to be carried along with the air stream through the compressor and into the air brake system. The alcohol thus introduced into the air brake system acts as an antifreeze.

220. Disassembly

Unscrew glass jar from strainer body and discard gasket. Remove retaining ring and strainer from body. Unscrew filler cap and discard gasket. Remove tubing connector and evaporator tube from body.



RA PD 134934

Figure 234. Alcohol evaporator.

221. Cleaning and Inspection

a. *Cleaning.* Wash all parts with dry-cleaning solvent or volatile mineral spirits.

b. *Inspection.* Inspect strainer body for cracks or damage and replace if defects are found. Check the evaporator tube and be sure it is not plugged or restricted with foreign matter. Glass jar must be replaced if any cracks are found.

222. Assembly

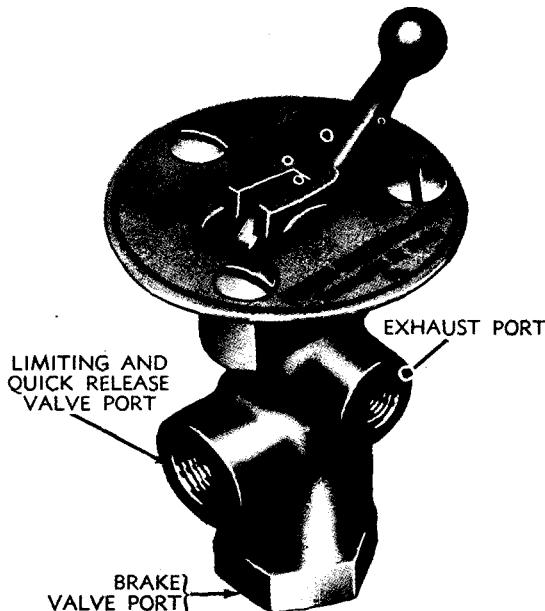
(fig. 234)

Place strainer in body and secure with retaining ring. Install evaporator tube and tubing connector. Install new gasket in body and screw glass jar in place. Install filler cap with new gasket.

Section VI. TWO-WAY VALVE

223. Description and Operation

a. *Description* (fig. 235). The two-way valve is used only in combination with a combined limiting-and-quick-release valve (fig. 238) in the air brake systems of trucks and tractors (figs. 9 and 10). It is a dash-mounted valve which, when used in combination with the combined-limiting-and-quick-release valve, permits full brake valve



RA PD 135056A

Figure 235. Two-way valve.

pressure to front wheel brakes when on dry roads, or limiting this pressure to 50 percent of brake valve pressure on slippery roads, at option of driver.

b. Operation (fig. 236). When valve is set for "SLIPPERY ROAD" position, valve plunger is raised by plunger spring and inlet valve is held closed on its seat by spring in end cap. In this position, air from brake valve is cut off and the hollow plunger permits exhaust of all pressure from the line to limiting-and-quick-release valve. When valve is set for "DRY ROAD," plunger is depressed, makes contact with inlet valve, and unseats it. In this position, air passage through hollow plunger is closed and air from brake valve has free passage to the line to limiting-and-quick-release valve.

224. Disassembly

(fig. 237)

- a. Remove name plate.*
- b. Drive out pivot holding lever in body; remove pivot, lever, and cam. Do not lose cam pin.*
- c. Remove end cap, inlet valve assembly, valve seat, and grommet.*
- d. Push plunger, plunger spring, and grommets from body.*

225. Cleaning, Inspection, and Repair

- a. Cleaning.* Wash all metal parts with dry-cleaning solvent or volatile mineral spirits.
- b. Inspection and Repair* (figs. 236 and 237).
 - (1) Check plunger for damage. Hole in plunger must be clean and free from all foreign matter. Examine small end; if chipped or uneven replace plunger.
 - (2) Check valve seat. If contact edge for inlet valve shows wear, replace seat.
 - (3) Check inlet valve assembly and replace assembly if valve, guide, or spring (fig. 236) show any damage.
 - (4) Check plunger spring for breaks, distortion, or any evidence of weakness.

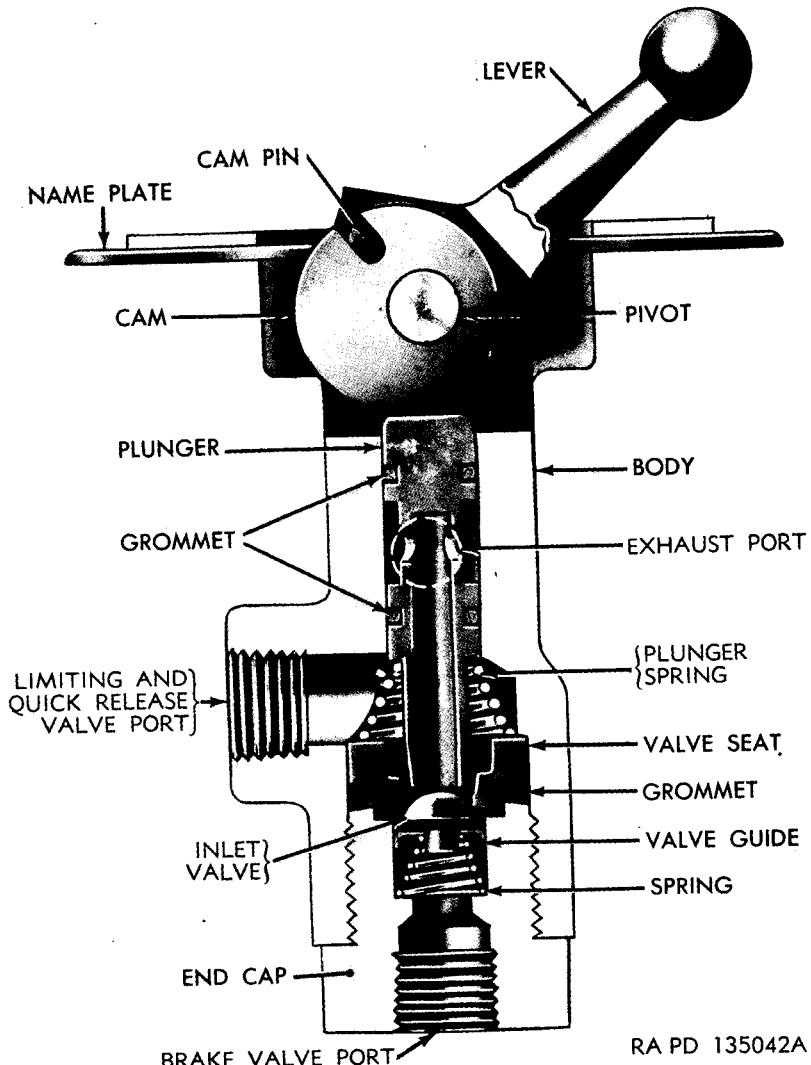
226. Assembly

(fig. 237)

- a. Replace plunger grommets if they show signs of wear. Coat plunger with aircraft and instrument grease (GL) and insert plunger in body. Plunger must move freely with only a slight drag due to*

grommets. Polish hole in body with crocus cloth if roughness is apparent.

- b. Install plunger spring with small end against plunger shoulder. Place valve seat on spring and install new grommet.
- c. Set inlet valve assembly in end cap and install cap.
- d. With finger, press plunger into body. Plunger spring must return plunger.



RA PD 135042A

Figure 236. Sectional view—two-way valve.

e. Place cam in lever and aline cam slot and center hole with lever. Insert cam pin. Holding body with small exhaust port up, place lever and cam in body. Cam pin must be on same side as port to limiting-and-quick-release valve. Insert lever pivot, aline pin hole, and drive pin flush with finished surface. Install name plate.

227. Test

- a. Prepare test bench (fig. 71 and par. 60b).
- b. Plug limiting-and-quick-release valve port and connect line 1 (fig. 71) to brake valve port of two-way valve. Operate valve 1 to maintain a pressure of 105 psi at gage 1. Open valve 3 (fig. 71) (par. 60b). With lever of two-way valve in "SLIPPERY ROAD" position, open valve 2 (fig. 71). Check for leakage at the exhaust port with soap suds.
- c. Move lever of two-way valve to "DRY ROAD" position. Check for leakage at exhaust port with soap suds.
- d. Leakage in the above tests must require more than 1 second to produce a 1-inch soap bubble.

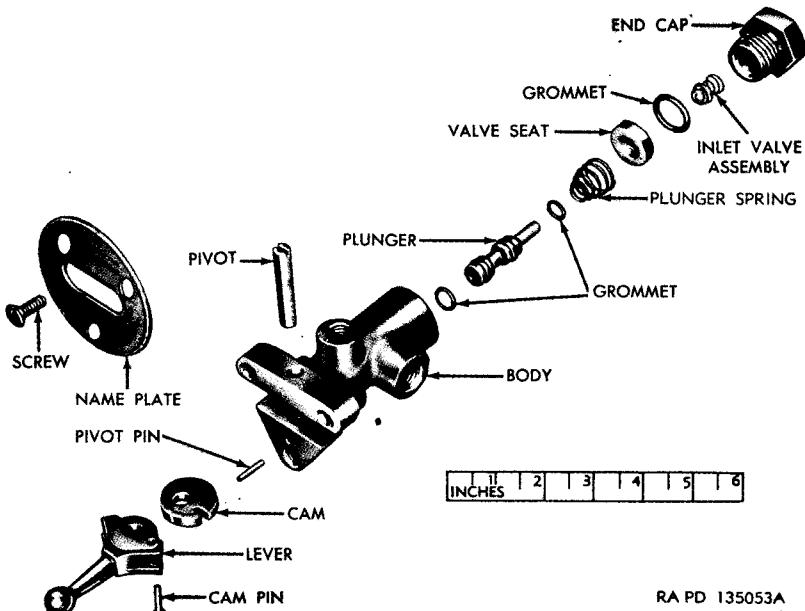


Figure 237. Two-way valve—exploded view.

Section VII. COMBINED-LIMITING-AND-QUICK-RELEASE VALVE

228. Description and Operation

a. Description (fig. 238). The combined-limiting-and-quick-release valve is used only in combination with a two-way valve (fig. 235) in the air brake system of trucks and tractors. The combined-limiting-and-quick-release valve is interchangeable in mounting with the quick release valve (par. 87) and serves the same purpose with the additional function of providing an automatic reduction of front wheel brake pressure, at option of driver, on slippery roads.

b. Operation (fig. 239).

(1) *Dry road.* In normal operation on dry road, air pressure from brake valve enters brake valve port at bottom of valve. At the same time, air pressure from two-way valve is admitted at the two-way valve port at the side of the combined-limiting-and-quick-release valve. The combined pressures, on the lower portion of the valve carrier (from the brake valve) and on the annular surface of the larger diameter of the valve carrier (from the two-way valve), raises the valve carrier to

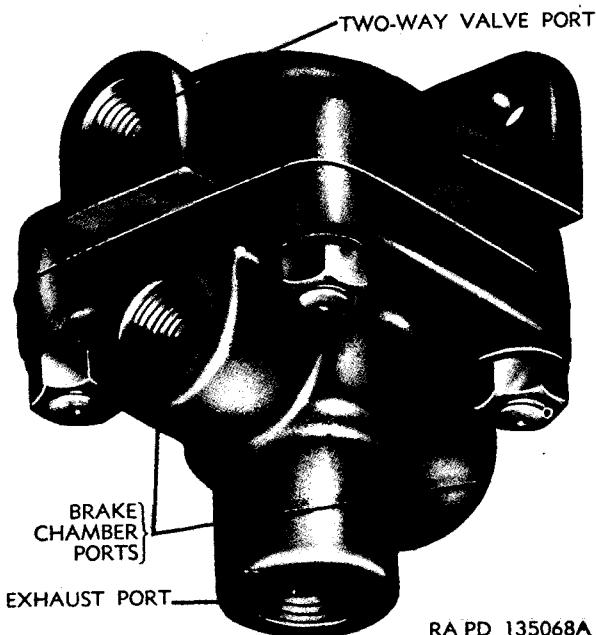
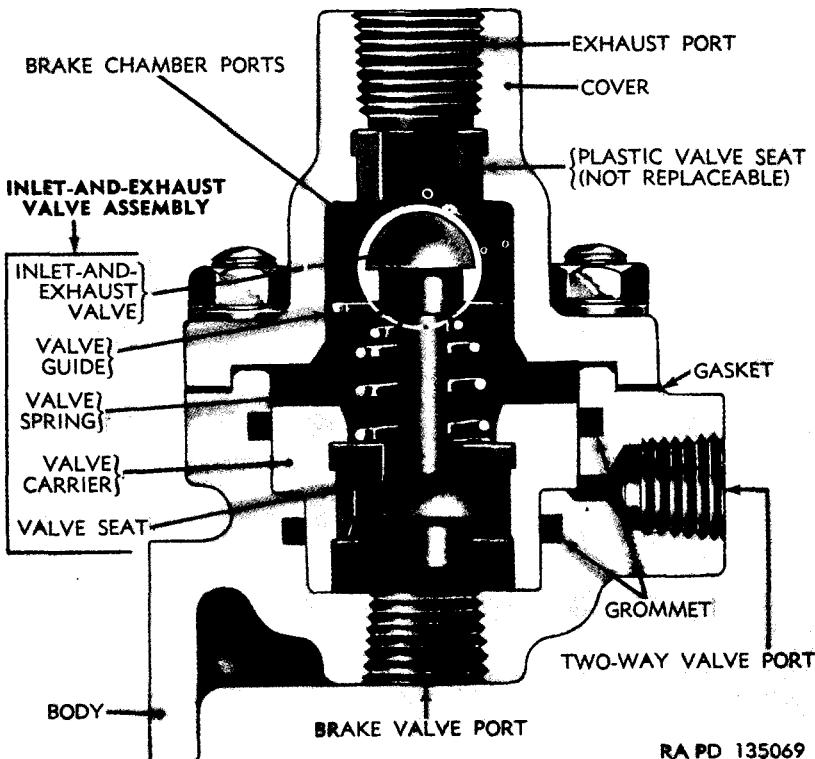


Figure 238. Combined-limiting-and-quick-release valve.

the limit of its travel. With the valve carrier in this position, the upper portion of the inlet-and-exhaust valve closes the exhaust port and the valve seat in the valve carrier is lifted from the lower portion of the inlet-and-exhaust valve, releasing full brake valve pressure to the brake chambers.

(2) *Slippery road.* When two-way valve (par. 223) is set for "SLIPPERY ROAD," brake valve pressure is cut off from the two-way valve port at the side but enters at the brake valve port at the bottom. The valve carrier rises to limit of its travel as before, sealing exhaust port and opening air passage through valve carrier and port to air brake chambers. As pressure builds up in brake chambers, it is also applied against the upper surface of valve carrier. The area of the upper surface of the valve carrier is approximately twice the area of lower portion and the resultant total thrust on upper surface of valve



RA PD 135069

Figure 239. Sectional view—combined-limiting-and-quick-release valve.

carrier, assisted by the spring load, will move carrier down when pressure in brake chambers (and upper portion of valve) is one-half the pressure from the brake valve. The valve carrier is lowered sufficiently to seat the lower portion of the inlet-and-exhaust valve in the valve seat of the carrier, closing the brake valve port, but not far enough to unseat the upper portion of the inlet-and-exhaust valve. If the brake valve is then operated to deliver increased pressure, the valve carrier will raise and admit air to the brake chambers until $\frac{1}{2}$ -brake valve pressure is again established. If the brake valve is operated to reduce the delivered pressure, the valve carrier will be lowered sufficiently to unseat the upper portion of the inlet-and-exhaust valve, opening the exhaust port and releasing air pressure from the air brake chambers. When the pressure in the air brake chambers again equals about $\frac{1}{2}$ -brake valve pressure, the valve carrier raises and seats the upper portion of the inlet-and-exhaust valve, closing the exhaust port and maintaining the pressure in the air brake chambers at about one-half the pressure delivered by the brake valve. If the brake valve is operated to release its delivered pressure, the pressure under the valve carrier collapses and the compression of the spring aided by the air brake chamber pressure above the carrier thrusts the carrier to its lowest position, completely opening the exhaust port and quickly venting the air brake chamber pressure.

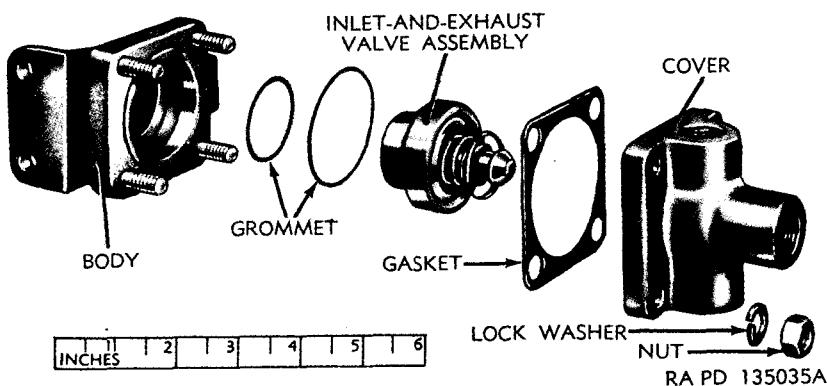


Figure 240. Combined-limiting-and-quick-release valve—exploded view.

229. Disassembly

(fig. 240)

- a. Remove nuts and lock washers holding cover to body, separate the parts and discard gasket.
- b. Push inlet-and-exhaust valve assembly out of body and remove grommets.

230. Cleaning and Inspection

- a. *Cleaning.* Wash all parts with dry-cleaning solvent or volatile mineral spirits.
- b. *Inspection.* Examine body and cover for cracks or other damage. Check valve seat in cover. If edge of seat is chipped or worn, replace cover. Remove slight scratches or scores from inner surface of body, or on outer surface of valve carrier with crocus cloth. If valve spring is distorted, replace inlet-and-exhaust valve assembly (fig. 239).

231. Assembly

(fig. 240)

- a. Install new grommets in valve body.
- b. Set inlet-and-exhaust valve assembly in body, place new gasket in position and install cover. Use care when installing cover so that valve guide (fig. 239) is not damaged.
- c. Install lock washers and nuts, and tighten.

232. Test

- a. Prepare test bench as shown in figure 71 (par. 60b) except that a tee is installed on line 2 and (air supply) valve 3 is removed from line 1 and installed in one of the legs of the tee. The air supply valve must be installed so that arrow on air supply valve body will point *away* from tee.
- b. Connect the air supply valve to the two-way valve port and the free leg of the tee to the brake valve port of the combined-limiting-and-quick-release valve to be tested. Place handle of air supply valve parallel with body of valve (open position).
- c. Plug one air brake chamber port and connect line 4 (fig. 71) to other air brake chamber port of combined-limiting-and-quick-release valve. Close valve 6.
- d. Fully apply valve 4 (fig. 71). Gage 4 must register same as gage 2.

[REDACTED]

e. With pressure still on, check exhaust port for leakage with soap suds. Leakage which will produce a 1-inch soap bubble in 1 second is permissible. Coat the remainder of the valve with soap suds. No leakage is permissible.

f. Turn handle of air supply valve perpendicular to body (closed position) to exhaust pressure from line to two-way valve port of valve. Gage 4 (fig. 71) should drop to approximately one-half of the pressure shown on gage 2.

APPENDIX REFERENCES

1. Publication Indexes

Special Regulations in the 310-20 series, SR 110-1-1, ORD 1, FM 21-8, and SB 9-1.

2. Supply Catalogs

The following catalogs of the Department of the Army Supply Catalog pertain to this matériel:

Antifriction Bearings and Related Items	ORD 5 SNL H-12
Cleaners, Preservatives, Lubricants, Recoil Fluids, Special Oils, and Related Maintenance Materials	ORD 3 SNL K-1
Electrical Fittings	ORD 5 SNL H-4
Items of Soldering, Metallizing, Brazing, and Welding Materials: Gases and Related Items	ORD 3 SNL K-2
Lubricating Equipment, Accessories, and Related Dispensers	ORD (*) SNL K-3
Major Items and Major Combinations of Group G	ORD 3 SNL G-1
Miscellaneous Hardware	ORD 5 SNL H-2
Oil Seals	ORD 5 SNL H-13
Pipe and Hose Fittings	ORD 5 SNL H-6
Shop Set, Maintenance (Field) Automotive	ORD 6 SNL J-8, Sec 13
Shop Set, Headquarters and Service Company, Depot Maintenance, Automotive or Armament	ORD 6 SNL J-9, Sec 2
Standard Hardware	ORD 5 SNL H-1
Tool Set, General Mechanic's	ORD 6 SNL J-10, Sec 4
Tool Set, Maintenance (Field), Motor Vehicle Assembly Company	ORD 6 SNL J-8, Sec 7

* See ORD 1 for published catalogs of the ordnance section of the Department of the Army Supply Catalog.

Tool Sets, Field and Depot Maintenance
for: Carriage, motor, twin 40-mm gun,
M19A1 (SNL G-248); Carriage, motor,
105-mm howitzer, M37 (SNL G-238);
Carriage, motor, 155-mm howitzer, M41
(SNL G-236); Tank, light, M24 (SNL
G-200) ORD 6 SNL J-16, Sec 11

3. Forms

The following forms pertain to this matériel:

WD AGO Form 9-71, Locator and Inventory Control Card.

WD AGO Form 9-72, Ordnance Stock Record Card.

DA Form 9-76, Request for Work Order.

DA Form 9-77, Job Order Register.

WD AGO Form 9-78, Job Order.

DA Form 9-79, Parts Requisition.

WD AGO Form 9-80, Job Order File.

WD AGO Form 9-81, Exchange Part or Unit Identification Tag.

DA Form 461-5, Limited Technical Inspection.

DA Form 468, Unsatisfactory Equipment Report.

WD AGO Form 865, Work Order.

WD AGO Form 866, Consolidation of Parts.

WD AGO Form 867, Status of Modification Work Order.

DD Form 6, Report of Damaged or Improper Shipment.

4. Other Publications

The following publications contain information pertinent to this matériel and associated equipment.

a. Camouflage.

Camouflage, Basic Principles FM 5-20

Camouflage of Vehicles FM 5-20B

b. Decontamination.

Decontamination TM 3-220

Decontamination of Armored Force Vehicles FM 17-59

Defense Against Chemical Attack FM 21-40

c. *Destruction to Prevent Enemy Use.*

Explosives and Demolitions	FM 5-25
Ordnance Service in the Field	FM 9-5

d. *General.*

Military Vehicles	TM 9-2800
Motor Transport	FM 25-10
Motor Vehicles	AR 700-105
Principles of Automotive Vehicles	TM 9-2700
Report of Accident Experience	SR 385-10-40
Supplies and Equipment: Unsatisfactory Equipment Report	SR 700-45-5

e. *Maintenance and Repair.*

Abrasive, Cleaning, Preserving, Sealing, Adhesive, and Related Materials Issued for Ordnance Matériel	TM 9-850
Hand, Measuring, and Power Tools	TM 10-590
Instruction Guide: Care and Maintenance of Ball and Roller Bearings	TM 37-265
Lubrication	TM 9-2835
Maintenance and Care of Hand Tools	TM 9-867
Maintenance Supplies and Equipment: Maintenance Responsibilities and Shop Operation	AR 750-5
Modification of Ordnance Matériel	SB 9-38
Motor Vehicle Inspection and Preventive Maintenance Services	TM 37-2810
Ordnance Maintenance and General Supply in the Field ..	FM 9-10
Ordnance Maintenance: Hydraulic Brakes (Wagner-Lockheed)	TM 9-1827C
Ordnance Maintenance: Vacuum Brake System (Bendix BK)	TM 9-1827B
Ordnance Maintenance: Vehicular Maintenance Equipment, Grinding, Boring, Valve Reseating Machines, and Lathes	TM 9-1834A
Painting Instructions for Field Use	TM 9-2851
Preparation of Ordnance Matériel for Deep Water Fording	TM 9-2853

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