

**MASTER CYLINDER
SERVICE INSTRUCTIONS**

EXPANDER TUBE BRAKE SYSTEM

MANUAL G6

**INSTALLATION, OPERATION, MAINTENANCE, AND
OVERHAUL OF B F GOODRICH MASTER CYLINDER ASSY.,
FOR INDUSTRIAL EQUIPMENT**

**Used on
BFGoodrich Expander Tube Brake Assemblies**

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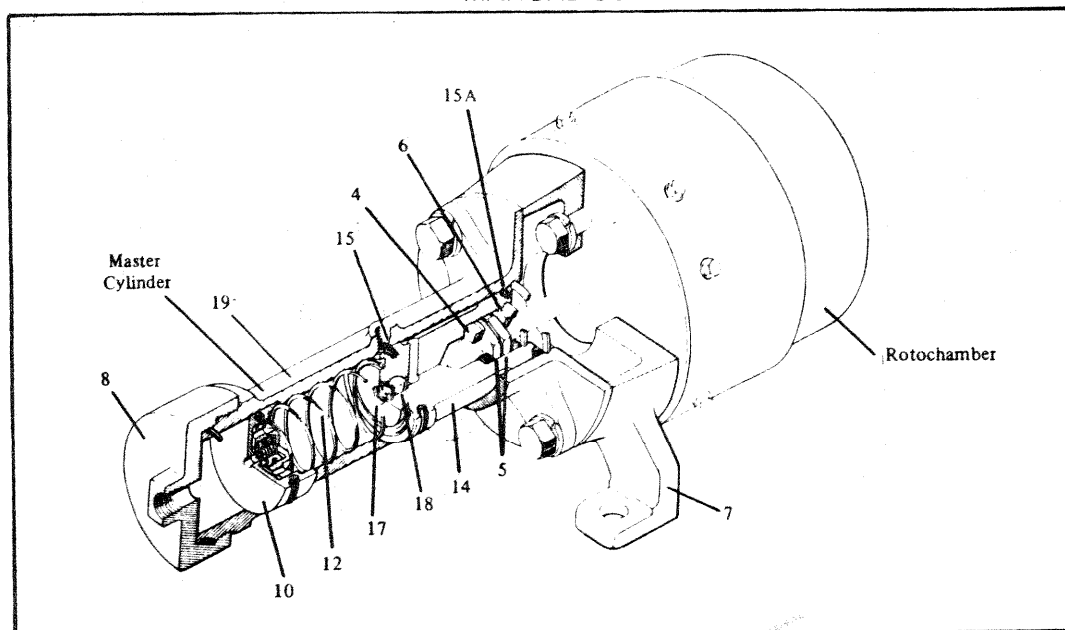


Figure 1. Air and Hydraulic Actuator Assembly

1. DESCRIPTION:**WARNING**

THE MASTER CYLINDERS IN THIS MANUAL ARE DESIGNED TO USE MINERAL OIL PER PARAGRAPH 5.5.2. USE OF IMPROPER FLUID WILL AFFECT RUBBER COMPONENTS OF BRAKES AND MASTER CYLINDERS, RESULTING IN LOSS OF BRAKING AND POSSIBLE CATASTROPHIC FAILURE. IT IS IMPERATIVE THAT THE ABOVE WARNING BE PASSED ON TO ANYONE USING, SERVICING OR SHIPPING THIS PRODUCT.

- 1.1 The master cylinder assembly may be shipped separately or assembled to an air actuated rotochamber. As a separate unit the master cylinder assembly is identified as BFGoodrich Part No. 87-. When assembled to a rotochamber, the combination is identified as BFGoodrich Part No. 221-. See Figure 1 for typical assembly of rotochamber and master cylinder.

NOTE: The master cylinder alone, or assembled to a rotochamber, may be purchased from BFGoodrich Transportation Products Division, Troy Plant, Troy, Ohio. The rotochamber is manufactured by Bendix-Westinghouse, Elyria, Ohio, and may be purchased, by itself, directly from them.

- 1.2 The master cylinder assembly consists basically of a housing (19), a mounting bracket (7), an actuation piston (14), and an automatic adjusting piston assembly (10). The unit is available completely assembled.
- 1.3 This master cylinder assembly has a four-in. stroke capacity and its fluid inlet is at the pressure face of the piston when the piston is in the completely retracted position. In the cap end of the housing, the diameter of the bore increases for a distance of about three-in. from the cap end. This increased bore contains the floating automatic adjuster piston (10). An end cap (8) closes the housing.

- 1.4 The rotochamber conveys air pressure into the actuation piston (14) through a 3/4 in. maximum diameter rod. Jam nuts (5) attach the actuating rod to the actuating piston. The nuts are located on the rod between washer (4) which is ahead of the nuts, and washer (6) and retaining ring (3) behind the nuts. The retaining ring (3) is located in the actuating piston (14). The piston has two packings (15, 15A) along its cylindrical surface and a ball-check valve (17, 18) in the pressure face. Automatic adjustment is made by a sensing piston backed by a sensing piston spring moving in a housing to open and close a port through which fluid passes into and through the adjuster piston (10). A light spring (12) separates the actuating and adjuster pistons.

2. OPERATION:

- 2.1 From the reservoir tank, actuation fluid enters the threaded inlet hole located about midway of the piston housing (19). When the actuation piston (14) is fully retracted, fluid fills the piston housing between it and the adjuster piston (10). When the actuation piston moves forward, the adjuster piston also moves forward the length of its available travel, about half the stroke of the actuation piston. Continued pressure on the actuation piston causes the sensing piston to open the port, allowing fluid to pass through the automatic adjuster into the brake as long as the piston is under pressure. The fluid leaves the piston housing through the port in the cap to be conveyed to the brake assembly.
- 2.2 When the pressure is removed from the actuation piston, brake pressure decreases until all that remains is the back pressure caused by the brake block retracting springs. All linings are still in contact with the drum. Then the sensing piston closes and both actuation piston and adjuster piston retract in the piston housing. The adjuster piston retracts the entire length of its available travel and the actuation piston retracts to its starting position. Fluid can pass through the ball-check valve (17, 18) into the front of the piston as it retracts, thereby preventing a vacuum lock in front of the actuation piston.

3. INSTALLATION:

WARNING

USE MINERAL BASE OIL ONLY IN ACCORDANCE WITH
SPECIFICATIONS IN PARAGRAPH 5.5.2.

- 3.1 The master cylinder is shipped from the factory completely assembled.

NOTE: Instructions for installing a 221- Air and Hydraulic Actuator Assembly are covered in paragraph 3.3.

- 3.2 To assemble the master cylinder to the air rotochamber proceed, as follows:

- 3.2.1 Remove mounting bracket (7) from master cylinder and attach to air rotochamber using lock washers under the nuts and tightening securely.

NOTE: When attaching mounting bracket to a No. 36 Roto-chamber, two bushings (20) must be installed and used. Type No. 50 Roto-chamber does not require bushings.

- 3.2.2 Remove retaining ring (3), washer (6), and jam nuts (5) from the rear of the piston.

3.2.3 With air rotochamber push rod retracted, position jam nuts (5) so that the distance from the face of the mounting bracket (7) to closest face of washer (6) is 9/16 in.; then lock jam nuts (5) together. See Figure 4.

3.2.4 Apply pressure to air rotochamber to extend push rod.

NOTE: Check to see that the washer (4) is correctly seated in the piston.

3.2.5 Insert air rotochamber push rod into the end of piston (14), seating the jam nuts against the washer (4).

3.2.6 Lock the retaining ring (3) in its groove in the piston.

3.2.7 Release the air from the air rotochamber.

WARNING

BE SURE INLET FITTING DOES NOT PROTRUDE THROUGH PISTON HOUSING WALL INTO PISTON HOUSING (19) CAUSING DAMAGE TO POWER PISTON PACKING (15).

3.2.8 Align the threaded holes in the mounting bracket with the holes in the master cylinder so that the oil inlet is at the top when the unit is installed.

3.2.9 Install lock washers (2) and bolts (1) and tighten evenly and firmly to 130 to 140 lb ft.

NOTE: The entire unit, consisting of the air rotochamber, mounting bracket, and master cylinder, is ready to attach to the vehicle through holes in the mounting bracket.

3.3 To mount the master cylinder and rotochamber assembly proceed as follows:

3.3.1 Install the master cylinder and rotochamber assembly in a horizontal position, with the inlet at the top of the barrel.

NOTE: BFG Engineering approval is required if the assembly is to be mounted differently.

3.3.2 After mounting the assembly, connect the air line to the air rotochamber, the brake line to the cap (8), and the reservoir line to the cylinder inlet.

WARNING

BE SURE INLET FITTING DOES NOT PROTRUDE THROUGH PISTON HOUSING WALL INTO PISTON HOUSING (19) CAUSING DAMAGE TO POWER PISTON PACKING (15).

3.3.3 Bleed the brake system in accordance with the following procedure:

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- 3.3.3.1 **Checking:** Before trying to bleed the equipment, check the following:
- 3.3.3.2 **Reservoir Line Size:** Recommended size is 5/16 in. minimum ID.
- 3.3.3.3 **Reservoir Size:** A vented reservoir of at least 2 qt. capacity is required for each master cylinder used. The reservoir should be equipped with an outlet strainer and an inlet filter screen.
- 3.3.3.4 All reservoir lines should drain to the master cylinder.
- 3.3.3.5 Bleeder valves should be installed at the highest point in the line between the master cylinder and brake, as near the brake as possible.

WARNING

FLUID USED MAY CAUSE IRRITATION. AVOID ANY CONTACT WITH EYES OR PROLONGED CONTACT WITH SKIN.

- 3.3.3.6 Use additional bleeder valves at the master cylinder outlet if supply lines to brake exceed 4 ft.
- 3.3.3.7 To bleed fill the reservoir with oil as noted in paragraph 5.5 and proceed as follows:
 - NOTE:** Keep reservoir full throughout the bleeding procedure. Each time the bleeder is opened, permit complete drainage from the bleeder until all flow stops.
- 3.3.3.8 Hold brake pedal down and open bleeder valve to vent air from master cylinder. When fluid stops draining, close bleeder valve and release brake pedal.
- 3.3.3.9 Wait two minutes for master cylinder to replenish and repeat the procedure in the above paragraph.
- 3.3.3.10 Actuate brake pedal with the bleeder valve closed, hold pressure for 10 seconds, and release. Wait two minutes and repeat cycle.
- 3.3.3.11 Repeat paragraph 3.3.3.8 to clear air from the brake side of the automatic adjuster in the master cylinder and from the expander tube. Repeat until no air can be detected escaping from the bleeder valve. Wait two minutes between each brake release and the next application.
- 3.3.3.13 After operating the vehicle for approximately an hour, open the bleeder with brakes released, to permit the escape of remaining air which may work to the top of the system during operation.

4. MAINTENANCE:

- 4.1 **Inspection:** When the vehicle is available for inspection, examine master cylinder cap (8) end and fluid connections for leakage and the master cylinder mounting bracket (7) for tightness or damage.
- 4.2 **Repair:** Tighten loose cap bolts (1) to 130 to 140 lb ft. to assure proper support. Correct any leak at the fluid connections by tightening the fittings.

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- 4.3 Replacement: If there is a leak in the cap that cannot be stopped by tightening the cap on the piston housing (19), remove the cap and replace the packing (9). If there is a leak at the fittings that cannot be stopped by tightening, replace the fitting.
- 4.4 Dragging Brakes: Air in the hydraulic system may cause the brake to drag. If this condition is suspected, with brake released, open bleeder screw and drain all air and fluid that will come out. Then tighten bleeder screw, check the reservoir level, and refill if necessary. Apply the brakes three times allowing at least 30 seconds between applications. Repeat the procedure until removal of all air from brake is assured.
- 4.5 Trouble Shooting:

AIR OVER HYDRAULIC ACTUATING SYSTEM

TROUBLE	POSSIBLE CAUSE	CORRECTION
Brakes dragging or running hot.	Air trapped in hydraulic actuating system.	Bleed system and brake in accordance with paragraph 3.3.3.
	Residual air pressure at roto-chamber.	Check air system to insure zero pressure at rotochamber.
	Rotochamber retraction obstructed.	Inspect rotochamber to insure full retraction.
	Master cylinder actuation piston not retracting.	Inspect cylinder bore and actuation piston OD for burrs, chips, or other obstruction and correct.
	Master cylinder floating piston not retracting.	Inspect cylinder bore and floating piston OD for burrs, chips, or other obstruction and correct.
	Return spring between master cylinder pistons out of engagement.	Seat spring in groove on end of each piston.
	Broken or flattened brake retracting spring.	Compare spring arch with new spring and replace flattened or broken springs with complete set of twelve.
	Improper oil in system causing vaporization in brake.	Purge system, replace all rubber parts and refill with hydraulic oil as specified in paragraph 5.5.
	Master cylinder adjuster not working.	Remove floating piston assembly and insert blunt tool into small hole in face of piston and push inward. If there is no definite movement, replace with a new part.

AIR OVER HYDRAULIC ACTUATING SYSTEM (continued)

TROUBLE	POSSIBLE CAUSE	CORRECTION
Brakes will not apply.	Brakes not bled of air allowing master cylinder to bottom.	Bleed system and brakes in accordance with paragraph 3.3.3.
	Reservoir located below master cylinder restricting oil flow.	Relocate reservoir above master cylinder to allow gravity feed.
	Feed-line from reservoir restricted or too small.	Insure free flow using 5/16 min. ID line without restriction.
	Master cylinder actuation piston not retracting to seat, closing off inlet.	Adjust rotochamber push rod attachment as outlined in paragraph 3.2.3.
	Master cylinder actuation piston stuck in cylinder bore.	Free up piston removing obstruction. If cylinder wall or piston OD is excessively damaged, replace with new part.
	Vacuum trapped in reservoir.	Insure vent air passage in reservoir.
	Insufficient oil reserve.	Keep reservoir filled with hydraulic oil as specified in paragraph 5.5.
	Check valve in master cylinder actuation piston not closing.	Insure free motion of ball check and remove all foreign particles.
	Master cylinder adjuster not working.	Remove floating piston assembly and blow with mouth into small hole in face of piston. If air passes, replace with new part.
	Packing on master cylinder actuation piston not sealing.	Replace packing with new BFGoodrich replacement part.
	Supply line leaking.	Check lines and fittings to insure sealing.
	Air pressure inadequate.	Air pressure at rotochamber should be not less than 80 psi with brakes applied. Correct air system as required to obtain 80 psi min.
Master cylinder leaking at mounting bracket joint.	Packing not sealing.	Replace all master cylinder packings.
Brake leaking.	Expander tube nozzle packing not sealing.	Replace packings and inspect connector block nozzle hole for surface damage. If surface does not appear satisfactory for sealing, replace connector with new part.
	Expander tube leaking.	If tube shows definite leak, replace with a new tube.

4.6 Cold Weather Maintenance: When the 221-8 assembly is used at temperatures between -40° to -65°F, the following maintenance procedure is required:

- 4.6.1 Drain all components, including the oil reservoir, master cylinder, hydraulic lines, and brakes, of oil. Allow time for retracting springs in the brakes to retract and exhaust all the oil from the brakes.
- 4.6.2 Rebuild the 221-8 assembly using the cold weather modification kit (Part No. 198-25). This kit includes the following cold weather parts; diaphragm for the Type 36 Rotochamber, replacement O-rings for items 9, 11, 15, and 15A, and a replacement piston assembly (10). The 15A O-ring is identified by a molded white dash; this is in addition to the molded orange dash found on each of the O-rings included in this kit. The floating piston assembly (Part No. 116-110) is impression stamped Cold Weather.
- 4.6.3 After 221-8 assembly is rebuilt, fill with MIL-H-5606 hydraulic fluid and completely bleed the brake system per paragraph 3.3.3.

WARNING

DO NOT USE COLD WEATHER PARTS OR MAINTENANCE
PROCEDURE WHEN EQUIPMENT IS TO BE OPERATED IN
NORMAL TEMPERATURES ABOVE 32°F.

- 4.6.4 Re-identify the converted assemblies by changing the part numbers from 87-97 to 87-99, and the 221-8 to 221-11. Stamp the new part numbers on the piston housing (19) as a permanent record.
- 4.6.5 The 87-100 and 221-10 assemblies are equipped with components suitable for cold weather operation to -65°F.

5. OVERHAUL:

NOTE: Use only BFGoodrich approved parts for overhaul.

NOTE: When the master cylinder requires overhaul, modify it to the latest dash number design in accordance with the Parts Breakdown.

5.1 Disassembly:

- 5.1.1 Unscrew outlet end cap (8) and remove end cap packing (9).

NOTE: Be careful not to let the adjuster piston (10) fall out as you remove cap.

- 5.1.2 If adjuster piston does not come out when you remove the cap, tap end of piston with a plastic mallet to loosen it so that the spring (12) can push it out the open end.
- 5.1.3 Remove spring (12) and take bolts (1) from bracket end of piston housing (19).
- 5.1.4 Apply air to air rotochamber to extend rod. Then remove retaining ring (13) from piston housing (19).
- 5.1.5 Remove actuation piston (14).
- 5.1.6 Remove retaining ring (16), washer (16A), conical spring (17), and ball (18) from ball-check end of piston.

5.1.7 Remove packings (11, 15) from all grooves.

5.2 Cleaning: Clean all parts.

WARNING

DO NOT IMMERSE ADJUSTER PISTON (10) IN CLEANING FLUID. SOME CLEANING FLUIDS MAY DAMAGE SENSING PISTON DIAPHRAGM RESULTING IN POSSIBLE CATASTROPHIC FAILURE.

5.3 Inspection:

5.3.1 Inspect adjuster piston (10) by inserting a smooth, blunt tool into the small hole in the face of the piston and pushing inward. If there is no definite movement, replace with a new part. If definite movement occurs, blow with mouth into the small hole. If air passes through the assembly, replace with a new part.

5.3.2 Inspect piston housing (19) bore for surface condition. If unsatisfactory for packing seal, replace with a new part.

5.3.3 Inspect ball-check seat surface in piston (14) for lodged foreign particles and remove if found.

5.4 Replacement: If replacement of parts is necessary, use only those parts listed for the latest dash number assemblies. Replace all packings.

NOTE: All packings (15A) used at the low pressure end of the actuation piston (14) are identified with a white slash on the OD of the packing.

5.5 Hydraulic Oil: Check level of oil in reservoir, daily.

5.5.1 Only mineral oils meeting the following specifications should be used in expander tube brakes and master cylinders covered in this manual.

WARNING

DO NOT USE ANY OTHER TYPES OF OIL OR FLUID. AVOID THE USE OF AUTOMOTIVE BRAKE FLUID, AS IT IS ESPECIALLY DESTRUCTIVE TO THE BRAKE SYSTEM COMPONENTS AND MAY RESULT IN CATASTROPHIC FAILURE.

PHYSICAL PROPERTIES

Saybolt Universal Viscosity at 210°F.....	43 seconds, minimum
Saybolt Universal Viscosity at 100°F.....	145 to 155 seconds
Viscosity Index (Dean and Davis)	90 minimum
Pour point (ASTM)	-25°F minimum
Color (ASTM)	No. 2 or lighter
Neutralization Number (ASTM).....	0.10 or less
Copper Strip Test (Corrosion) 3 Hours at 212°F.....	Negative
Emulsion Test at 130°F, Distilled Water:	
Time for Complete Separation	30 minutes, maximum
Rust Test (ASTM) Distilled Water.....	No rust
Oxidation Test (ASTM) Time to	
Neutralization Number 2.0	1500 hrs., minimum
Foam Test (ASTM):	
Sequence 1, 2, 3ML foam after 10 minutes standing.....	None
Flash Point.....	370°F minimum
Aniline Point Additives	200°F or more
Oils containing additives harmful to Buna N (Nitrile) and neoprene rubber compounds must not be used.	

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5.5.3 For military vehicles, oil in accordance with MIL-L-2104 has been approved for the 87-97 master cylinder and the 2-907 brake. MIL-H-5606 hydraulic fluid may be used, with BFGoodrich Engineering approval, at ambient temperatures below the operating range of MIL-L-2104.

5.6 **REASSEMBLY:** Reassemble in reverse order of disassembly, replacing all packings. Before installing, remove identifying paint slashes from packings (15A) using a cloth saturated with mineral oil (MIL-H-5606). Dry torque cap (8) to 50 lb ft minimum.

NOTE: Inlet fitting must not extend through the piston housing wall.

5.6.1 Adjust rotochamber rod attachment to piston (14) in accordance with paragraph 3.2.3.

6. SPECIAL TOOLS:

6.1 Waldes Truarc pliers No. 1 with 45° tips, used to remove ball check retaining ring (16).

6.2 Waldes Truarc pliers No. 5 with 45° tips, used to remove piston retaining ring (13).

6.3 Waldes Truarc pliers No. 3 with 45° tips, used to remove attaching parts from piston.

7. SPARES:

(SPARES RECOMMENDED FOR AVERAGE CONSTRUCTION SERVICE FOR 10 MASTER CYLINDER ASSEMBLIES ON YEARLY OVERHAUL BASIS)

INDEX NO.	ITEM	QUANTITY
1	BOLT, MACHINE.....	10
2	WASHER, LOCK.....	10
3	RING, RETAINING (Waldes-Kohinoor).....	5
4	WASHER, FLAT.....	5
5	NUT, JAM.....	10
6	WASHER, FLAT.....	5
7	BRACKET, MOUNTING.....	2
8	CAP.....	2
*9	PACKING, PREFORMED.....	5
10	PISTON ASSEMBLY.....	5
*11	PACKING, PREFORMED.....	5
12	SPRING, HELICAL COMPRESSION.....	2
13	RING, RETAINING (Waldes-Kohinoor).....	2
14	PISTON.....	2
*15	PACKING, PREFORMED.....	5
*15A	PACKING, PREFORMED.....	5
16	RING, RETAINING (Waldes-Kohinoor).....	5
16A	WASHER, FLAT.....	5
17	SPRING, CONICAL.....	5
18	BALL 0.500 DIA.....	2
19	HOUSING, PISTON.....	2

*Included in parts kits listed in parts catalog. Order kits for packing stock.

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8. PARTS

Index No.	Part Name	Qty. Req'd	Index No.	Part Name	Qty. Req'd
+1	BOLT, MACHINE	4	+13	RING, RETAINING	1
+2	WASHER, LOCK	4	14	PISTON	1
+3	RING, RETAINING	1	+15	PACKING, PREFORMED	1
+4	WASHER, FLAT	1	+15A	PACKING, PREFORMED	1
+5	NUT, JAM	2	+16	RING, RETAINING	1
+6	WASHER, FLAT	1	+16A	WASHER, FLAT	1
7	BRACKET, MOUNTING	1	+17	SPRING, CONICAL	1
8	CAP	1	+18	BALL, 0.500 DIA.	1
+9	PACKING, PREFORMED	1	19	HOUSING, PISTON	1
10	PISTON ASSY., 3.250 DIA.	1	20	BUSHING	2
+11	PACKING, PREFORMED	1	—	PARTS KIT, PACKING	1
+12	SPRING, HELICAL COMPRESSION	1	+—	PARTS KIT, OVERHAUL	1

+Kit contains part index nos. 1-6, 9, 11, 12, 13
and 15-18, Quantities per "Qty. Req'd"

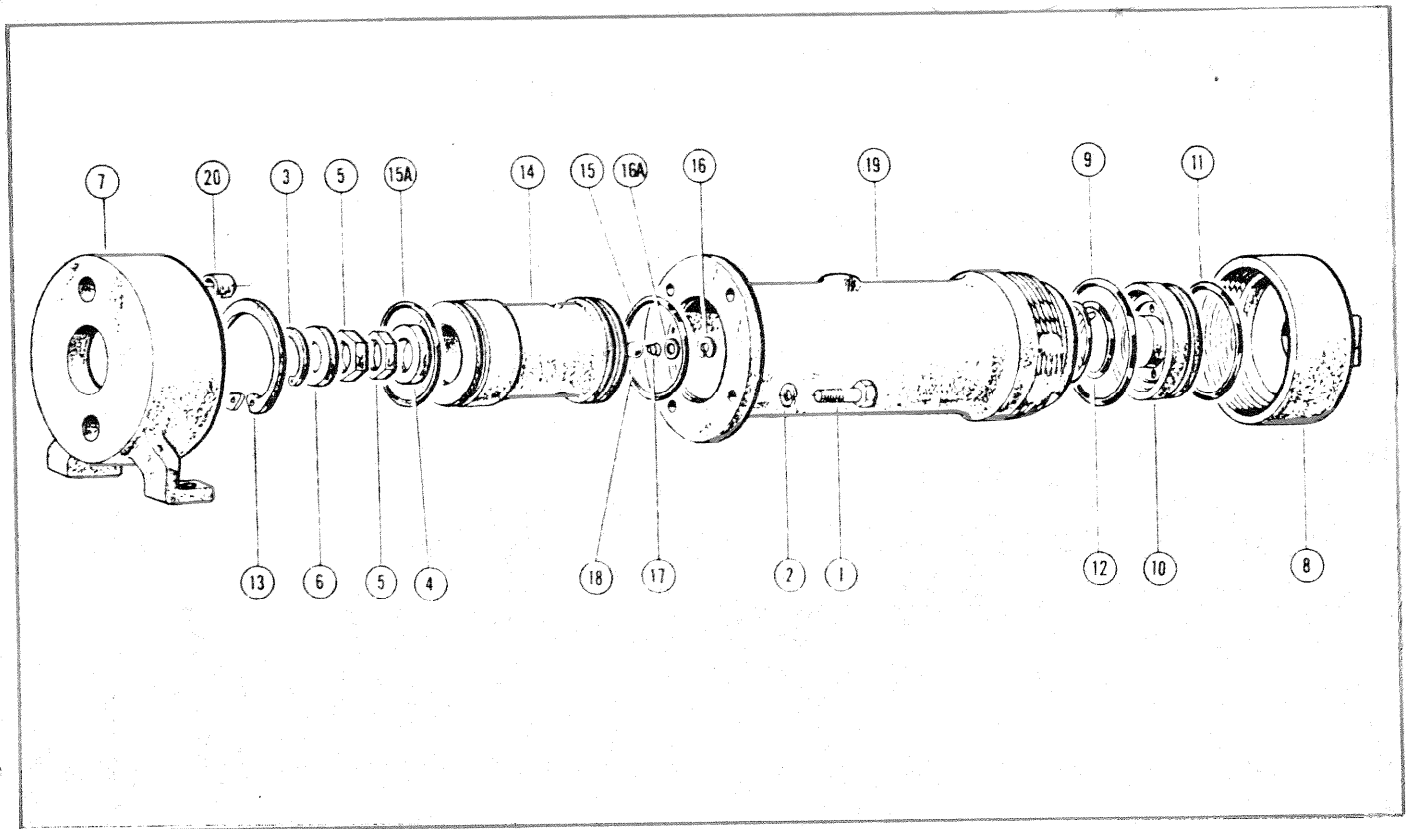


Figure 2. Exploded View

Master Cylinder Assembly

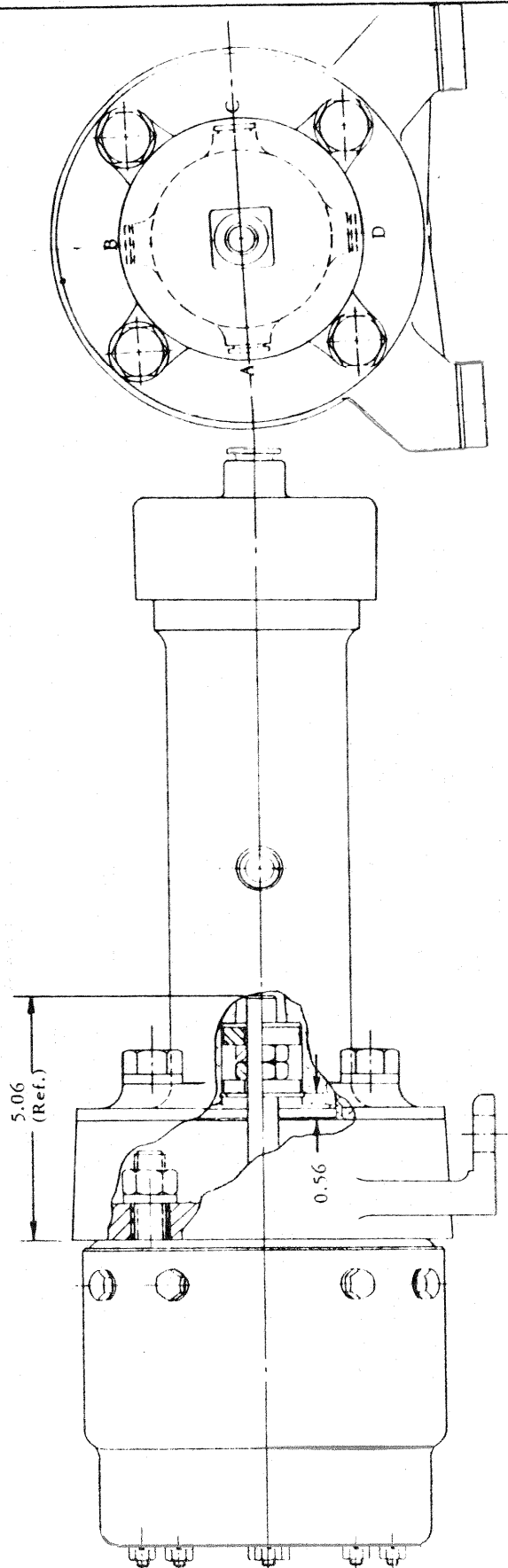


Figure 4. Actuator Assembly - Installation Positions of Inlet Port