INSTRUCTIONS

BULLETIN 947000F

OILGEAR TYPE "D" VARIABLE DELIVERY PUMPS

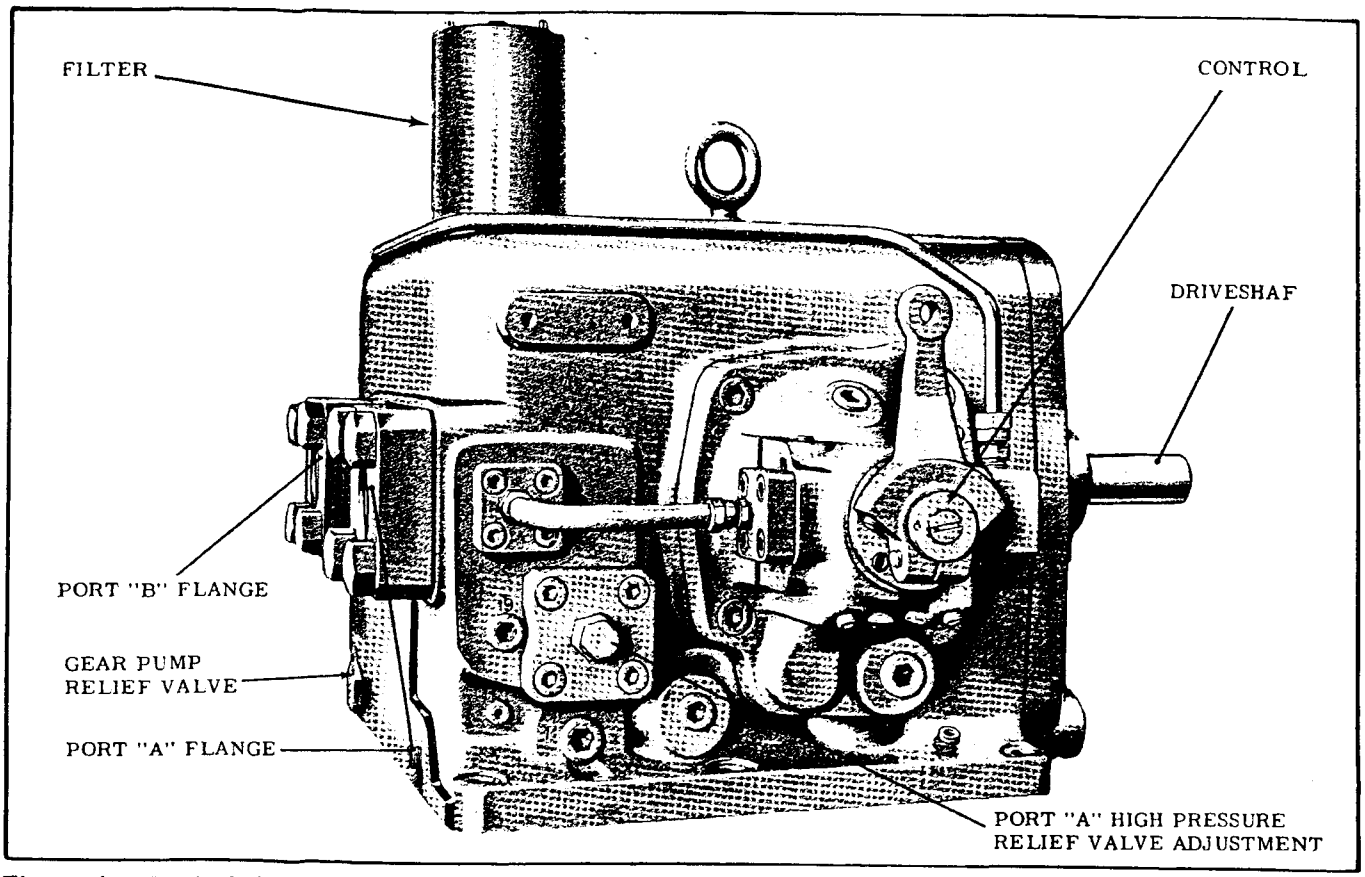


Figure 1. Typical Oilgear Type "D" Pump, Port "A" Side with "H" Servo Lever Control (53265).

REFERENCE BULLETINS

Pump Controls

"A"	Pneumatic	947005
"E"	Electric Pilot Motor	947301
"H"	Hydraulic Servo	947401
"M"	Electric Multi-Position	947280
"P"	Pressure Unloading	947501
"R"	Hydraulic Remote	947601
"R-T"	HYTAC	947610
"S"	Handwheel	947101
"V-W & -H"	Electrohydraulic Servo with Hydraulic Amplifier	947770
"V-V & -N"	Electrohydraulic Servo	947742
"X"	Electric 3-Position	947801

For pumps using dual controls (such as "DMP") refer to "M" and "P" control instructions.

Opposing Operators		DS-947015
"C"	Acceleration-Deceleration	947918

Suction Valves

One-Way Pumps, Check Type	947913
Two-Way Pump, Suct. Check, Supercharge Check Type	DS-947909
Two-Way Pump, Plunger Types	947914
Two-Way Pump, Check Valve Type	947915
Two-Way Pump, Pintle Check Type	947919
Filtration Recommendations	90007
Gear Pump Full Flow Filter (New Units)	DS-89907
"P" Filters for Older size 4 and 35	DS-89900
"P" Filters for Older size 60, 100 & 150	DS-89901
Cooler Fluid Circuits (One-Way)	DS-947905
Cooler Fluid Circuits (Two-Way)	DS-947906
Duplex Gear Pumps w/Unloading Valve	948912
Fluid Recommendations	90000
Contamination Evaluation Guide	90004
Piping Information	90011

TO THE USER AND OPERATOR OF OILGEAR TYPE "D" PUMPS:

These instructions are written to simplify your work of installing, operating and maintaining Oilgear Type "D" One-Way flow and Two-Way flow pumps. Your acquaintance with the construction, principle of operation and characteristics of these units will help you attain satisfactory performance, reduce shutdowns and increase the pump's life. We feel confident the Oilgear pump will operate to your satisfaction if these instructions are adhered to. Some Oilgear units have been modified from those described in this bulletin and other changes may be made without notice.

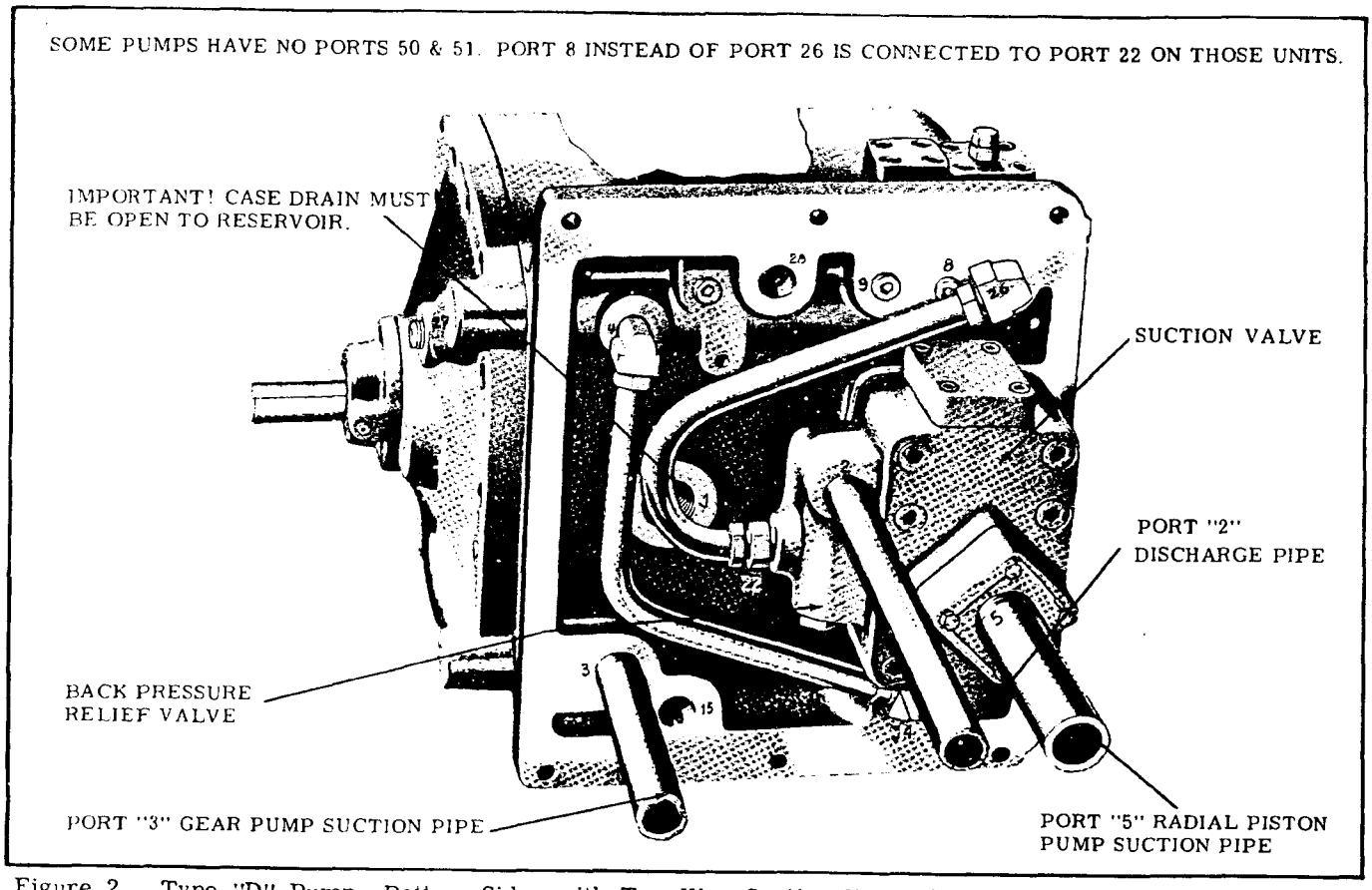


Figure 2. Type "D" Pump, Bottom Side, with Two-Way Suction Valve (Plunger Type) (52264-A).

I. PREPARATION AND INSTALLATION

A. MOUNTING

1. PUMPS WITHOUT RESERVOIRS. These pumps are shipped with or without suction and discharge tubes in place. When shipped WITH tubes in place, avoid undue jarring or abusive handling to protect tubes and pump mechanism. Remove all pipe tap protectors from case bottom. IMPORTANT: Drain port "1" must be open to discharge above the reservoir fluid level... no tube is required. When pump is shipped WITHOUT tubes in place, remove all pipe tap protectors (not pipe plugs) from case bottom. Port numbers are stamped on pump case, suction valve and furnished tubes. Connect discharge tube "2" to port "2" (see bulletin on "Piping Information" for sealing joints). For units equipped with pintle check valves, discharge pipe must be curved to aim discharge away from suction pipe. Connect suction tubes "3" and "5" to ports "3" and "5". Screw suction tubes securely in place to prevent air being drawn into the system. Suction and discharge tubes should reach within one or two times the tube diameter from bottom of reservoir. Do not allow tubes to bottom on reservoir. Clean external surfaces of pump thoroughly and secure pump with gasket to mounting surface.

2. PUMPS WITH RESERVOIRS. These units are usually fully equipped. Mount reservoir on a level foundation at least six inches above floor level to facilitate draining of fluid.

B. PIPING AND FITTINGS.

See Oilgear bulletin on "Piping Information".

C. POWER AND STARTING

Power is required in proportion to volume and pressure used. Motor size recommendations for specific applications can be obtained from The Oilgear Company. Standard low starting torque motors are suitable for most applications. Never start or stop unit under load unless system is approved by Oilgear. It may be necessary to provide a delivery bypass in some circuits.

D. DRIVE

Pump driveshaft must rotate clockwise when facing end of pump shaft. (Special pumps are available for counterclockwise rotation.) See Rotation Direction plate on gear pump housing, or circuit. Use either direct, belt, silent chain or gear drive. Provide an easy slip fit for coupling, pulley, sheave sprocket or gear and fasten with set screw. Do not use a drive fit.

E. FLUID AND FILLING RECOMMENDATIONS

Refer to instruction plate on reservoir or machine and/or Oilgear bulletins on "Fluid Recommendations". Pump all fluid thru a clean filter.

Fill reservoir to, but not above, high level on sight gage. Turn driveshaft a few times by hand to be sure parts are "free". With pump control at "neutral", turn drive unit on and off several times before allowing pump to attain full speed. The system is filled by running the pump and operating control. Watch fluid level and stop pump if level becomes

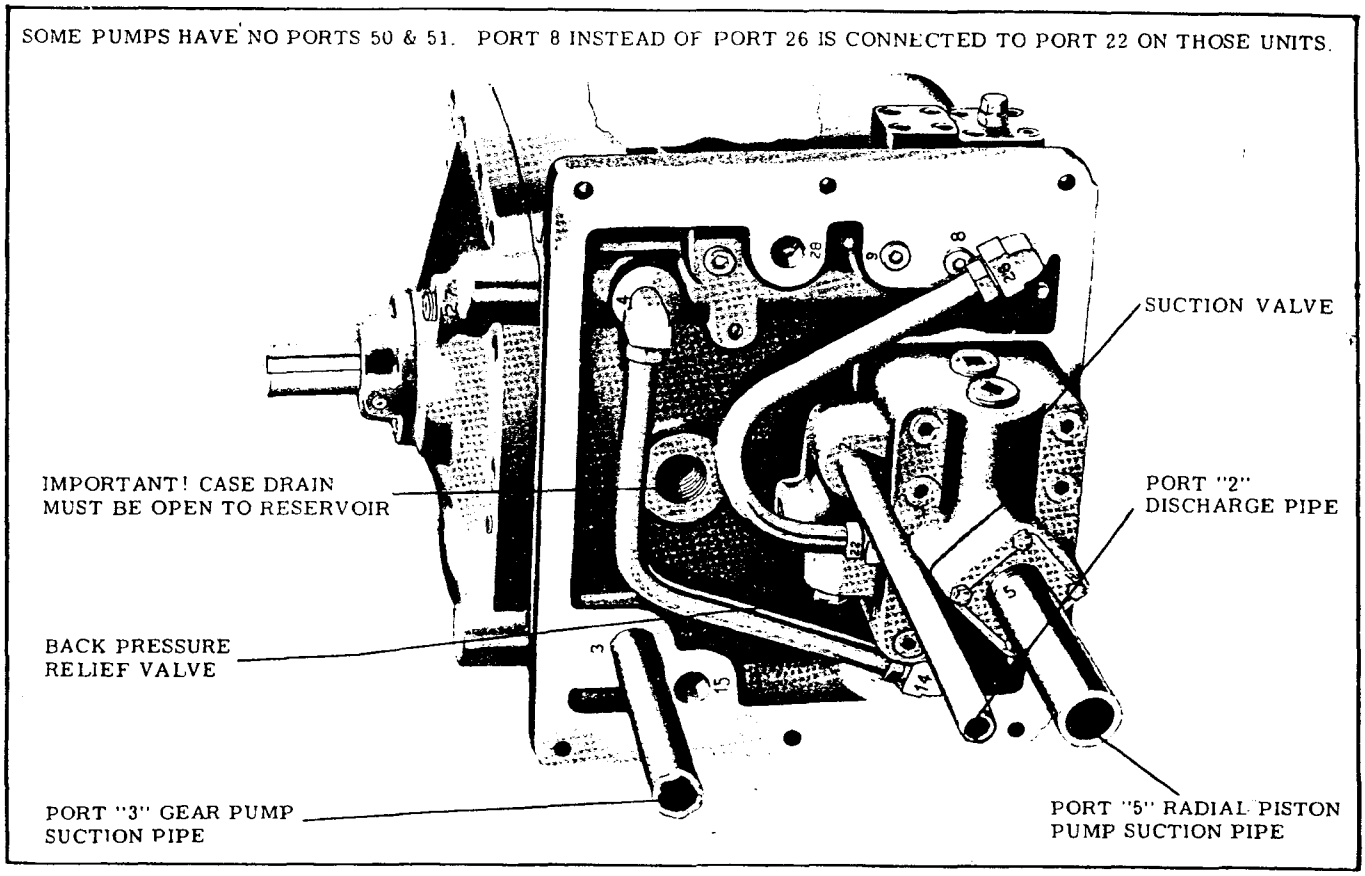


Figure 3. Type "D" Pump, Bottom Side, with Two-Way Suction Valve (Check Type) (51788)

low. Add fluid and start again. On differential systems, be sure fluid level is not above "high level" when ram is retracted, or below "low level" when ram is extended. Bleed air from system by loosening connections or opening petcocks at the highest points in the system. Tighten connections or close petcock when a solid stream of fluid appears. To assure long service life from your Oilgear unit, keep hydraulic fluid clean at all times.

F. FLUID FILTER

Refer to reference bulletin on "Filtration Recommendations". When unit is equipped with a fluid filter, see referenced reference material for information on specific filter. Replace filter element when filter condition indicator reaches change area at normal fluid temperature. Drain and thoroughly clean filter case. Use replacement elements of same beta 10 ratio (normally a ratio of 4). An additional filter is provided with some controls It is important it's element is replaced when dirty.

G. AIR BREATHER

On most installations, an air breather is mounted on top of fluid reservoir. Keep breather case filled to the fluid level mark. About once every six months, remove wing nut and cover from breather and clean screen with solvent. Fill container to mark with clean fluid and install dry screen. It is important the air breather be of adequate size and kept clean to allow air flow in and out of the reservoir as fluid level rises and falls with differential systems.

H. FLUID COOLING

When pump is operated continuously at rated pressure or frequently at peak load, auxiliary cooling of fluid may be necessary. Fluid temperature should not exceed the limits specified in the Oilgear bulletin on "Fluid Recommendations". If a cooler is added, refer to "Cooler Fluid Circuits" for proper connections.

II. CONSTRUCTION

Basic pump components are a pintle (5), a cylinder (6) and bushing assembly (7) with closely fitted radial rolling pistons (8), thrust rings (18), a rotor (16), a rotor cover (65), a gear pump housing (72), a slideblock (82), a driveshaft (1) and a case (56). The cylinder and tapered bushing assembly, lined with bearing metal, rotates on a fluid film about the stationary tapered pintle pressed into the case. The driveshaft (1) rotates in two bearings (11 and 12) and is directly connected to the cylinder through a splined floating coupling (19). The rotor (16), rotor cover (65) and thrust ring assembly (18) mounted in the slideblock (82) rotates freely in anti-friction bearings (9 and 10). A slideblock, equipped with horizontal liners (84) and (85) is moved at right angles to the shaft axis in the case by the control mechanism to vary the pump delivery and reverse the fluid flow.

Sizes 100 and larger pumps provide automatic control of the steep tapered cylinder bushing and pintle running clearance thru flat springs (97), yoke (98), coupling flange (19) with piston ring (19A), orifice (95) and relief valve (103).

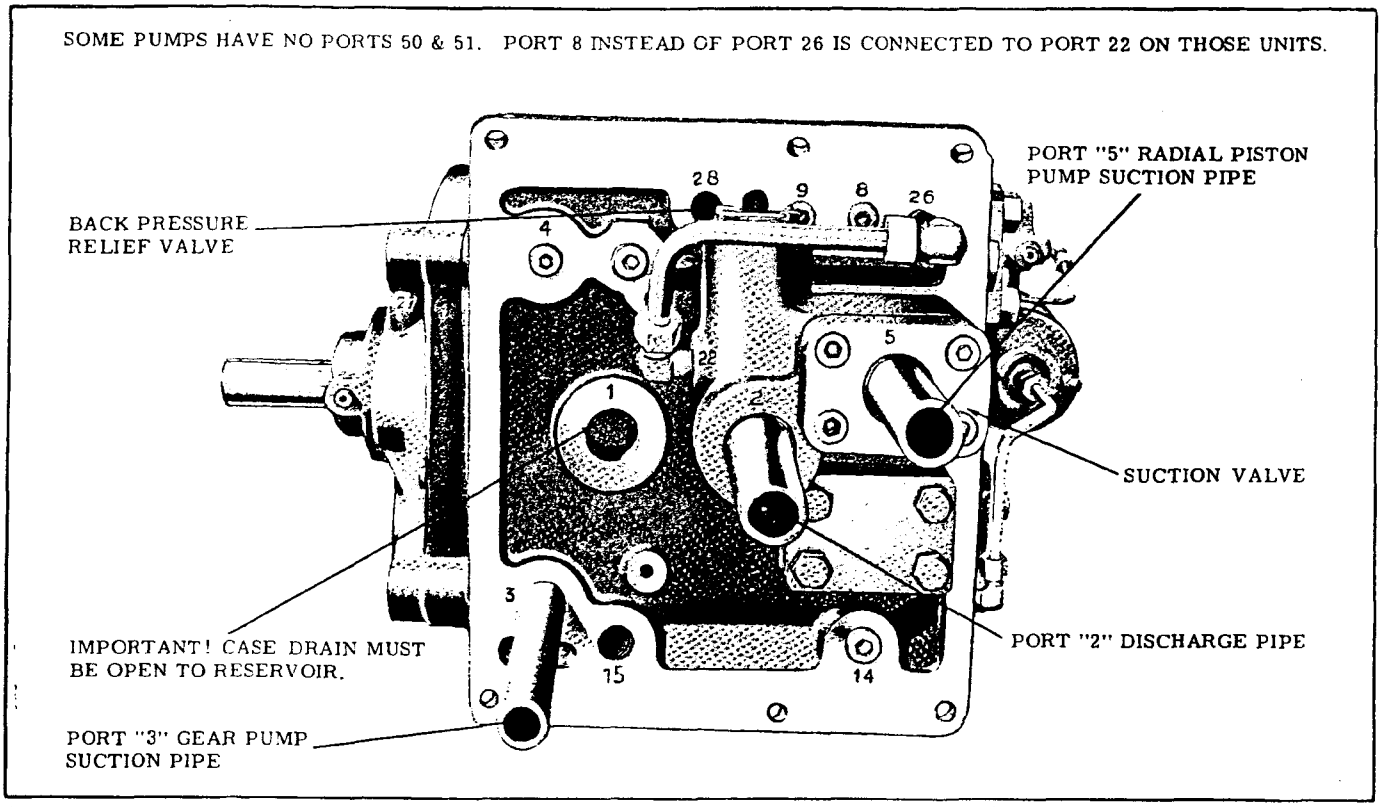


Figure 4. Type "D" Pump, Bottom Side, with One-Way Suction Valve (53269).

A constant delivery gear pump (22 and 23), built into gear pump housing (72), supercharges the main system; supplies hydraulic controls; supplies fluid to auxiliary equipment; provides flow for continuous filtering and cooling of fluid when necessary. The gear pump system is protected by an integral relief valve assembly (50 and 51). (For instructions on duplex gear pumps, see reference bulletin).

High pressure relief valve assemblies (34 and 35) in pump case protect the radial piston pump, work and machine against overload. One-way pumps may have one or two assemblies; Two-way units have two.

For instructions on suction valve bolted to bottom of case; controls and opposing operators mounted on side of case, see reference bulletins.

III. PRINCIPLE OF OPERATION. (Refer to figure 7)

A. RADIAL PISTON UNITS (all sizes)

Clockwise rotation of driveshaft, rotates the cylinder and piston assembly on a lubrication film about the pintle through the floating coupling and drives the gear pump. Centrifugal force plus back pressure in the system keeps pistons against thrust rings so rotor and rotor cover assembly in the slideblock rotate with cylinder assembly. Slideblock, with rotor and rotor cover assembly, is moved at right angles to cylinder-pintle axis by controls on either or both sides of case. Fluid is conveyed to and from the pistons through cored and drilled passages in the case, pintle and cylinder assembly.

When the cylinder and rotor vertical centerlines coincide, no inward or outward motion is imparted to pistons while the shaft rotates; consequently, no fluid is delivered out of either port and the pump is in "Neutral Position".

With slideblock and rotor assembly moved to the left by the control mechanism (see instruction bulletin on individual controls for their principle of operation) and input shaft rotating clockwise, the pistons move outward during lower half revolution to receive fluid returned through case port "B", supercharge fluid or fluid from the reservoir to fill the cylinder radial bores. The pistons move inward during the upper half revolution of the cylinder, delivering fluid under pressure through the upper pintle passage to case port "A". Drilled and cored passages in the case carry fluid to and from the built-in relief valves, suction valve and pump controls.

With slideblock and rotor assembly moved to the right by the control mechanism, the pistons move outward during the upper half revolution to receive fluid returned through case port "A", supercharge fluid or fluid from the reservoir to fill the cylinder radial bores. During the lower half revolution of the cylinder, the pistons move inward and deliver fluid under pressure through the lower pintle passage to case port "B".

This description covers two-way flow pumps which are equipped with two high pressure relief valves, a two-way suction valve and a pintle with four equal passages in the pintle. The slideblock on one-way units usually moves from "neutral" to a position on the left only and are usually equipped with one high pressure relief valve and a one-way suction valve. Some early one-way units may be equipped with a three hole pintle.

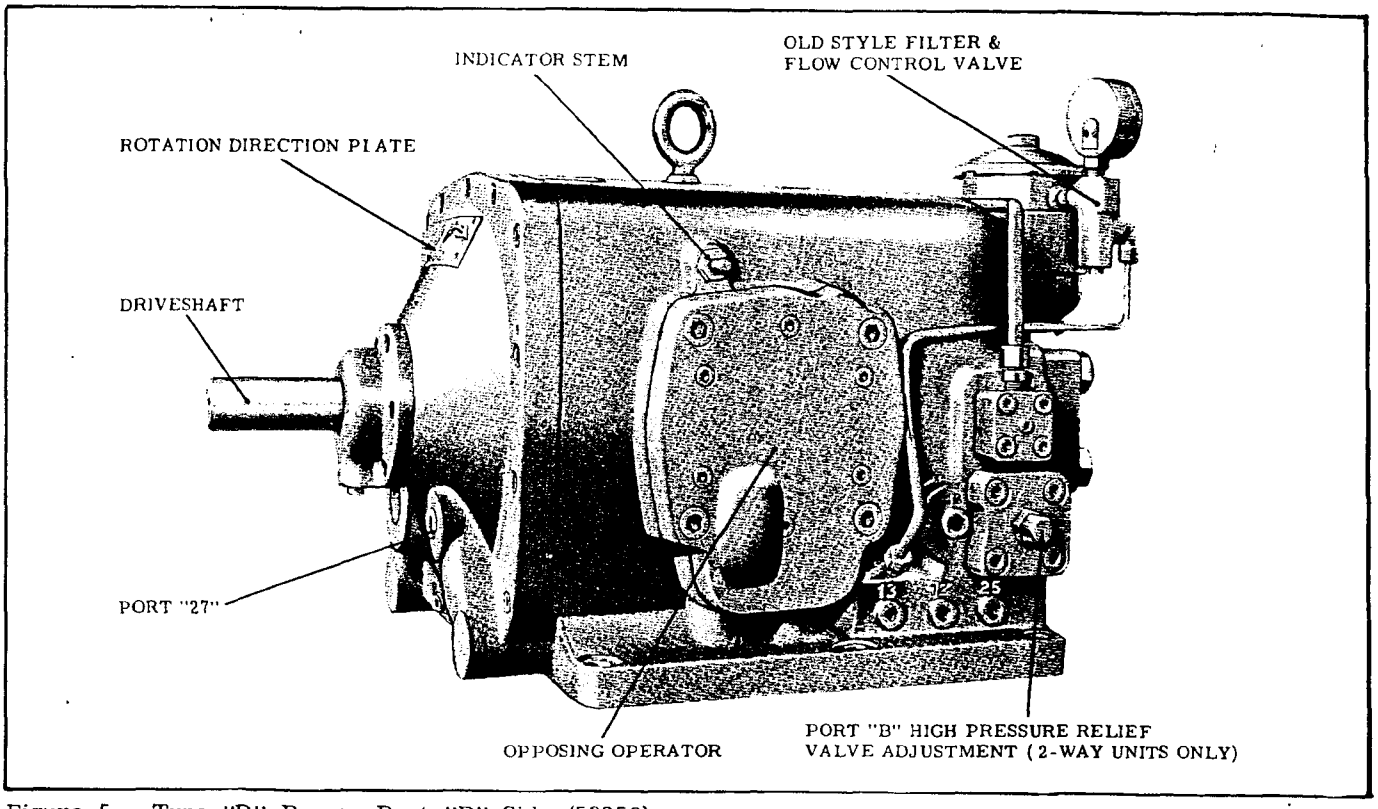


Figure 5. Type "D" Pump, Port "B" Side (53259)

B. CYLINDER CLEARANCE CONTROL (Size 100 and larger) Refer to figure 6.

The cylinder clearance control automatically moves the cylinder axially on the tapered pintle to maintain optimum running clearance at all pressures. Fluid escaping through the running clearance on small end of cylinder and pintle flows into the flat spring (97) chamber in the end of the cylinder. It's escape from the chamber is restricted by the coupling flange (19), coupling piston ring (19A) and an orifice (95) in the pintle (5). As the pump pressure increases, the amount, of fluid escaping through the running clearance gradually increases and builds up pressure in the chamber forcing the cylinder (6) farther onto the tapered pintle, thus reducing the running clearance. A relief valve (103) built into the pintle cover, limits the maximum pressure in the flat spring chamber. The pintle cover contains plugs 7, 8 and 9 opening to a compartment for installing thermo-bulb protective devices such as thermometers and thermo limit switches.

C. CONTROLS AND SUCTION VALVES.

See Oilgear reference bulletins.

(Continued on Page 8)

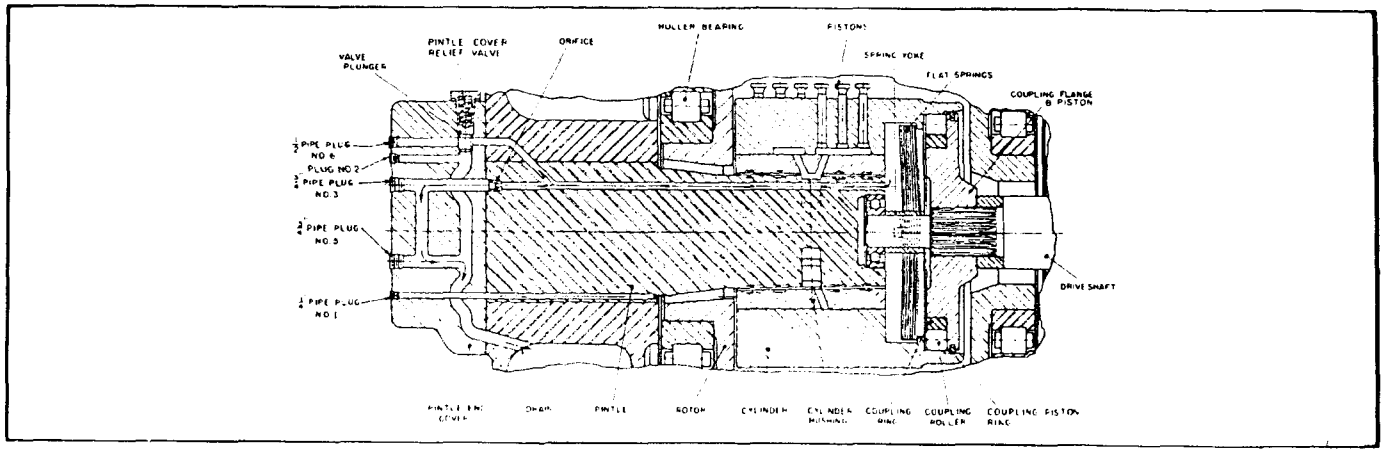


Figure 6. Cylinder Clearance Control. DS-947026-B (49215). See figure 11 for plug locations.

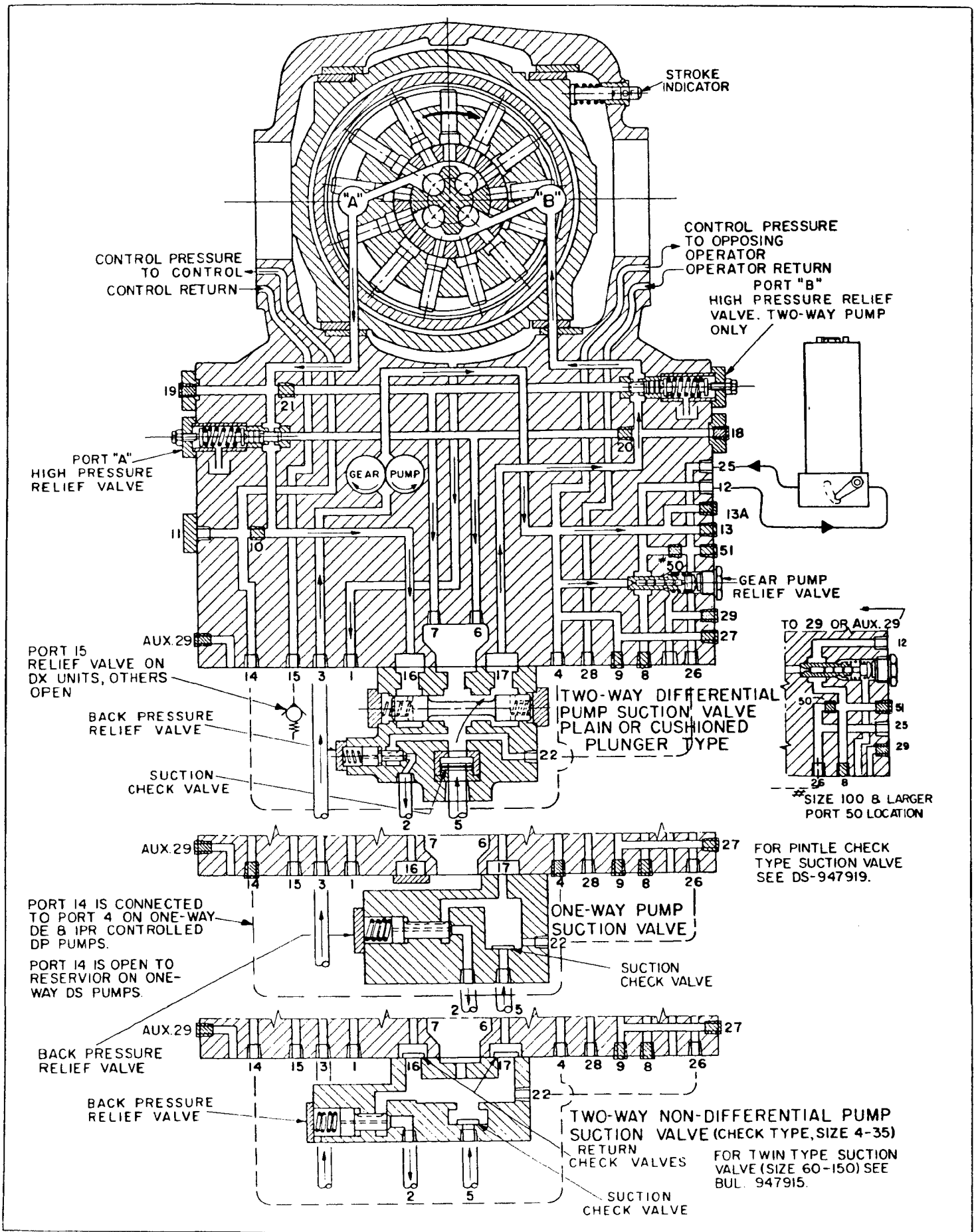
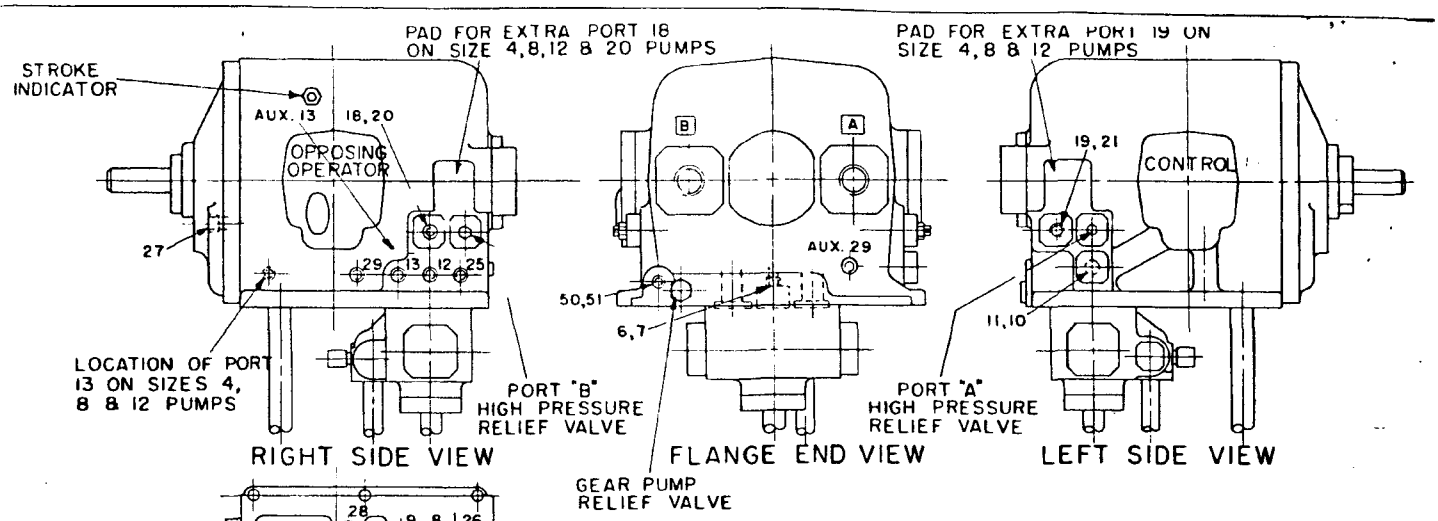
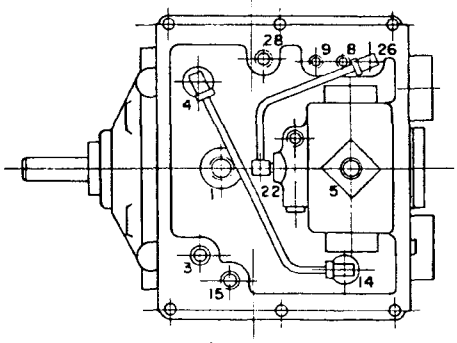


Figure 7. Cutaway Circuit Diagram of "D" Units without Controls DS-947020E (504221E)





BOTTOM VIEW

PORT DATA AND PIPE TAP SIZES

PORT NO.	PORT DESCRIPTION	PUMP SIZE 4	8	12	20	35	60	100	150 & LARGER
A	HIGH PRESSURE CONN.	3/4	1	1 1/4	1 1/2	2	2 1/2	2 1/2	2 1/2
B	HIGH PRESSURE CONN.	3/4	1	1 1/4	1 1/2	2	2 1/2	2 1/2	2 1/2
1	CASE DRAIN	3/4	1	1	1 1/4	1 1/2	2	2	2
3	GEAR PUMP SUCTION	3/4	1	1	1	1 1/4	1 1/4	1 1/4	1 1/2
4	GEAR PUMP PRESSURE	1/2	1/2	3/8	1/2	3/4	3/4	3/4	1
6	"A" RELIEF VALVE EXHAUST	3/8	1/4	1/4	3/4	1	1 1/4	1 1/4	1 1/4
7	"B" RELIEF VALVE EXHAUST	3/8	1/4	1/4	3/4	1	1 1/4	1 1/4	1 1/4
8	GEAR PUMP REL. VLV. EXH.	1/2	1/2	1/2	1/2	3/4	3/4	3/4	1
9	GEAR PUMP PRESSURE	—	—	—	1/2	3/4	1	1	1
10	"A" CORE TO CONTROL CONN.	1/4	1/4	1/4	1/2	1/2	3/4	3/4	3/4
11	"A" SIDE CONTROL CONN.	3/8	3/8	3/8	3/4	*	*	*	*
12	GEAR PUMP REL. VLV. EXH.	1/2	1/2	1/2	1/2	3/4	3/4	3/4	** 1 1/4
13	GEAR PUMP PRESSURE	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4
14	"A" SIDE CONTROL CONN.	1/4	1/4	3/8	3/4	3/4	3/4	1	1
15	"A" SIDE CONTROL EXH.	3/8	3/8	1/2	3/4	1	1 1/4	1 1/4	1 1/4
16	"A" CORE SIZE	7/8	1 1/8	1 3/8	1 5/8	2 1/4	3	3	3
17	"B" CORE SIZE	7/8	1 1/8	1 3/8	1 5/8	2 1/4	3	3	3
18	"B" CORE CONNECTION	3/8	3/8	3/8	1/2	*	*	*	*
19	"A" CORE CONNECTION	3/8	3/8	3/8	1/2	*	*	*	*
20	"A" REL. VLV. CROSS CONN.	1/4	1/4	1/4	3/8	1/2	†3/4	†3/4	†3/4
21	"B" REL. VLV. CROSS CONN.	1/4	1/4	1/4	3/8	1/2	†3/4	†3/4	†3/4
25	AUXILIARY CONNECTION	1/2	1/2	1/2	1/2	3/4	3/4	3/4	** 1 1/4
26	AUXILIARY CONNECTION	3/8	1/2	1/2	1/2	3/4	3/4	3/4	1
27	GEAR PUMP PRESSURE	1/2	1/2	1/2	1/2	3/4	3/4	3/4	1
28	"B" SIDE CONTROL EXH.	3/8	1/4	1/2	3/4	1	1 1/4	1 1/4	1 1/4
29	OIL FILTER DRAIN & AUX. 29	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
50	GEAR PUMP REL. VLV. EXH.	—	—	3/8	3/8	1/2	1/2	1/2	1/2
51	ACCESS TO PORT 50	—	—	1/2	1/2	3/4	3/4	3/4	3/4

* BLANK FLANGE UNLESS OTHERWISE SPECIFIED

** 1" ON UNITS W/O PINTLE CHECK TYPE SUCTION VALVE

SUCTION VALVE PORT DATA AND PIPE SIZES

(ONE-WAY)

2	EXCESS RETURN EXHAUST	3/8	1/2	3/4	1 1/2	2	2	2	2
5	PUMP SUCTION	3/4	1	1 1/4	1 1/2	2	3	3	3
22	STANDARD SUPERCHARGE	3/8	3/8	1/2	1/2	3/4	1	1	1

(TWO-WAY CHECK TYPE) — TWIN TYPE

2	EXCESS RETURN EXHAUST	1/2	1/2	3/4	3/4	3/4	1	1	1
**	PUMP SUCTION	3/4	1	1	1 1/4	1 1/2	3	3	3
22	STANDARD SUPERCHARGE	3/8	1/2	1/2	1/2	3/4	1	1	1

(TWO-WAY CUSHIONED PLUNGER TYPE)

2	EXCESS RETURN EXHAUST	—	—	3/4	1	1 1/2	2	2	2
5	PUMP SUCTION	—	—	1	1 1/4	2	3	3	3
22	STANDARD SUPERCHARGE	—	—	3/8	1/2	3/4	1	1	1

(TWO-WAY PLAIN PLUNGER TYPE)

2	EXCESS RETURN EXHAUST	1/2	1/2	3/4	1	1-1/4	1-1/2	1-1/2	1-1/2
5	PUMP SUCTION	1/2	3/4	1	1-1/4	1-1/2	2-1/2	2-1/2	2-1/2
22	STANDARD SUPERCHARGE	3/8	1/2	3/8	1/2	3/4	1	1	1

(PINTLE CHECK TYPE)

2	HIGH PRESSURE REL. VLV. EXH								2
5	PUMP SUCTION								3
22	AUX. PRESSURE REL. VALVE								1

NOTES

THIS CIRCUIT SHOWS A TWO-WAY PUMP LOOKING AT THE SHAFT END VIEW, PUMP ROTATION CLOCKWISE.

PUMP IS SHOWN OPERATING AT FULL STROKE WITH PRESSURE AT PORT "A".

SIZES 4 & 8 (AND ALL SIZES OF PUMPS PRIOR TO 1950) HAVE NO PORTS 50 & 51. PORTS 8 & 22 ARE CONNECTED.

PRESENT SIZES 12 & LARGER HAVE PORTS 50 & 51. PORTS 22 & 26 ARE CONNECTED. PORT 8 IS PLUGGED.

WHEN TYPE "P" FILTER IS CONNECTED FROM PORT 13A TO 29, AND A COOLER IS NOT USED, PORT 50 MUST BE OPEN.

PORTS 8 & 12 ARE TO THE RIGHT OF PORTS 25 & 26 ON SIZE 100, 8 LARGER PUMPS

CORED OR DRILLED PASSAGES ARE SHOWN: ———

OPEN PORTS ARE SHOWN: ———|

PLUGGED PORTS ARE SHOWN: ———▨

EXTERNAL PIPING OF STANDARD PUMPS IS SHOWN: ———

†PORTS 20 & 21 NOT USED ON SOME UNITS

** PORT NO. 5 ON SIZE 4 THRU 35 UNITS, PORT NOS. 16 & 17 ON SIZE 60, 100 & 150 UNITS.

IV. SPECIFICATIONS

A. RADIAL PISTON UNIT

a. Maximum eccentricity in inches.
b. Slideblock vertical clearance in liners, inches.
c. Slideblock end play, inches.
d. Rotor end play within slideblock, inches (+ .010 for size 4 thru 20) (+ .015 for size 60 and larger)
e. Cylinder should begin to get tight when pintle projects amount shown + .03 inches.
f. Approximate force in tons to press out pintle.
g. Approximate force in tons to press in pintle.
j. Cylinder off-of-tight position, in inches (+ .010)
k. Maximum normal rated speeds in rpm.

SIZE	a	b*	c*	d	e	f	g	j	k
411	.198	.004 to .007	.004 to .007	.010	.17	12	8	.14	1200
425	.198	.004 to .007	.004 to .007	.010	.15	12	8	.13	1200
811	.187	.005 to .008	.005 to .008	.015	.19	15	10	.16	1200
817	.187	.005 to .008	.005 to .008	.015	.17	15	10	.14	1200
825	.187	.005 to .008	.005 to .008	.015	.17	15	10	.14	1200
1211	.250	.005 to .008	.005 to .008	.015	.28	30	20	.25	1200
1217	.250	.005 to .008	.005 to .008	.015	.25	30	20	.22	1200
1225	.250	.005 to .008	.005 to .008	.015	.25	30	20	.22	1200
2011	.250	.005 to .008	.005 to .008	.020	.44	40	35	.41	1200
2017	.250	.005 to .008	.005 to .008	.020	.34	40	35	.31	1200
2025	.250	.005 to .008	.005 to .008	.020	.34	40	35	.31	1200
3511	.375	.006 to .010	.006 to .010	.031	.59	50	30	.56	1200
3517	.375	.006 to .010	.006 to .010	.031	.44	50	30	.41	1200
3525	.375	.006 to .010	.006 to .010	.031	.41	50	30	.38	1200
6011	.375	.008 to .012	.008 to .012	.031	.69	50	30	.75	1200
6017	.375	.008 to .012	.008 to .012	.031	.44	50	30	.50	1200
6025	.375	.008 to .012	.008 to .012	.031	.44	50	30	.50	1200
10011	.406	.010 to .015	.008 to .012	.035	.12	250	100	.05	900
10017	.406	.010 to .015	.008 to .012	.035	.12	250	100	.05	900
10025	.406	.010 to .015	.008 to .012	.035	.12	250	100	.05	900
15025	.531	.010 to .015	.008 to .012	.035	.12	250	100	.05	900
15030	.531	.010 to .015	.008 to .012	.035	.12	250	100	.05	900
15035	.531	.010 to .015	.008 to .012	.035	.12	250	100	.05	900
20035	.675	.010 to .015	.008 to .012	.035	.12	250	100	.05	900
23030	.675	.010 to .015	.008 to .012	.035	.12	250	100	.05	900

*Clearance should never be less than minimum shown; maximum clearance can be exceeded. Shims 0.010 inch are available.

B. GEAR PUMP & GEAR PUMP RELIEF (GPRV)
(For duplex units, see reference bulletin)

1. Gear Pump Volume for new pumps in cubic inches per minute at 150 psi pressure and rpm given in column k of above table. (Some size 8, 12 and 20 pumps have larger gear pumps delivering 2500 cipm).

2. Gear Pump Relief Valve setting in psi for pumps having type "H", "R", "X" Controls.

3. Gear Pump Relief Valve setting in psi for pumps having type "S", "E", "F" and "P" Controls.

4. Gear Pump Relief Valve setting for pumps having "A", "M" and "V" Controls.

5. Maximum gear pump pressure in psi when using the standard spring.

Consult the Oilgear Company for special settings.

SIZE	1	2	3	4	5
4	1100	150	85	180	190
8	1670	150	85	180	190
12	1670	150	85	180	190
20	1670	150	85	180	190
35	2050	150	85	180	160
60	2780	150	85	180	160
100	5315	150	85	180	160
150	7030	150	85	180	160
200	7030	215	85	215	160
230	7030	215	85	215	160

D. HIGH PRESSURE RELIEF VALVES (HPRV)

1. Pumps for general straight-line applications. Continuous service ratings are 1100, 1700, 2500, 3000 and 3500 psi as indicated by 11, 17, 25, 30 and 35 in body of the unit type designation. Relief valve setting is 1475, 2100, 3000, 3250 and 4000 psi respectively when blowing 1/2 pump volume.

2. Pumps for rotary drive applications. Rating for continuous service of 1100 and 1700 series pumps is 1100 and 1700 psi. Relief valve setting of these pumps is 1700 and 2500 psi respectively when blowing 1/2 pump volume.

3. Relief valves are often set for lower pressures to limit overload peaks.

E. PINTLE COVER RELIEF VALVE

1. The pintle cover relief valve is normally set to crack when pump high pressure relief valve is blowing.

V. MALFUNCTIONS AND CAUSES

A. UNRESPONSIVE OR SLUGGISH CONTROL.

1. See reference control instuction bulletin.
2. Misaligned control.
3. Worn slideblock liners.
4. Binding slideblock.
5. Wrong eye-bolt. If it's too long, it will restrict slideblock movement.

B. INSUFFICIENT PUMP VOLUME.

1. Worn radial piston pump.
2. Faulty suction valve (see instruction bulletin on "Suction Valves").
3. Obstructed suction passages in case or pintle.
4. Bushing turned in cylinder.
5. High pressure relief valve plunger binding in open position, worn or dirty valve seat, cracked or loose bushing, dummy plug.
6. Slideblock not going to full eccentricity due to sticking or binding liners or eye-bolt too long.
7. Faulty control (see control instruction bulletin).
8. Faulty gear pump, or gear pump relief valve.
9. Drive motor speed insufficient.

C. IRREGULAR OR UNSTEADY OPERATION.

1. Fluid level in reservoir is low.
2. Air in fluid power system. (See instruction bulletin on "Suction Valves").
3. Insufficient back pressure (see instruction bulletin on "Suction Valves").
4. Insufficient gear pump pressure.
5. Sticking pistons or worn radial piston unit.
6. Faulty hydraulic motor or cylinder.

D. LOSS OF PRESSURE.

1. Foreign sediment under high pressure relief valve, sticking HPRV plunger or defective HPRV spring.
2. Worn radial piston pump.
3. Faulty hydraulic motor or cylinder.

E. EXCESSIVE OR HIGH PEAK PRESSURE.

1. Binding HPRV plunger, obstructed axial groove on plunger or spring screwed down solid.

F. EXCESSIVE NOISE.

1. Loose fit between small end of HPRV plunger and bushing or too deep an axial groove in HPRV plunger.
2. Worn or pitted bearings; or thrust rings.
3. Incorrect rotor or slideblock or radial piston pump clearance.
4. Worn pumping unit.
5. Air entering system past large end of pintle or suction valve gasket.
6. Lack of back pressure (see instruction bulletin on "Suction Valve").
7. Air in the fluid power system.
8. Insufficient relief valve dashpot action due to worn parts.
9. Pump is incorrectly being started or stopped under load.

G. EXCESSIVE HEATING.

1. Operating pump above rated or peak pressure.
2. Worn radial piston unit or sticking radial pistons.
3. Leakage past high pressure relief valve.
4. Insufficient cylinder running clearance.
5. Low fluid level in reservoir.
6. Excessive gear pump pressure or worn gear pump.
7. Air in the fluid power system.
8. Insufficient back pressure (see instruction bulletin on "Suction Valves").
9. Faulty hydraulic motor or cylinder.

VI. TESTING AND ADJUSTING

A. HIGH PRESSURE RELIEF VALVE (HPRV). Refer to figure 9.

To check pressure at pump port "A", connect a gage (good for 1000 psi above pump rating) to port "A" flange or port 19. To check pressure at pump port "B", connect a gage to port "B" flange or port 18. Start pump at "neutral," then set control for approximately 1/2 volume. Check setting on indicator stem (88). Stall ram or output shaft of driven component. Gage will read HPRV setting. Compare setting with IV-D "Specifications". Make adjustments when fluid is warm. Loosen lock nut (40A) and turn adjusting screw (40 inward to increase pressure; or outward to decrease pressure. Discharge fluid past relief valve only long enough to check and adjust setting or excessive heating and damage may result. Do not adjust for pressures higher than those in "Specifications". Lock screw in place with nut.

B. GEAR PUMP RELIEF VALVE (GPRV). Refer to figure 8.

To check pressure, connect a pressure gage (500 psi) to pump port 13 or 27 and run pump. Compare reading with IV-B "Specifications". Note: The gear pump pressure may be higher than specified when the fluid is cold. Do not take reading or make adjustments until fluid is warm. Stop unit.

Remove cap (55) and gasket (54). Insert additional shims (53) to increase pressure or remove shims to decrease pressure. Each 1/32 inch thick shim will change pressure about 12 psi for sizes 4 through 20, and 5 psi for sizes 35 and up. CAUTION: Do not shim for pressures higher than those in IV-B-5 "Specifications", or the spring will be compressed solid. If additional shims in GPRV fail to increase pressure, disassemble gear pump relief valve, inspect and clean. Reassemble and recheck pressure.

C. GEAR PUMP (for duplex units, see reference instruction bulletin).

If gear pump pressure is still insufficient after adjusting GPRV, remove pipe plug from port 13 or 27 and install one leg of a tee fitting into port, needle valve in the other and a 500 psi gage in the remaining leg. Place a suitable container near the needle valve outlet to catch gear pump fluid. Start pump with control at neutral. Open needle valve until gage

reads 150 psi and then measure gear pump volume. See IV-B-1. Limit discharge to prevent dropping reservoir fluid below low fluid level. Check all components in hydraulic circuit supplied by gear pump to insure gear pump fluid is not bypassed or leaking somewhere in the circuit.

ALTERNATE METHOD. To test for worn out gear pump, run pump at neutral and check pressure. Remove hand hole cover on fluid reservoir and measure case slip out of port 1. The normal case slip at neutral is usually less than 20% of the gear pump volume given in IV-B-1 "Specifications".

D. RADIAL PISTON UNIT.

To check for worn radial piston unit, insert a high pressure gage (good for 1000 psi above unit's rating) in a pressure port (ports 18 or 19) of the pump. Block all high pressure lines to the circuit. Set the control at neutral, mount dial gage or other measuring device on slideblock indicator and set for zero or measure with a scale or a depth gage. Start the drive motor. Slowly adjust the control for delivery from the port with gage in it until gage reads 1000 psi. Check the slideblock indicator stem measurement. Shut down pump to prevent excessive discharge across relief valves. See what percent of maximum eccentricity is required to raise the pressure (IV-A-a "Specifications"). A new (size 4-60) radial piston pump requires approximately 5% eccentricity to raise 1000 psi. Larger sizes, with cylinder clearance control, will require a higher percentage of stroke at this pressure — but, only a slight increase in stroke should be necessary to raise additional pressure above 1000 psi. Additional eccentricity indicates wear. Only if the slip eccentricity is excessive for the particular application is repair necessary.

ALTERNATE METHOD. A quick check for high leakage can be made by removing eye bolt (90) from case. If fluid runs out of this hole, while unit is running under pressure, leakage (or slip) is excessive.

E. SUCTION VALVE

See reference instruction bulletin on "Suction Valve".

F. PINTLE COVER RELIEF VALVE.

Refer to figures 6 and 11. The pintle cover relief valve is set as shown in IV-E "Specifications" at the factory. This relief valve does not blow in normal service. If the pintle unit should become worn beyond the limits of the automatic clearance control mechanism, the pintle cover relief valve then blows and prevents excessive end thrust on the rotor assembly. If it should become necessary to test the setting of this relief valve, remove plug 2, stall ram or output shaft of driven component and slowly move pump on stroke. The pintle cover relief valve should start discharging past opening behind plug 2 at the same time the maximum high pressure relief valve setting is reached. Blow HPRVs only long enough to check setting or excessive heat and damage may result. Stop pump and add shims (101) if pintle cover relief valve discharged too soon, or remove shims if too late. Be sure orifice plug (95) is not plugged, but do not change it's size.

VII. DISASSEMBLY. (Refer to figure 10 for sizes 4 thru 60, and figure 11 for sizes 100 and larger.)

Depending upon what part or parts are to be inspected or replaced, it may not be necessary to completely disassemble pump. Refer to applicable sub-section.

Disconnect pump from circuit and drive motor. Remove A and B flanges, pintle cover (80) and pump mounting bolts. If used, remove pintle check valve seat (109) and O'Ring (119). Remove check valve assembly (107) by use of 1.500-6UNC tap on it's end. Set pump on flange end and block it firmly in place. Observe position of, and tag all gaskets, O'Rings and shims during disassembly so they can be returned to original position.

A. SUCTION VALVE - See reference instruction bulletin.

B. GEAR PUMP ASSEMBLY. (All sizes) For duplex units, see reference instruction bulletin.

Remove gear pump housing screws (72A), fasten a clamp to driveshaft (1) or screw hook bolts into taps in outer rim of gear pump housing (72) and lift entire gear pump assembly upward with a crane. Raise assembly carefully to prevent damage to the shaft, bearing or coupling flange. Remove lock wire (106) and gear pump cover screws (69) and gaskets (70). Lift off cover (73), gears (22 and 23) and key (26).

C. SHAFT REMOVAL. (All sizes)

Driveshaft (1) need not be removed unless inspection of shaft seal (27) and front shaft bearing (11) is necessary. Unscrew shaft seal gland screws (71A). File burrs on keyway. Place shim stock over keyway to prevent cutting of shaft seal (27). Carefully slide seal gland (71) and seal (27) off shaft. Lift shaft and bearing assembly out of gear pump housing. Remove washer (4) and lock nut (3). Pull bearing (11) off shaft (1). CAUTION: Keep shims (15) in front and rear of front bearing (11) separate to insure correct reassembly.

D. RADIAL PISTON UNITS.

1. Sizes 4 thru 60 only.

Lift off slideblock spacer ring (68) and shims (67). Remove lock wire (106) and slideblock cover screws (74). Screw three square head set screws into taps in rim of cover (75) and jack cover from slideblock (82). Turn each screw a little at a time to avoid cocking cover. Lift cover out by hand or use hook bolts and crane. Remove lock wire and rotor cover screws (66). Jack head from rotor with square head set screws. Lift cover (65) and bearing (10) out by hand or use hook bolts and crane. Lift out coupling flange (19), coupling rollers (20) and coupling ring (21). Screw hook bolts into taps in end of cylinder (6) and very carefully lift the cylinder (6), bushing (7) and piston (8) assembly off the pintle. Be careful pistons (8) do not fall from their bores. Do not cock unit and scratch inside of bushing when removing the assembly. If cylinder is frozen to pintle, press pintle out of case before attempting to separate the cylinder bushing and pintle. Screw hook bolts into end of rotor (16) and lift rotor assembly out of slideblock (82). Remove rear rotor bearing shims (14). Should it be necessary to inspect and clean slideblock and inside of case, remove the control

and control pistons (see instruction bulletin on specific "Pump Control"). To remove indicator, unscrew indicator bushing (87) and pull out indicator stem (88) assembly. Screw hook bolts into slideblock (82) and lift slideblock out of case. Case liners (85) are doweled to the pump case and slideblock liners (84) are doweled to the slideblock. If liners are removed, mark each liner and shim (84A) to be sure that each is returned to same position on slideblock or in case. If pintle (5) is to be replaced or reground, set pump case, with open end down, in a press. Insert a piece of wood or other soft material under inside end of pintle so when it is pressed from case it will not be damaged. Apply pressure to case end of pintle (see IV-A-f, for approximate force required). Pintle has 0.005 per inch taper so after pintle is pressed down a short distance it will drop the rest of the way. If cylinder is frozen to pintle, press pintle out of case before attempting to separate the cylinder, bushing and pintle. If it is necessary to remove thrust rings (18) from rotor, break the inner spacer ring (17A) by striking with a rod inserted in one or more of the radial holes in rotor directly behind the spacer ring. Then drive out the thrust rings (18) and outer spacer (17) by striking a brass bar inserted in the axial holes in bearing end of rotor.

2. Size 100 and larger only.

Lift off slideblock spacer ring (68) and shims (67). Remove lock wire and slideblock cover screws (74). Screw three square head set screws into taps in rim of cover and jack cover (75) from slideblock (82). Turn each screw a little at a time to avoid cocking cover. Lift cover out by hand or use hook bolts and crane. Remove lock wire and rotor cover screws (66). Jack cover (65) from rotor (16) with square head set screws. Lift cover and bearing (10) out by hand or use hook bolts and crane. Lift out coupling flange (19) and piston ring (19A), coupling ring (21), coupling rollers (20), flat springs (97), steel balls (96) and spring yoke (98). Screw hook bolts into taps in end of cylinder and very carefully lift the cylinder (6), bushing (7) and piston (8) assembly off of the pintle (5). Be careful pistons (8) do not fall from their bores. Do not cock unit or scratch inside of bushing when removing the assembly. If cylinder is frozen to pintle, press pintle out of case before attempting to separate the cylinder bushing and pintle. Screw hook bolts into end of rotor (16) and lift rotor assembly out of slideblock. Remove rear rotor bearing shims (14). Should it be necessary to inspect and clean slideblock and inside of case, remove the control (see instruction bulletin on specific "Pump Control"). To remove indicator (88), unscrew indicator bushing (87) and pull out indicator stem assembly. Screw hook bolts into slideblock (82) and lift slideblock out of case. Case liners (85) are doweled to the pump case and slideblock liners (84) are doweled to the slideblock. If liners are removed, be sure to mark each liner and shim (84A) so it will be returned to original position. If pintle is to be replaced or reground, set pump case, with open end down, in a press of about 250 tons capacity. Insert a piece of wood or other soft material under inside of pintle so when it is pressed and drops from case it will not be damaged. Apply pressure to case end of pintle. Pintle has .005" taper on diameter per inch of length so after pintle is pressed down a short distance it will drop the rest of the way. If it is necessary to remove thrust rings (18) from rotor (16), break the inner spacer ring (17A) by striking with a rod inserted in one or more of the radial holes in rotor directly behind the spacer ring. Then drive out the thrust rings (18) and outer spacer ring (17) by striking a brass bar inserted in the axial holes in bearing end of rotor.

F. GEAR PUMP RELIEF VALVE. (All sizes)

Relief valve can be removed without draining system or removing pump from reservoir. Unscrew cap (55) and remove gasket (54), shims (53), spacer (49), dashpot plunger (50), spring (52) and valve plunger (51). Avoid marring highly finished surfaces on dashpot plunger and valve plunger.

PARTS LIST

	49.	Spacer, G.P.R.V.
	*50.	Plunger, Dashpot
	*51.	Plunger, G.P.R.V.
	52.	Spring, G.P.R.V.
	53.	Shims, G.P.R.V.
(S)	54.	Gasket, G.P.R.V. Cap
	55.	Cap, G.P.R.V.

*Parts 50 & 51 furnished only as an assembly.
(S) Indicates included in "A" Seal Kit

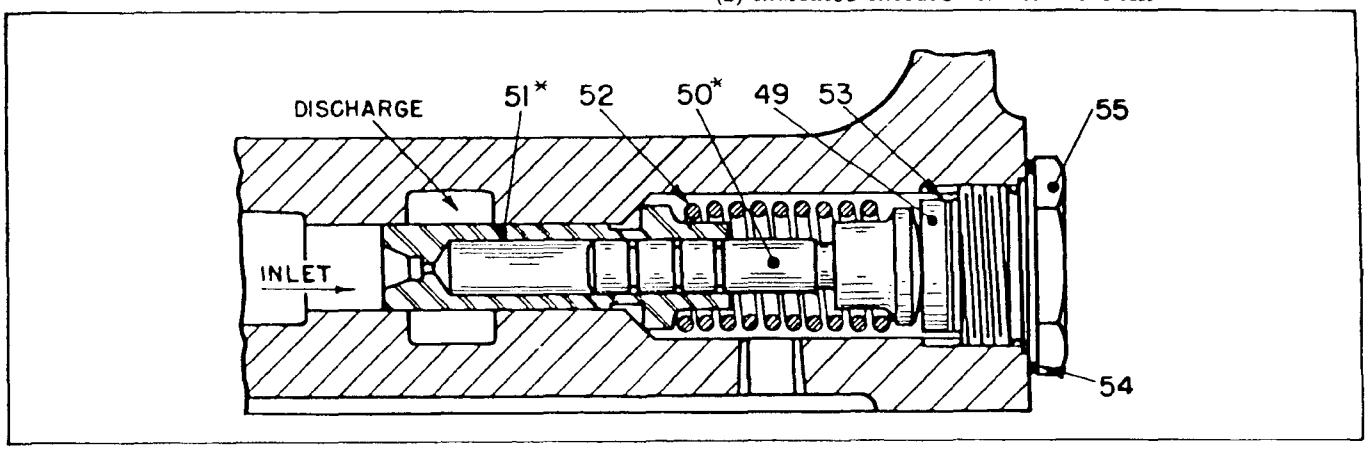


Figure 8. Typical Gear Pump Relief Valve (2V-8374-L)

G. HIGH PRESSURE RELIEF VALVES (All Sizes)

Types of Modifications.

1. Tapered bushing without O'rings on early units, pressed into pump case.
2. & 2a. Tapered bushing with O'rings on later units, pressed into pump case.
3. Straight bushing with O'ring on still later units. Bushing is a tight fit in pump case.
4. Sequence type — straight bushings with O'rings. Bushing is a tight fit in pump case. End of bushing is plugged.

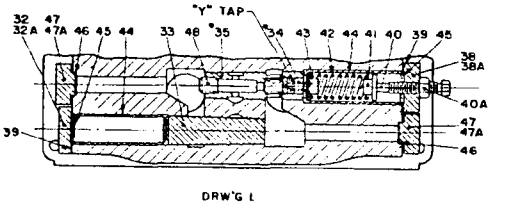
Two-way pumps are normally equipped with two HPRV. One-way pumps are normally equipped with one HPRV and a "dummy" plug. Figure 9 shows arrangement for one HPRV and "dummy".

Normally, the relief valves can be removed without draining system. However, if unit is lower than other large volume components of system, equipment above unit should be drained or pressure lines blocked. Record the distance adjusting screw (40) extends out of flange. Loosen lock nut (40A) and turn screw outward until spring resistance is released. Keep individual HPRV assemblies separate from other HPRV. Remove cap screws, (38A), cap (38), gasket (39), shims (45), spring guide (41 or 43), spring (42), spring guide (43), retainer (44) and plunger (34). If plunger is stuck in bushing, turn a screw, size "X" or "Y" into plunger and pull or jack out straight. Avoid marring finish of plunger. Bushing (35) should be removed only when replacement is necessary. To remove, remove pipe plug or flange directly opposite bushing hole and unscrew core plug (48), when used. (Units for non-differential circuits have cross piped Relief Valves and plug (48) is omitted). Tap bushing out spring side with brass rod slightly smaller than core hole.

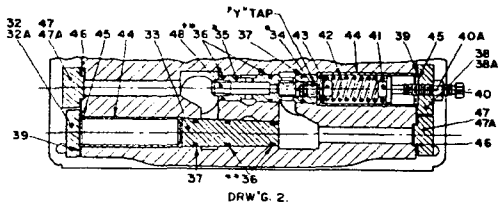
PARTS LIST

32.	Cap, R. V. Blind	40A.	Nut Lock
32A.	Screw	(S)40B.	Seal, Thread
33.	Plug Dummy	41.	Guide, Spring
*34.	Plunger, HPRV	42.	Spring, HPRV
*35.	Bushing, HPRV	43.	Guide, Spring
(S)36.	Seal, O'ring	44.	Retainer, Bushing
(S)37.	Seal, O'ring	45.	Shims, Retain.
37A.	Ring, Back-up	(S)46.	Gasket
38.	Cap, HPRV	47.	Cap, Aux. Port
38A.	Screw	47A.	Screw
(S)39.	Gasket, HPRV	48.	Plug, Pipe
40.	Screw, Adj.		

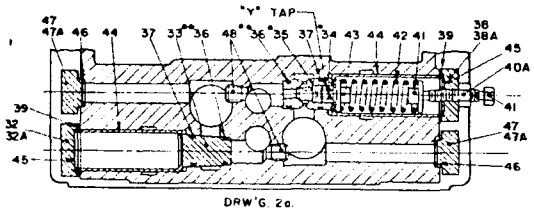
*Parts 34 and 35 furnished as an assembly.
(S) Indicates included in "A" Seal Kit



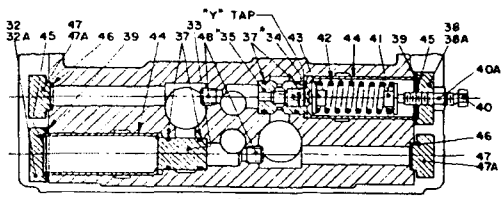
TAPERED BUSHING RELIEF VALVE WITHOUT O'RINGS



TAPERED BUSHING RELIEF VALVE WITH O'RINGS (SIZE 4 THRU 35)



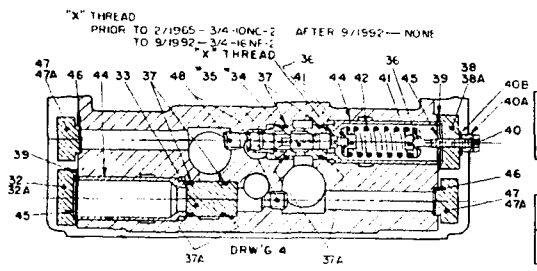
TAPERED BUSHING RELIEF VALVE WITH O'RINGS (SIZE 60 THRU 150)



STRAIGHT BUSHING RELIEF VALVE WITH O'RINGS

"Y" TAP, 1/4-20NC-2 SIZES 4 THRU 12
3/8-16NC-2 SIZES 20 THRU 150

ON TWO-WAY PUMPS, A RELIEF VALVE ASSEMBLY REPLACES THE DUMMY PLUG



SEQUENCE TYPE RELIEF VALVE (SIZE 60 & LARGER)

O'RING SIZES
CROSS SECTION X O.D. DURO ± 5

PART NO.	UNIT SIZE			
	4 - 8 - 12	20 - 35	60	100 & LARGER
TAPERED BUSHINGS (DRWGS. 2 & 2A)				
36	$\frac{3}{32} \times \frac{7}{8}$ 70	$\frac{1}{8} \times 1\frac{1}{2}$ 70	$\frac{1}{8} \times 1\frac{3}{4}$ 70	$\frac{1}{8} \times 1\frac{3}{4}$ 70
37	$\frac{3}{32} \times \frac{15}{16}$ 70	$\frac{1}{8} \times 1\frac{11}{16}$ 70	$\frac{1}{8} \times 1\frac{7}{8}$ 70	$\frac{1}{8} \times 1\frac{7}{8}$ 70
STRAIGHT BUSHING & SEQUENCE (DRWGS. 3 & 4)				
37	$\frac{3}{32} \times 1\frac{1}{16}$ 70	$\frac{1}{8} \times 1\frac{3}{4}$ 70	$\frac{1}{8} \times 1\frac{7}{8}$ 70	$\frac{1}{8} \times 1\frac{7}{8}$ 70
36			$\frac{1}{16} \times \frac{3}{4}$ 70	$\frac{1}{16} \times \frac{3}{4}$ 70

* CENTER O'RING SIZE 35 ONLY — $\frac{1}{8} \times 1\frac{5}{8}$ 70

Figure 9. Parts Drawing, Typical High Pressure Relief Valves for Type "D" Units. DS-947911E (504034E).

VIII. INSPECTION

A. GEAR PUMP ASSEMBLY. (For duplex units, see reference bulletin).

Inspect gear (22 and 23) teeth for wear. Check stub shaft (25) and roller bearing (24). Inspect wear surfaces in gear housing (72) and cover (73). Check depth of driving and driven gear pockets with depth gage and add amount of wear in cover. Measure width of gears. Normal running clearance is 0.001 to 0.0035 inch for units through size 20 and 0.003 to 0.005 inch for the larger units. Normal clearance over outside diameter of gear is 0.001 to 0.003 inch for units through size 20 and 0.003 to 0.005 inch for the larger units.

B. SHAFT SEAL

Inspect shaft seal (27) for cracks, cuts, hardening or deterioration of seal material. If seal needs replacement, tap out old seal and tap new seal into position carefully to prevent distorting seal.

C. RADIAL PISTON PUMP

Clean all parts thoroughly and make certain that all chips, grit and foreign matter have been removed. Inspect all bearings for pitting, galling and binding. Inspect pistons and bores for cracks, scratches or other signs of wear. Inspect working surfaces on pintle, bushing and thrust rings. Inspect slideblock and case liners for grooves or scratches. Check scratch mark or number stamp on upper face of cylinder and bushing to make certain that bushing has not turned in cylinder. Replace any parts which appear worn or damaged. Be sure orifice plug (95) in pintle of size 100 and larger units is not clogged, but do not change orifice size.

D. GEAR PUMP RELIEF VALVE

Wash parts thoroughly. Clean foreign matter from grooves in dashpot plunger and small hole in end of valve plunger. Check valve plunger seat for scoring or foreign matter. Polish or lap sticking plungers.

E. HIGH PRESSURE RELIEF VALVE

Wash parts thoroughly. Clean foreign matter from grooves in plunger. Check seat in bushing for scoring or foreign matter. Relap plunger on seat, if necessary. When lapping seat, retain close fit between smaller plunger diameter and bushing.

Be sure reservoir and system components are clean.

IX. ASSEMBLY

Clean and lubricate parts with a film of fluid just prior to assembly. If bearing races are heated in oil to ease assembly, exercise extreme care to prevent heating over 300°F.

A. HPRV (all sizes) refer to figure 9.

Replace plug (48) and press bushing (35) with seals (if used) in case. Be sure plunger is free in bushing. Reassemble parts in reverse of disassembly. Insert sufficient shims (45) to hold retainer (44) against bushing and prevent leakage at gasket (39). Turn screw (40) in to previously marked position. Tighten lock nut (40A).

B. GPRV (all sizes) refer to figure 8.

Reassemble in reverse order of disassembly. Anneal gasket (54) if necessary and be sure it is on cap shoulder before tightening cap.

C. GEAR PUMP (all sizes) see reference bulletin for duplex units.

Replace parts in reverse order of disassembly. Check driveshaft key (26) fit in driveshaft and driving gear (22). Gear must be sliding fit over shaft and key. Check clearances as described in VIII-A. Lock gear pump cover screws (69) with soft iron or brass wire (106). If only the gear pump assembly was dismantled, refer to following paragraphs on "Driveshaft" for insertion and shimming of front shaft bearing and correct shimming for cylinder endplay.

D. RADIAL PISTON UNIT (size 4 thru 60)

1. PINTLE

If pintle (5) was removed, set case with open end facing up in a press (see IV-A-g for force needed). Apply a thin coat of anti-seize lubricant on the large tapered surface of pintle and insert pintle into case locating it with key (77). Slip a sleeve over the small pintle end so it rests against shoulder, not pintle's small end*. Press on sleeve until pintle end is flush with back of case. Cylinder bushing (7) and pintle (5) have .005" taper on diameter per inch of length. Suspend cylinder and bushing assembly (6 and 7) in a crane with large end of bore downward. Clean pintle and bushing surfaces thoroughly. Slowly lower cylinder over pintle, do not scrape bushing against edges or pintle ports. Stop when cylinder begins to become tight on pintle. Do not let entire weight of cylinder rest on pintle or cylinder will become too tight and damage the bushing. At this point, pintle should project past the cylinder bushing face the amount shown in IV-A-e (see figure 12). Record actual dimension and identify it as "e". Remove cylinder from pintle.

* Early model pumps have no shoulder. Press pintle in with a bar in rear driveshaft bearing counter bore.

2. SLIDEBLOCK

If slideblock was removed, fit bronze case liners (85) to case and steel slideblock liners (84) on slideblock in their original positions (as marked). Insert shims (84A) if used, in their original positions. Lower slideblock into case and check liner clearance with a feeler gage (at point "b" of figure 10) to see if it is within tolerances given in IV-A-b. Hold slideblock central, top to bottom with pintle within 0.005". Shim under slideblock liner, if necessary. Slip spring (89) on indicator stem (88) and insert it in threaded end of bushing (87) and screw bushing into case.

3. ROTOR

If removed, press spacers (17 and 17A) and thrust rings (18) in evenly. If new rotor bearing (9) is used, install bearing on rotor hub, thrust side of outer race faces away from hub shoulder (on size 60s — install original shims (14) in slideblock and press outer race of roller bearing, with thrust flange down, into slideblock; install inner race on rotor hub).

Lubricate rotor bearing with hydraulic fluid. Replace original rotor bearing, shims (14) and place rotor assembly in slideblock. Make sure bearing turns freely.

4. CYLINDER

Lubricate mating surfaces of pintle (5) and cylinder bushing (7). Lower cylinder with pistons (8) on pintle, do not scratch bushing on pintle edges. With cylinder resting on rotor (16), be sure cylinder turns freely. See figure 13 and dimension given in IV-A-j. If dimension "e" recorded in IX-D-1 is greater than "j", subtract "j" from "e" (e minus j). The difference should equal pintle projection beyond the cylinder bushing face. —— If "e" is less than "j", subtract "e" from "j" (j minus e). The difference should equal the cylinder bushing projection beyond pintle. Add, or remove rotor bearing shims (14) for correct off-of-tight position of cylinder on pintle. If new rear driveshaft bearing (12) is used, install in pintle with outer race thrust side facing away from open case end. Lubricate bearing.

5. ROTOR COVER

If new rotor cover bearing (10) is used, install on rotor cover (65) so thrust side of outer race faces open case end. Size 60 units, measure race protrusion, (see figure 15) and record + or - "t" dimension. Insert coupling ring (21), coupling rollers (20) and coupling flange (19). Force cover (65) down uniformly with screws to hold spacers (17) and thrust rings (18) firmly in place (on size 60s, match balance "o" marks on cover with rotor). Clearance between rotor and cover should be approximately .062". Secure screws with new soft iron locking wire (106).

6. SLIDEBLOCK COVER (for size 60, see E-7) Replace original rotor cover bearing shims (13) in slideblock cover (75) and bolt cover tightly in place. Measure the clearance between front rotor bearing and counterbore in cover with a feeler gage (at "d" of figure 10) for correct rotor end play. Add, or remove, shims until clearance dimension in IV-A-d is obtained. When obtained, secure slideblock cover screws (74) with soft iron locking wire (106). To adjust for correct slideblock end play (at "c" of figure 10), place slideblock shims (67) and slideblock spacer ring (68) on slideblock cover. See figure 18. Measure distance "k" from gear pump cover (73) to gasket face of gear pump housing (72). Subtract .008" from "k" resulting in "m" (k-.008=m). Measure distance "n" from end of case to face of spacer ring (68). Subtract "m" from "n" (n minus m). The difference should equal IV-A-c. add or remove shims (67) to obtain correct dimension.

7. DRIVESHAFT

Remove shaft (1) from gear pump housing (72) assembly (see VII-C on "Shaft Removal") and fasten housing assembly with gasket (29) to case. To adjust for proper cylinder end play of .031", remove front bearing (11) and slide shaft with coupling spacer (2) and key (26) in place, through housing assembly and coupling flange into rear driveshaft bearing (12) firmly. While shaft, spacer, coupling and cylinder rest on rotor, measure distance from upper face of housing to driveshaft shoulder which contacted the inner front driveshaft bearing race (11). Insert shims in housing counterbore until they are .031" higher than shoulder. Measure distance from face of housing to driveshaft end before and after bearing is installed to be sure driveshaft rises .031". Install bearing (11), lockwasher (4) and tighten nut (3) to hold bearing against shoulder. Bend one prong of washer to lock nut. Insert sufficient shims (15) between outer race of front driveshaft bearing and gland (71) to eliminate driveshaft end play and leakage at gland gasket (28). Install seal (27) and gasket (28), with holes aligned and secure gland to housing.

E. RADIAL PISTON UNIT (size 100 and larger)

1. PINTLE

If pintle (5) was removed, set pump case with open end facing up in a press (see IV-A-g for force needed). Apply a thin coat of anti seize lubricant on the large tapered surface of pintle and insert pintle into case locating it with key (77). Slip a sleeve over small pintle end so it rests against large diameter shoulder, not pintle's small end. Press on sleeve until pintle end is flush with back of case. Cylinder bushing (7) and pintle (5) have 0.032" taper on diameter per inch of length. Suspend cylinder and bushing assembly in a crane with large end of bore downward. Clean pintle and bushing surfaces thoroughly. Slowly lower cylinder and bushing over pintle, do not scrape bushing against edges or pintle ports. Stop when cylinder begins to become tight on pintle. Do not let entire weight of cylinder rest on pintle or cylinder will become too tight and damage the bushing. At this point, the pintle should project past cylinder bushing face the amount shown in IV-A-e (see figure 12). Record actual dimension and identify it as "e". Remove cylinder from pintle.

2. SLIDEBLOCK

Install a minimum of eight 0.010" thick shims (14) in rotor bearing counterbore. If measurement "e" from step 1 was less than shown in IV-A-e, add one additional shim for each .010" less. Press rotor bearing (9) outer race, with thrust flange down, into slideblock. Fit bronze case liners (85) to case, and steel slideblock liners (84) with shims (84A), if used, on slideblock in their original positions. Lower slideblock into case and check liner clearance with a feeler gage (at point "b" of figure 11) to see if it is within tolerances given in IV-A-b. If slideblock liners of different thickness are used, the thicker pair should be on slideblock bottom. Thickness of top and bottom liner pairs (and shims if used) should be equal within .005".

3. ROTOR

If spacers (17 and 17A) and thrust rings (18) were removed, press in evenly, Install inner race of rotor bearing (9) on rotor (16) and rotor cover bearing (10) on rotor cover (65). Be sure bearing races are tight against hub shoulders. Lubricate bearings and place rotor assembly in slideblock and make sure bearing turns freely. Lubricate mating surfaces of pintle and cylinder bushing, and lower cylinder over the pintle. Be sure cylinder turns freely on pintle. With cylinder resting on inside rotor face, measure pintle projection (see figure 13). It should project beyond the cylinder bushing face by an amount equal to "e" (from step 1) less dimension given in

IV-A-j ("e" minus "j"). Add or remove rotor bearing shims (14) for correct off-of-tight position of cylinder. Record actual final measurement as "u".

4. DRIVESHAFT

Lift cylinder off pintle and place a .187" thick spacer ring inside rotor. Position cylinder on pintle so it rests on this spacer. Fit coupling ring (21) and coupling flange (19), without rollers, in cylinder end. Remove driveshaft (1) assembly from gear pump housing assembly (72)(see VII-C on "Shaft Removal"). Place housing assembly in position with gasket (29) (use pieces if available) and tighten mounting screws. If removed, fit front driveshaft bearings (11) on shaft with both outer race thrust sides facing seal (27) end, install lockwasher (4), tighten nut (3) to hold bearing tight against shaft shoulder and bend one prong of washer to lock nut. Remove any shims (15) from counterbore in housing. Slide shaft, with coupling spacer (2) and key (26) in place, through housing firmly. Be certain outer bearing race is all the way down and measure from top of outer race to face of gear pump housing. Add shims under bearing until this measurement increases .005" to .010". Add .010" shims (15) between outer front driveshaft bearing (11) and gland (71) until gap between gland and housing (without gasket in place) is .005". Install seal (27), match gasket holes to gland and secure gland with gasket to housing. Remove gear pump and driveshaft assembly from case, coupling flange and ring from cylinder, cylinder from pintle and .187" spacer ring from rotor.

5. CYLINDER

Insert pistons (8) in cylinder (6) and carefully lower assembly part way on pintle. Hold it high enough to set spring yoke (98) on rear shaft bearing (12), balls (96) in yoke and flat springs (97) on balls in each side of yoke. Size 100 units use six springs, size 150 and larger use seven. Lower cylinder until it hangs on springs (see figure 14). Measure from bushing face to end of pintle to determine spring deflection. Shim (15A) under bearing (12) to obtain measurement of .34" minus "u" for size 100; or .38" minus "u" for size 150 and larger. The "u" dimension was recorded in step 3. Be sure outer race thrust face of rear driveshaft bearing (12) faces down. Install coupling ring (21) and rollers (20). Check for free fit of coupling piston ring (19A) in cylinder bore, install ring in coupling flange (19) and assembly in cylinder.

6. ROTOR COVER

Position rotor cover (65), with balance mark "O" matching "O" mark on rotor (16) and force cover down uniformly with cover screws (66) holding spacers (17 and 17A) and thrust rings (18) securely. There should be approximately .062" clearance between rotor and cover when cover is tight. Secure screws with new soft iron lock wire (106). With outer race of rotor cover bearing (10) resting on roller faces, measure height difference between outer and inner race faces (see figure 15). If rotor cover bearing is not replaced, check projection in a similar manner; but with rotor cover and slideblock cover separated from pump assembly. Record this difference as "+t" if inner race projects, or as "-t" if outer projects.

7. SLIDEBLOCK COVER

If rotor cover bearing (10) is replaced, measure width of lip at bottom of bearing bore in slideblock cover (75) (see figure 16). Record dimension as "s". Tighten down slideblock cover on slideblock, without rotor cover bearing outer race installed, with two screws (74). Measure distance from top face of slideblock cover to top face of rotor cover bearing inner race. Record dimension as "r". Calculate number of .010" rotor cover bearing shims (13) to be used as follows: —

$$\frac{[(\text{"r"} - .035) - \text{"s"}] \pm \text{"t" (from step 6.)}}{.010} = \text{no. of shims}$$

Install shims and outer race of rotor cover bearing in slideblock cover (75). If rotor cover bearing (10) was not replaced, secure slideblock cover, with shims (13) and outer rotor cover bearing race, securely to slideblock. To check shimming (see figure 17) measure from top face of slideblock cover to rotor cover bearing outer race. Record dimension as "q". Measure from slideblock cover to inner race. Record dimension as "p". The difference of "p" minus "q", plus or minus initial race projection "t" (measured in step 6), should equal IV-A-d. Remove or add shims (13) to obtain correct dimension. Place spacer ring (68) on slideblock cover without shims (67) in place (see figure 18). Measure distance "k" from gear pump cover (73) to gasket face of gear pump housing (72). Subtract .008" from "k" resulting in "m" ("k" minus .008=m). Measure distance "n" from end of case to face of spacer ring (68). Subtract "m" from "n" ("n" minus "m"). The difference should equal IV-A-c, add or remove shims (67) to obtain correct dimension.

F. GEAR PUMP (all sizes)

Place gasket (29) on case and secure complete gear pump and driveshaft assembly to case.

G. SUCTION VALVE & CONTROLS. See reference bulletins for suction valves, controls and opposing operators. Mount suction valve, control and opposing operator on pump case.

H. PINTLE RELIEF VALVES (size 100 and larger)

Insert pintle check valve assembly (if used) in pintle, being sure body (107) seats on it's shoulder. Replace O'Ring (119) and seat (109). Reassemble pintle relief valve in reverse order of disassembly. Test and adjust per VI-F. Be sure orifice plug (95) in pintle is not plugged (do not change size). Fasten cover with gasket or seals (81 and 81A) to rear of case.

I. MOUNTING

Bolt pump and pump case gasket (56A) to reservoir. Turn pump over by hand several times to make certain no parts are binding. Couple pump to drive motor; re-install piping and electrical connections; test and adjust pump and relief valves if necessary.

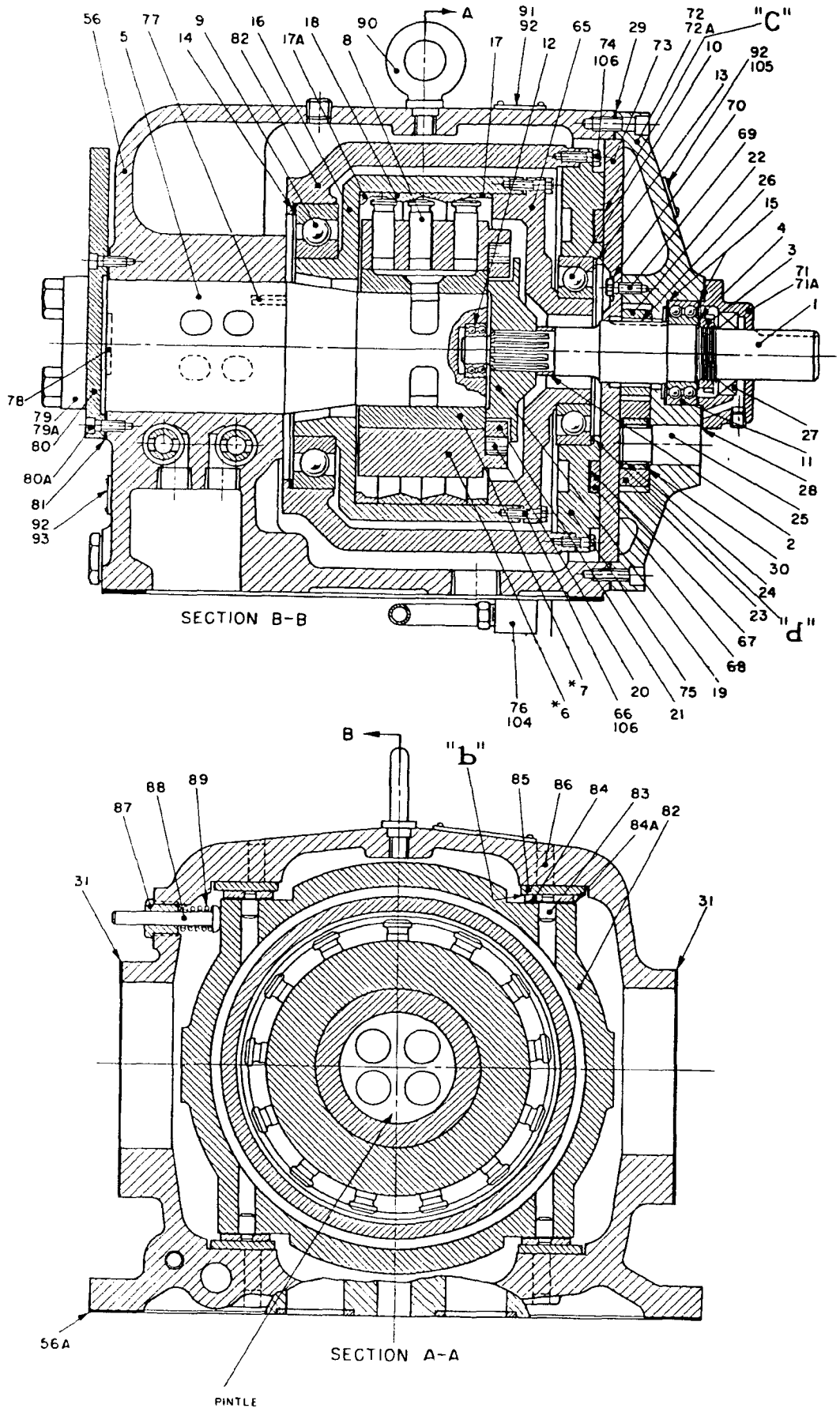


Figure 10. Parts Drawing, Oilgear Type "D" Units size 4 thru 60. DS-947916E (503293E)

Parts used in the assembly are per Oilgear specifications. Use Oilgear parts to insure compatability with assembly requirements. When ordering replacement parts, be sure to include pump type and serial number, bulletin number and item number. Specify type of hydraulic fluid for packings and seals.

X. PARTS LIST
OILGEAR TYPE "D" VARIABLE DISPLACEMENT PUMPS
SIZES 4 THRU 60

Item No.	Description
*1	Shaft, Drive
*2.	Spacer, Coupling
(B) 3.	Nut, Lock
(B) 4.	Washer, Lock
(B)*5.	Pintle w/checks (loose)
(B)*6.	Cylinder
(B)*7.	Bushing, Cylinder
(B) 8.	Piston, Radial
(B) 9.	Bearing, Rotor
(B)10.	Bearing, Rotor Cover
(B)11.	Bearing, Front Driveshaft
(B)12.	Bearing, Rear Driveshaft
(B)13.	Shims, Rotor Cover Bearing
(B)14.	Shims, Rotor Bearing
(B)15.	Shims, Front Driveshaft Bearing
16.	Rotor
17.	Ring, Spacer
(B)17A.	Ring, Spacer
(B)18.	Ring, Thrust
19.	Flange, Coupling
20.	Roller, Coupling
21.	Ring, Coupling
(B)22.	Gear, G. P. Driving
(B)23.	Gear, G. P. Driven
(B)24.	Bearing, Roller
(B)25.	Shaft, Stub
(S) 26.	Key, Driveshaft
(S) 27.	Seal, Shaft
(S) 28.	Gasket, Seal Gland
29.	Gasket, G. P. Housing
#(B)30.	Spacer, Bearing
(S) 31.	Gasket, Control Mounting
56.	Case, Pump
(S) 56A.	Gasket, Pump Mounting
65.	Cover, Rotor
66.	Screw, Rotor Cover
67.	Shims, Slideblock Cover
68.	Ring, Slideblock Spacer
69.	Screw, G. P. Cover
(S)70.	Gasket, G. P. Cover Screw
71.	Gland, Shaft Seal
71A.	Screw
72.	Housing, Gear Pump
72A.	Screw
73.	Cover, Gear Pump
74.	Screw, Slideblock Cover
75.	Cover, Slideblock
76.	Tubing, w/Fittings
(B)77.	Key, Pintle
(S)78.	Gasket, Flange
79.	Flange, Pipe
79A	Screw
80.	Cover, Pintle End
80A.	Screw
(S)81.	Gasket, Pintle Cover
82.	Slideblock
83.	Pin, Dowel
84.	Liner, Slideblock
84A.	Shims, Liner
85.	Liner, Case
86.	Pin, Dowel
87.	Bushing, Indicator Stem
88.	Stem, Stroke Indicator
89.	Spring, Indicator Stem
90.	Eyebolt
91.	Plate, Name
92.	Screw, Drive
93.	Plate, Cooler Inst.
104.	Tubing, w/Fittings
105	Plate, Rot. Name
106.	Wire, Lock

Not used in some units

NOTE: *Parts numbered (5, 6 & 7) and (1 and 2) are furnished only as assemblies. See reference material for filter and filter indicator.

(S) Indicates included in "A" Seal Kit
(B) Indicates included in "B" Overhaul Kit

OILGEAR EXCHANGE SERVICE

Standard replacement pumps and motors are available to users of Oilgear equipment where comparable units will be returned in exchange. When standard replacements must be modified to replace units which are special, shipment will depend on availability of parts and assembly and test time necessary.

To obtain this service, place an order for an exchange unit and give serial number and type designation. The replacement will be shipped F.O.B. our factory, Milwaukee, wisconsin. User retains the replacement and returns the worn unit prepaid to The Oilgear Company for reconditioning and test. When the unit is reconditioned and stocked, the user is billed the cost of reconditioning, or a flat rate exchange price, if one has been applied to that particular type of unit.

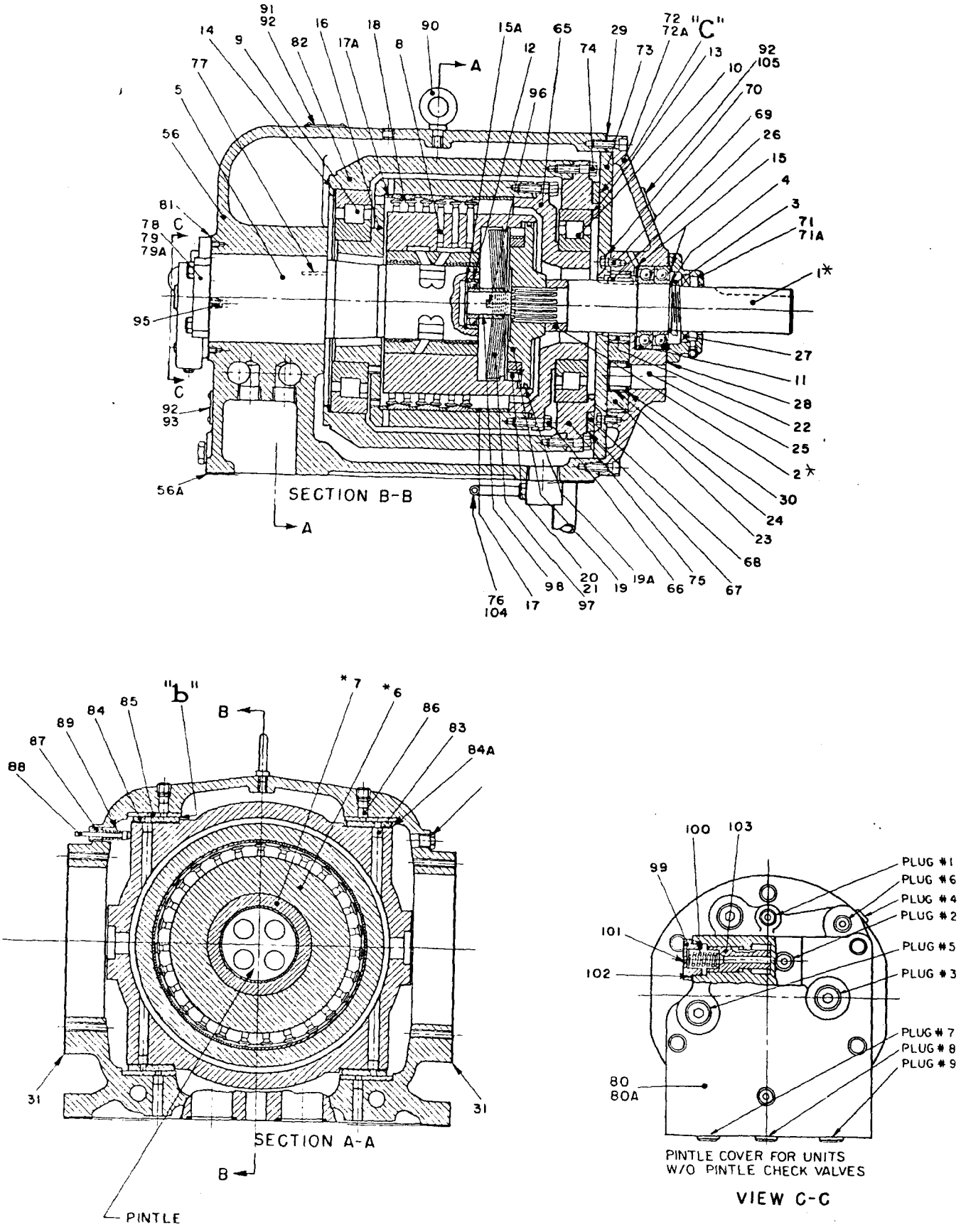


Figure 11. Parts Drawing, Oilgear Type "D" Units size 100 and larger. (DS-947917E) (503297E)

Parts used in this assembly are per Oilgear specifications. Use Oilgear parts to insure compatability with assembly requirements. When ordering replacement parts, be sure to include pump type and serial number, bulletin number and item number. Specify type of hydraulic fluid for packings and seals.

X. PARTS LIST

OILGEAR TYPE "D" VARIABLE DISPLACEMENT PUMPS
SIZES 100 AND LARGER

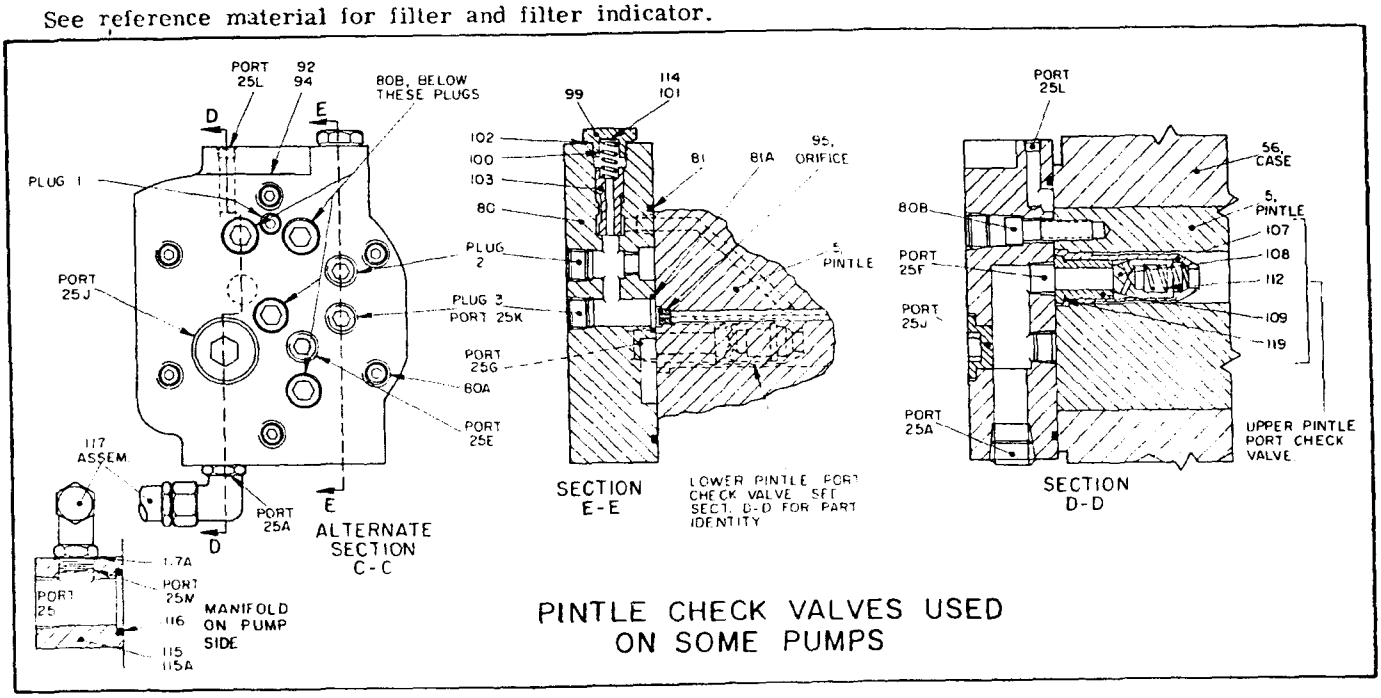
Item No.	Description
*1.	Shaft, Drive
*2.	Spacer, Coupling
(B) 3.	Nut, Lock
(B) 4.	Washer, Lock
(B)*5.	Pintle
(B)*6.	Cylinder
(B)*7.	Bushing, Cylinder
(B)*8.	Piston, Radial
(B) 9.	Bearing, Rotor
(B)10.	Bearing, Rotor Cover
(B)11.	Bearing, Front Driveshaft
(B)12.	Bearing, Rear Driveshaft
(B)13.	Shims, Rotor Cover Bearing
(B)14.	Shims, Rotor Bearing
(B)15.	Shims, Frt. Driveshaft Brg.
(B)15A.	Shims, Rear Driveshaft Brg.
16.	Rotor
17.	Ring, Spacer
(B)17A.	Ring, Spacer
(B)18.	Ring, Thrust
19.	Flange, Coupling
19A.	Ring, Coupling Piston
20.	Roller, Coupling
21.	Ring, Coupling
(B)22.	Gear, G. P. Driving
(B)23.	Gear, G. P. Driven
(B) 24.	Bearing, Roller
(B) 25.	Shaft, Stub
(B) 26.	Key, Driveshaft
(S) 27.	Seal, Shaft
(S) 28.	Gasket, Seal Gland
(S) 29.	Gasket, G. P. Housing
(B) 30.	Spacer, Bearing
(S) 31.	Gasket, Control Mounting

Item No.	Description
56.	Case, Pump
(S)56A.	Gasket, Pump Mounting
65.	Cover, Rotor
66.	Screw, Rotor Cover
67.	Shim, Slideblock Cover
68.	Ring, Slideblock Spacer
69.	Screw, G. P. Cover
(S) 70.	Gasket, G. P. Cover Screw
71.	Gland, Shaft Seal
71A.	Screw
72.	Housing, G. P.
72A.	Screw
73.	Cover, Gear Pump
74.	Screw, Slideblock Cover
75.	Cover, Slideblock
76.	Tubing, w/Fittings
(B)77.	Key, Pintle
(S)78.	Gasket, Flange
79.	Flange, Pipe
79A.	Screw
80.	Cover, Pintle End
80A.	Screw
80B.	Screw
(S) 81.	Gasket, Pintle Cover
(S) 81.	Seal, O'ring 1/8 x 8-1/2-70
(S) 81A.	Seal, O'ring 1/8 x 1-1/4-70
82.	Slideblock
83.	Pin, Dowel
84.	Liner, Slideblock
84A.	Shims, Liner
85.	Liner, Case
86.	Pin, Dowel
87.	Bushing, Indicator

Item No.	Description
88.	Stem, Indicator
89.	Spring, Indicator
90.	Eye Bolt
91.	Plate, Name
92.	Screw, Drive
93.	Plate, Cooler Inst.
94.	Plate, Instructions
95.	Plug, Orifice
96.	Ball, Steel
97.	Spring, Flat
98.	Yoke, Flat Spring
99.	Cap, Pintle Cover, R. V.
100.	Spring, Pintle Cover, R. V.
101.	Shims, Pintle Cover, R. V.
(S)102.	Gasket, Cap
103.	Plunger, Pintle Cover, R.V.
104.	Tubing, w/Fittings
105.	Plate, Rot. Name
106.	Wire, Lock
(B)*107.	Body, Pintle Check Valve
(B)*108.	Plunger, Pintle Check Valve
(B)*109.	Seat, Pintle Check Valve
(B)*112.	Spring, Pintle Check Valve
114.	Washer, 1/4" Plain
115.	Manifold
115A.	Screw
(S) 116.	Seal, O'ring 3/16 x 2-1/4 - 70
117.	Assembly, Piping
(S) 117A.	Seal, O'ring ARP 920
(S)119.	Seal, O'Ring 1/8 x 1-1/2 - 90

(S) Indicates included in "A" Seal Kit
(B) Indicates included in "B" Overhaul

NOTE: * Parts numbered (1 and 2), (5, 6, 7 and 8) and (107 thru 112) are furnished only as assemblies.
See reference material for filter and filter indicator.



PINTLE CHECK VALVES USED ON SOME PUMPS

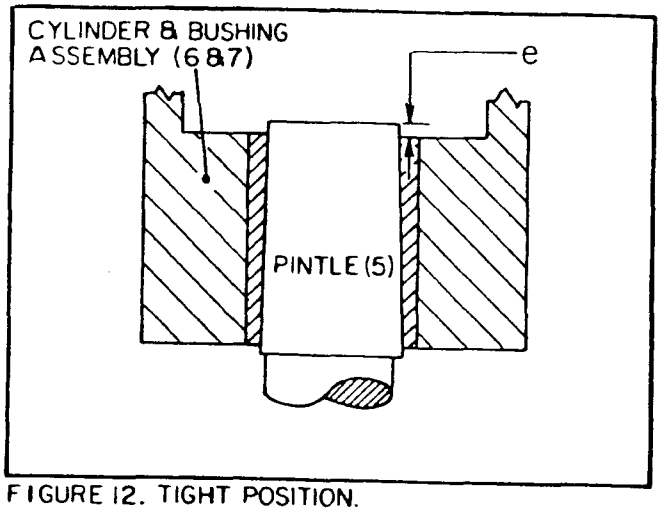


FIGURE 12. TIGHT POSITION.

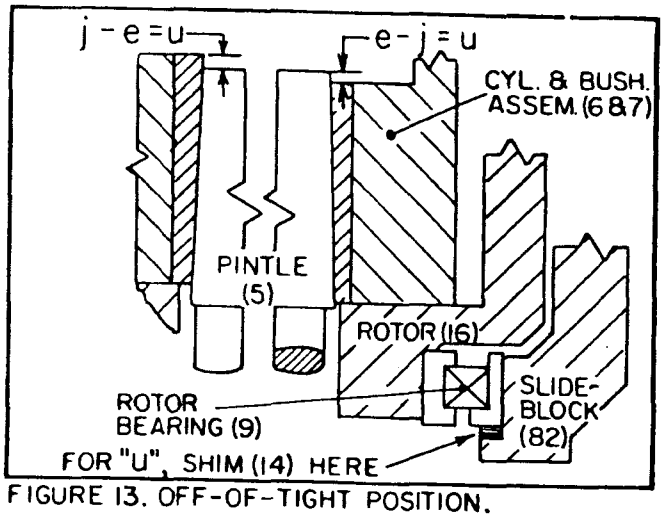


FIGURE 13. OFF-OF-TIGHT POSITION.

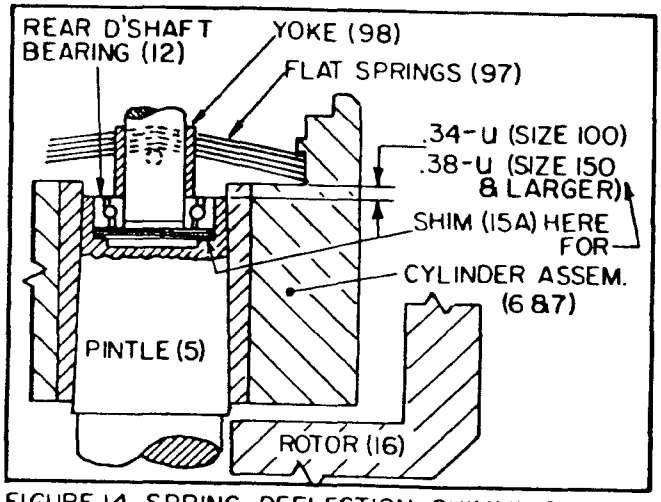


FIGURE 14. SPRING DEFLECTION SHIMMING

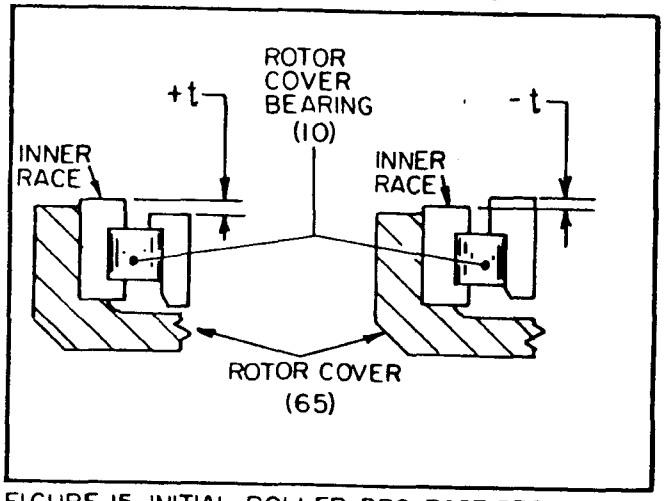


FIGURE 15. INITIAL ROLLER BRG. RACE PROJECTION

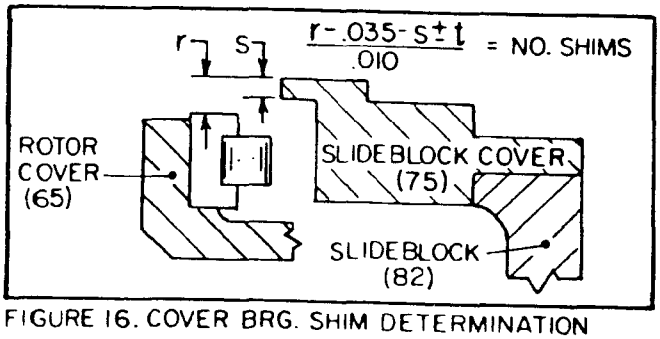


FIGURE 16. COVER BRG. SHIM DETERMINATION

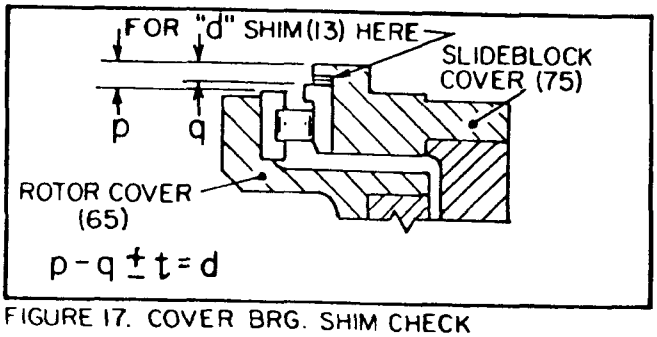


FIGURE 17. COVER BRG. SHIM CHECK

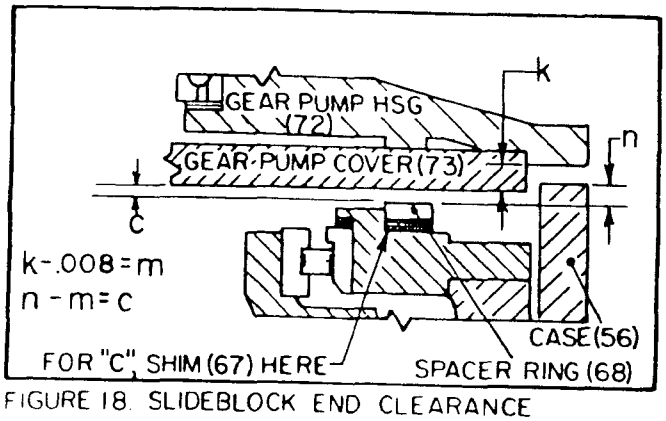


FIGURE 18. SLIDEBLOCK END CLEARANCE

THE OILGEAR COMPANY
MILWAUKEE, WISCONSIN, U.S.A. 53219

Litho in U.S.A.