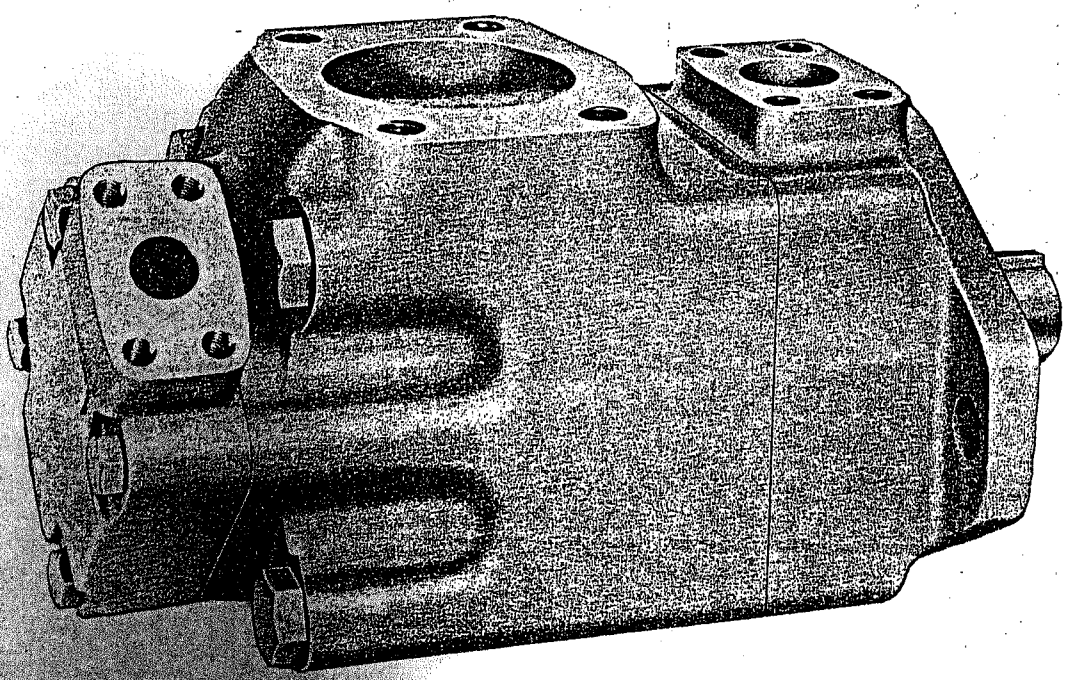
VICKERS

Overhaul Manual

Flex-Plate Type Double Pumps

2520VQ, 3520VQ, 4520VQ, 3525VQ, 4525VQ, and 4535VQ SERIES



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I-3174-S

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MODEL CODE BREAKDOWN

F*-4520VQ60E11-11AA6D20L-*

SPECIAL SEALS

SERIES

FLEX-PLATE TYPE VANE PUMP

RING SIZE SHAFT END

25**	35**	45**
12	21	42
14	25	47
17	30	50
19	35	57
21	38	60

CODE	INLET	OUTLET SHAFT PUMP	OUTLET COVER PUMP
A	4-bolt flg.	4-bolt flg.	4-bolt flg.
C	4-bolt flg.	SAE str. thd.	SAE str. thd.
E	4-bolt flg.	4-bolt flg.	SAE str. thd.
F	4-bolt flg.	SAE str. thd.	4-bolt flg.

RING SIZE COVER END

**20	**25	**35
5	12	21
8	14	25
9	17	30
11	19	35
12	21	38
14		

SHAFT TYPE

SPECIAL FEATURES SUFFIX

LEFT HAND (CCW) ROTATION (OMIT FOR RIGHT HAND (CW) ROTATION) (VIEW FROM SHAFT END)

DESIGN

RELIEF VALVE SETTING (INTEGRAL RELIEF VALVE MODELS ONLY)

C - 750 PSI G - 1750 PSI
D - 1000 PSI H - 2000 PSI
E - 1250 PSI *J - 2250 PSI
F - 1500 PSI *K - 2500 PSI
***20 MODELS ONLY

CONTROLLED FLOW RATE (INTEGRAL FLOW CONTROL MODELS ONLY)

2 - 2 USPGM 8 - 8 USGPM
4 - 4 USGPM 10 - 10 USGPM
6 - 6 USGPM 12 - 12 USGPM
7 - 7 USGPM

OUTLET PORT POSITIONS VIEWING COVER END

OUTLET BODY #1 WITH RESPECT TO INLET PORT
A - OPPOSITE INLET B - 90° CCW FROM INLET C - IN LINE WITH INLET D - 90° CW FROM INLET
OUTLET BODY #2 (COVER) W/RESPECT TO INLET PORT
A - 135° CCW FROM INLET B - 45° CCW FROM INLET C - 45° CW FROM INLET D - 135° CW FROM INLET
OUTLET BODY #2 (COVER) W/RESPECT TO INLET PORT (4535 VQ ONLY)
A - OPPOSITE INLET B - 90° CCW FROM INLET C - IN LINE WITH INLET D - 90° CW FROM INLET

TABLE 1.

Section I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual has been prepared to assist the users of Vickers high performance double pumps in properly installing, maintaining and repairing their unit. The double pumps are described in detail and their theory of operation is discussed in addition to instructions for installation, maintenance and overhaul.

The general series of models covered are 2520VQ, 3520VQ, 4520VQ, 3525VQ, 4525VQ, and 4535VQ. The information given applies to the latest design series listed in Table 1.

B. GENERAL INFORMATION

1. Related Publications: Service parts information and installation dimensions are not contained in this manual. The parts catalogs and installation drawings listed in Table II are available from any Vickers application engineering office or from:

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2. Model Codes: There are many variations within each basic model series, which are covered by variables in the model code. Table I is a complete breakdown of the codes covering these units. (When integral flow control and relief valve features are not used, the letters and numbers are omitted). Service inquiries should always include the complete unit model number as stamped on the back cover.

MODEL	PARTS DWG.	INSTALLATION DWG.
2520VQ	I-3166-S	504000
3520VQ	I-3169-S	504300
4520VQ	I-3170-S	504600
3525VQ	I-3171-S	504500
4525VQ	I-3172-S	504800
4535VQ	I-3173-S	505000

Table 2. - Parts Catalogs and Installation Drawings

Section II - DESCRIPTION

A. GENERAL

Pumps in this series are used to develop hydraulic fluid flow for the operation of Mobile equipment. The positive displacement pumping cartridges are of the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the pump size and the speed at which it is driven.

All units are designed so that the direction of rotation, pumping capacity and port positions can be readily changed to suit particular applications.

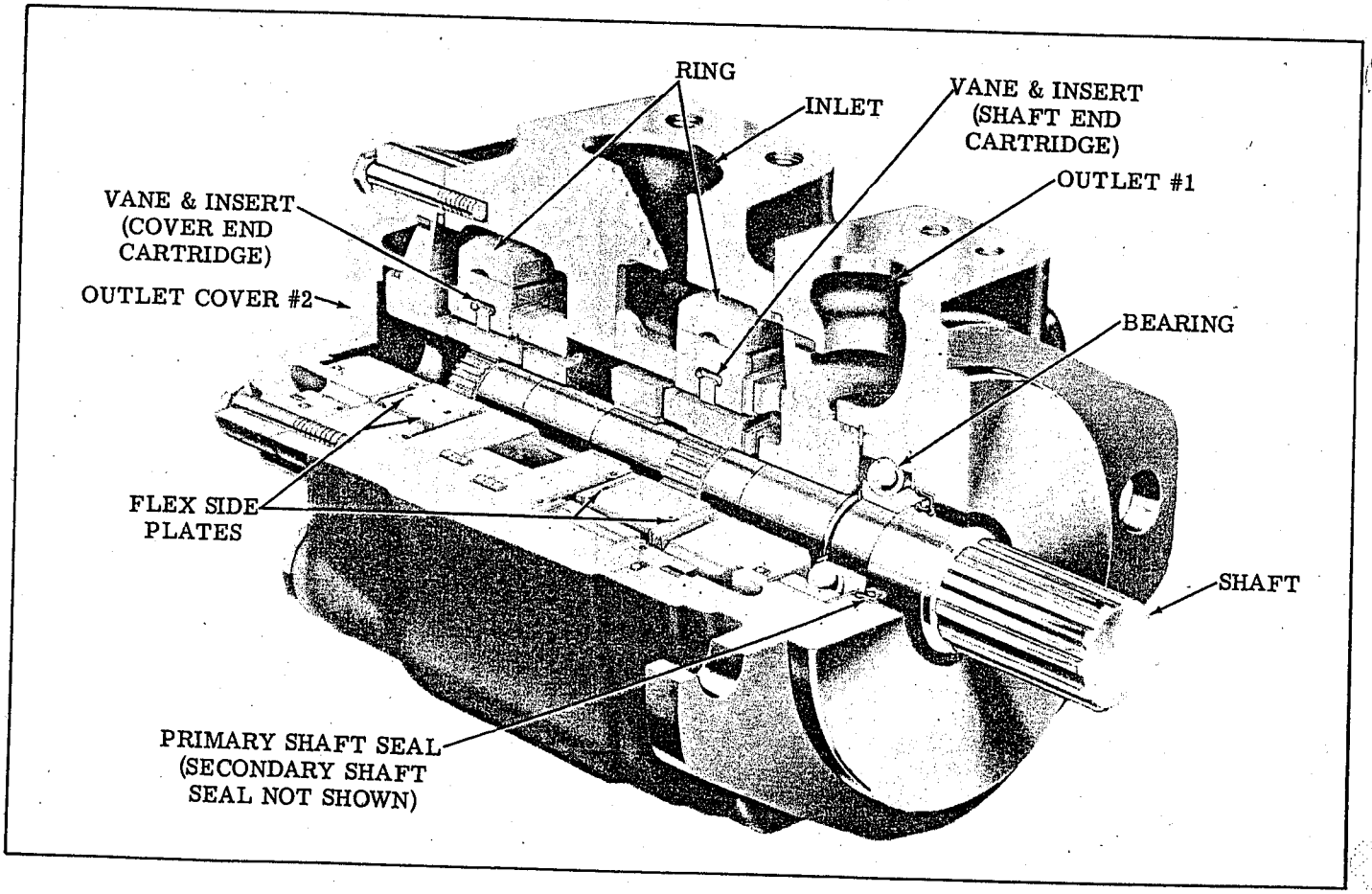

Figure 1. Cutaway View of Typical Double Pump.

B. ASSEMBLY AND CONSTRUCTION

1. Basic Pumps: The pump illustrated in Figure 1 is representative of all double pumps in this series. The pump consists principally of an inlet housing, two outlet bodies, a drive shaft and two pumping cartridges. The principal components of a cartridge are an elliptical cam ring, a slotted rotor splined to the drive shaft, an inlet and outlet support plate fitted with four special seal pack subassemblies, two flex side plates, and ten vanes and inserts fitted to the rotor slots. Fluid enters the cartridge through the inlet port and is discharged through the outlet of flex side plate and support plate to the outlet ports.

C. APPLICATION

Pump rating in USGPM, as shown in the model coding, are at 1200 RPM and 100 PSI. For rating at other speeds and pressures, methods of installation or other application information, refer to the applicable sales installation drawing or consult a Vickers application engineer.

Section III - PRINCIPLES OF OPERATION

A. PUMPING CARTRIDGE

As mentioned in Section II, fluid flow is developed in the pumping cartridge. The action of the cartridge is illustrated in Figure 2. The rotor is driven within the ring by the driveshaft, which is coupled to a power source. As the rotor turns, centrifugal force on the vanes, aided by under-vane pressure fed from the outlet port, causes the vanes to follow the elliptical inner surface of the ring.

Radial movement of the vanes and turning of the rotor causes the chamber volume between the vanes to increase as the vanes pass the inlet sections of the ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers.

An additional inlet fluid path exists through a drilled hole in the cam ring. This hole connects the inlet port directly to the inlet areas of the cam ring and provides an additional flow path for fluid to get into the cartridge. See Figure 1 and 15.

Fluid is trapped between the vanes and carried past a sealing land to the outlet section of the ring. As the outlet section is approached, the chamber volume decreases and fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the ring during normal operation.

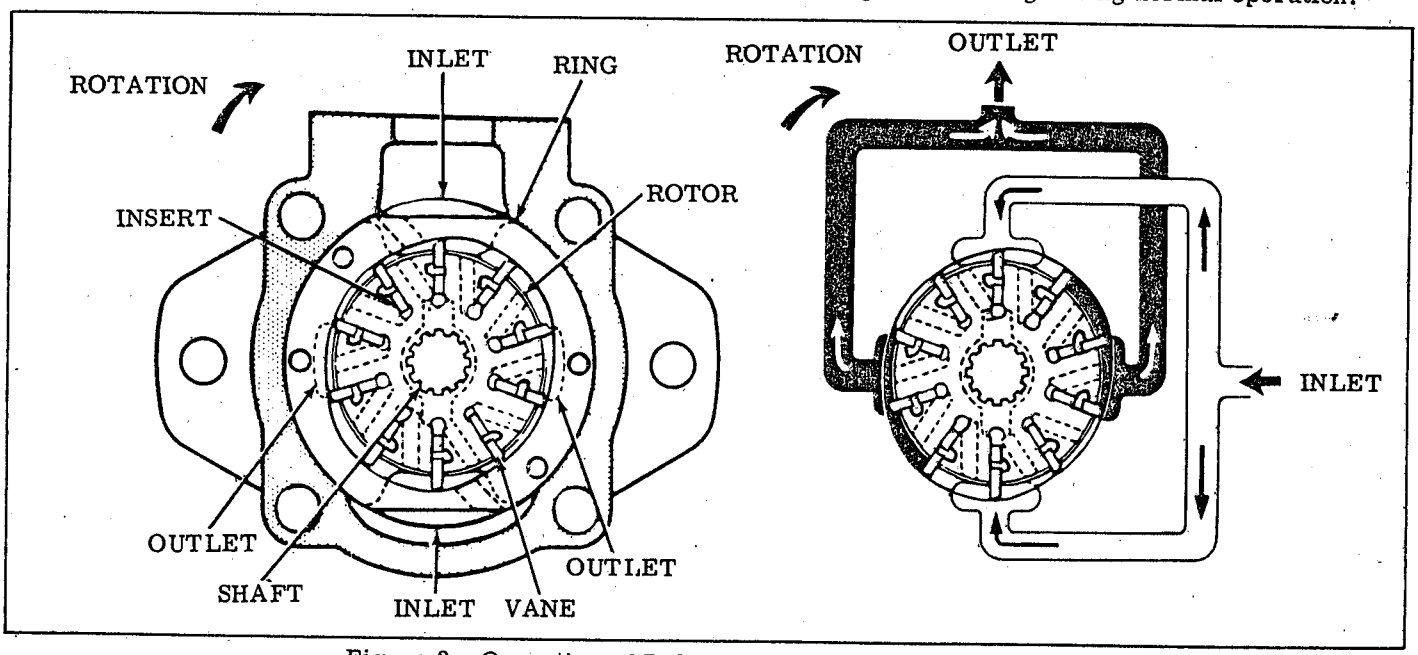

Figure 2. Operation of Balanced, Vane-Type Cartridge.

B. VANE PRESSURE FEED

The intra-vane design provides a means of controlling the outward thrust of the vane against the ring and maintains tip loads within reasonable limits. In the intra-vane cartridge, full system pressure is continuously applied only to the area between the vane and insert. This area is small and thrust is correspondingly light. During vane travel through pressure areas, full system pressure is applied against the bottom area of the outer vane. The valving of pressure to and from the bottom area of the vane is through holes drilled in the rotor, as shown in Figure 3. This selective application of pressure maintains the vane in substantially constant radial hydraulic balance in all positions.

Vane tip wear is compensated for automatically. As the vane wears, pressure moves the vane farther out in the rotor slot holding the vane tip against the cam ring.

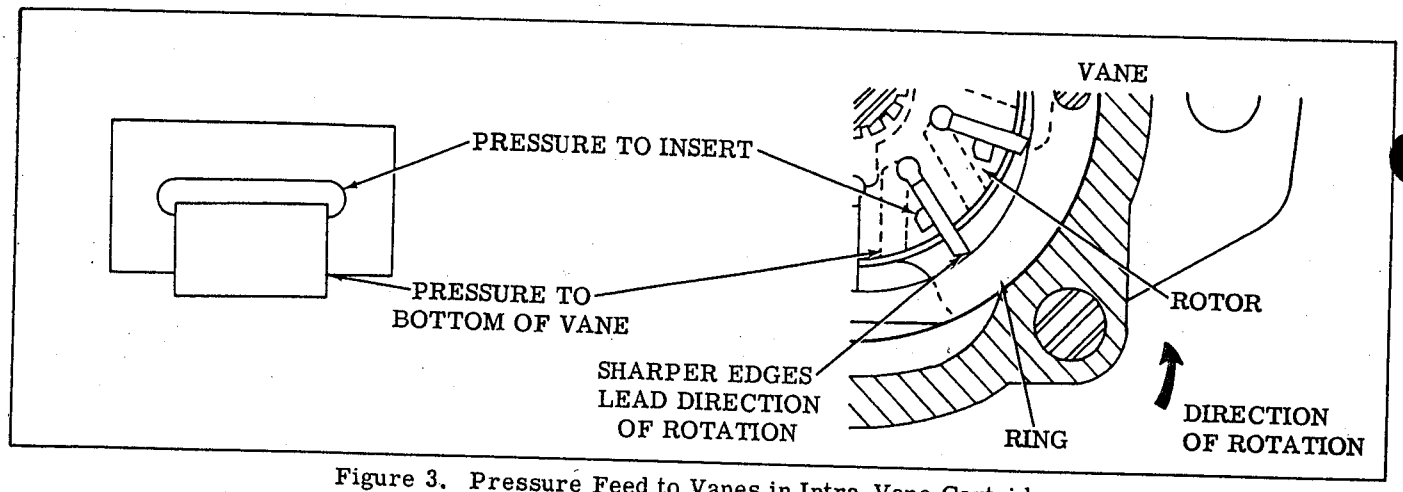

Figure 3. Pressure Feed to Vanes in Intra-Vane Cartridge.

C. HYDRAULIC BALANCE

The pump ring is shaped so the two pumping chambers are formed 180 degrees apart (Figure 2). Thus, opposing hydraulic forces which develop side loads on the shaft cancel out.

D. FLEX SIDE PLATE OPERATION

The flex side plates for both inlet and outlet are symmetrical. Pressure is fed behind each side plate into two kidney shaped cavities, which are sealed by special seal pack subassemblies. The two flex side plates and their associated kidney shaped cavities function in the following manner. As pressure builds up in the outlet, pressure also builds up in the cavities. The pressure in the cavities hold the flex side plates in hydrostatic balance against the rotor and provide optimum running clearances for minimum internal leakage and minimum friction. (See Figure 4)

The flex side plates also provide passages for feeding under vane pressure to the space between the vane and insert.

The bronze faces of the flex side plates ride next to the rotor and provide excellent wear and cold start characteristics.

The inlet and outlet support plates hold the flex side plates in position and contain passages which allow fluid to pass from the inlet to the pumping cartridge and from the cartridge to the outlet port.

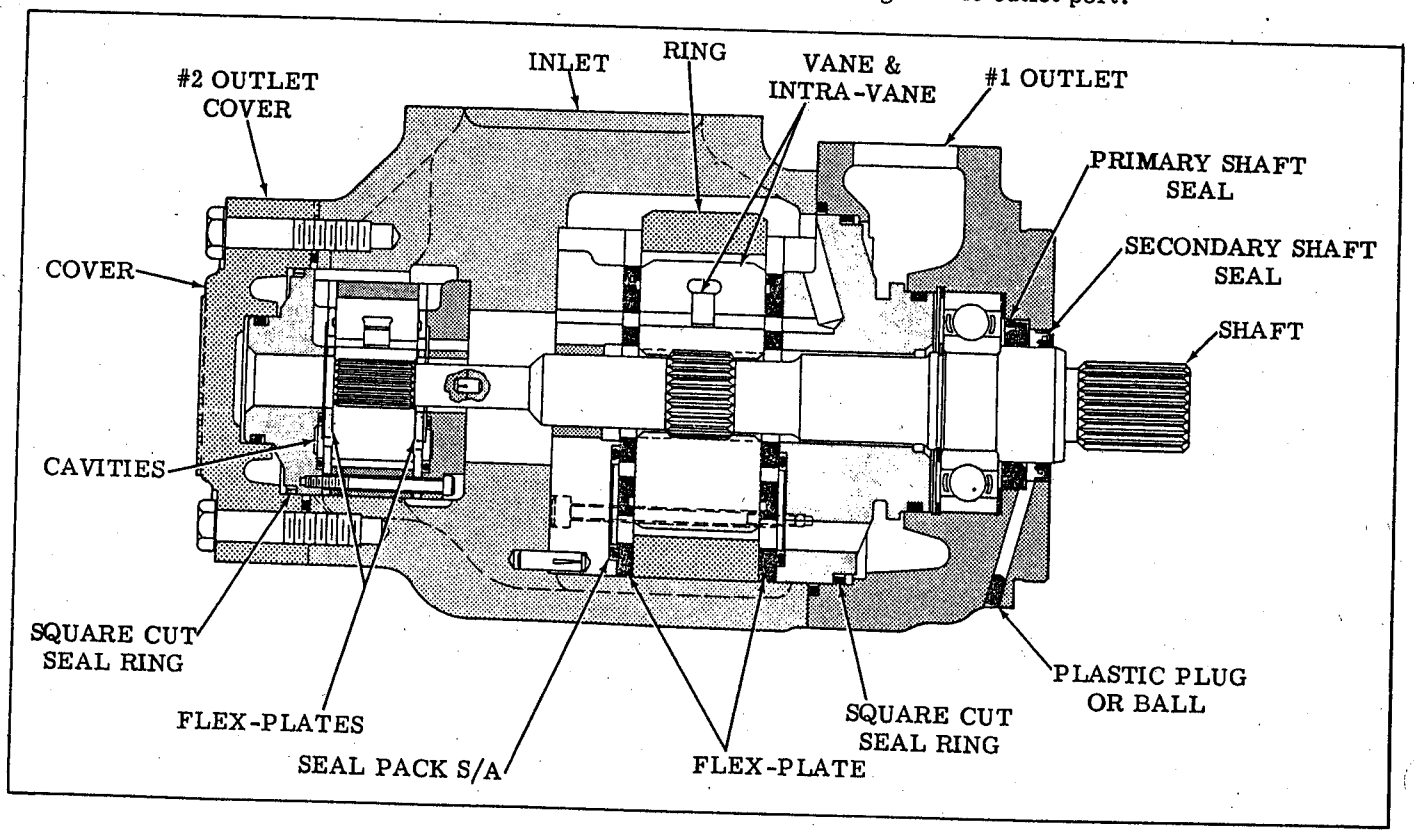

Figure 4. Flex Side Plate Operation

E. SHAFT END OUTLET BODY #1.

Two outlet body configurations and two shaft seal arrangements are available in this pump series. (See Figure 5).

When a single shaft seal is used, a steel ball is pressed into the body. (See Figure 5a).

Double shaft seal models use a plastic plug to seal the body drain opening. This prevents external contamination from entering the area between the seals. (Refer to Figure 5b) The outer shaft seal is rated at 7 PSI from an internal source and 2 PSI from an external source.

Double shaft seal models require a different shaft that may or may not be interchangeable with previous designs. This is due to an increase in shaft shoulder length to accommodate the second shaft seal. The overall shaft length of both shafts are not necessarily the same.

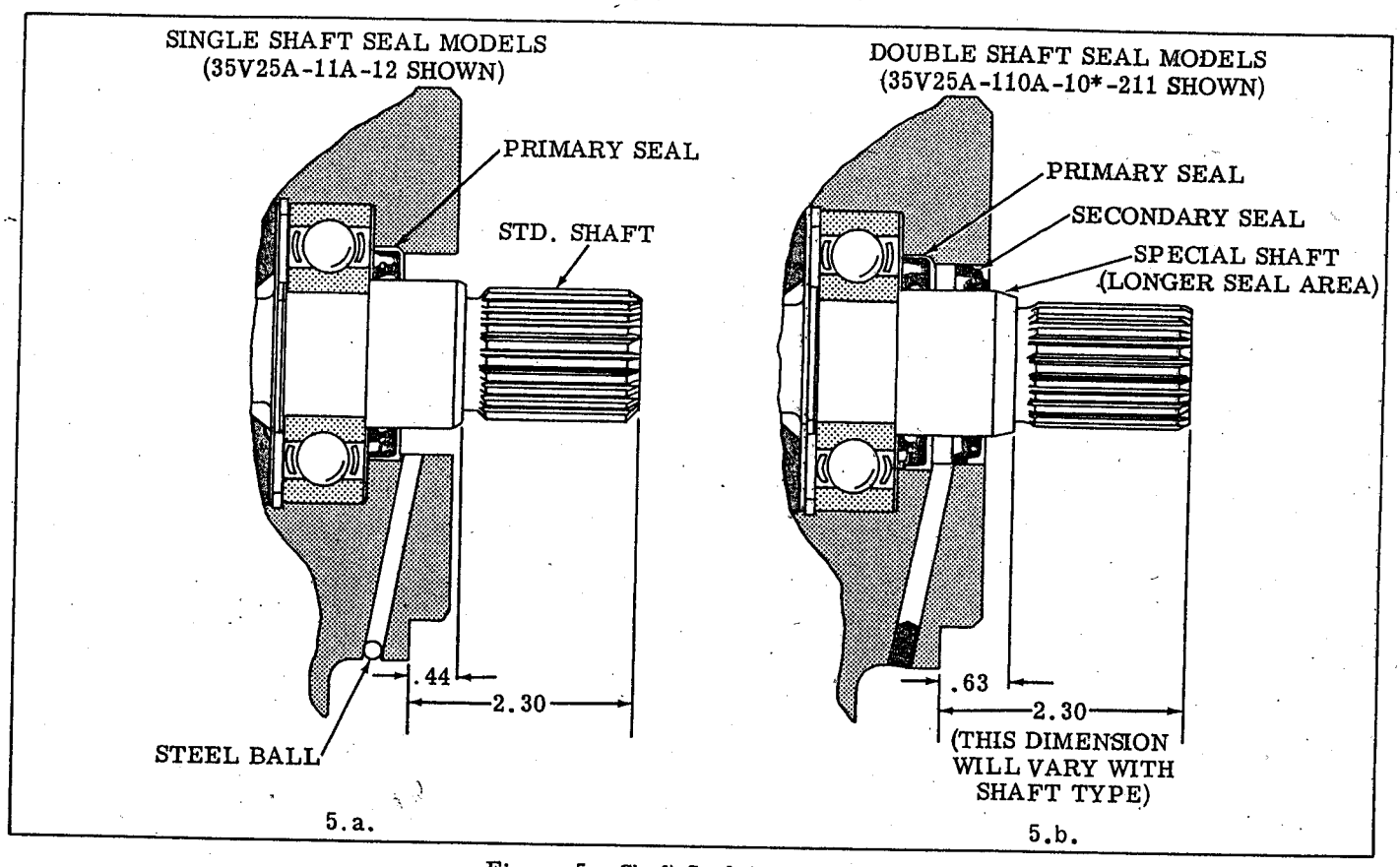

Figure 5. Shaft Seal Arrangement

F. FLOW CONTROL AND RELIEF VALVE.

In **20VQ pump cover end cartridges, it is possible to incorporate a combination flow control and relief valve in a special outlet cover. As shown schematically in Figure 6, this option consists essentially of (1) a flow control orifice in the pressure outlet port, (2) a spring loaded hydrostat spool which functions as a pressure compensator and (3) a spring loaded relief valve poppet, located inside the hydrostat.

1. Flow Control Operation: The light spring shown at the left of the hydrostat in Figure 6, is equivalent to approximately 40 PSI. The hydrostat, because of this spring, operated as a balanced compensating piston, maintaining a constant rate of flow across the flow control orifice.

View "A" shows the condition when the pump is driven slowly and its output is less than the controlled flow rate. Pressure at the pressure port is effective at the spring end of the hydrostat. However, in this condition, there is no pressure differential across the flow control orifice; therefore, pressure is the same at both ends of the hydrostat, and the light spring holds it closed. All of the pump delivery is through the pressure port.

In view "B", the hydrostat is operating as a compensating piston. Pump output is more than the controlled flow rate, resulting in a pressure differential across the flow control orifice. The hydrostat now is balanced between upstream pressure (at the right in the illustration) and the combination of spring force and downstream pressure at the left. It assumes a position which maintains a 40 PSI pressure differential across the flow control orifice. At the same time it throttles pump output in excess of the controlled flow rate to the tank port.

2. Relief Valve Operation: View "C" shows the operation when the preset maximum pressure is reached, as determined by the spring force on the relief valve poppet inside the hydrostat.

Assume the relief valve cracking pressure has been

reached and the poppet is unseated. Fluid will flow from the pressure port, through the sensing orifice, through an opening in the end of the hydrostat, past the poppet to tank. This flow creates a pressure differential across the sensing orifice, which again results in a pressure differential at the two ends of the hydrostat. The hydrostat still operates in balance, but now throttles all the pump output (except as required to maintain system pressure) to tank at the relief valve press setting plus 40 PSI.

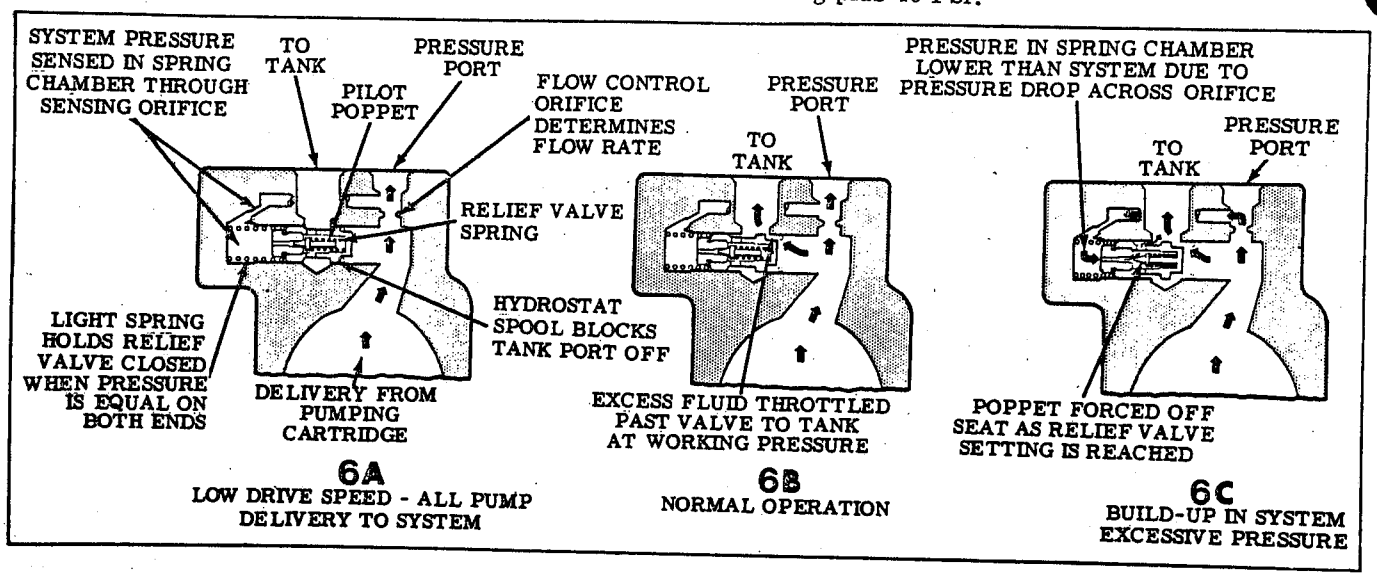

Figure 6. Flow Control and Relief Valve Operation

Section IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

The installation drawings listed in Table 2 show correct installation dimensions and optional port positions.

B. MOUNTING AND DRIVE CONNECTIONS

Vickers high performance VQ series vane pumps are designed for foot or flange mounting.

1. Direct Drive: A pilot on the pump mounting flange (Figure 7) assures correct mounting and shaft alignment, provided the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening all flange mounting screws to prevent misalignment.

If gaskets are used between flanges, they should be installed carefully so as to lie flat and should not be the type that will take a set. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

Proper coupling alignment is essential to prolong pump life.

CAUTION

Pump shafts are designed to be installed in couplings with a slip fit or very light press. Pounding the coupling on the shaft can ruin the bearings. Shaft tolerances are shown on the pump installation drawings. (See Table 2).

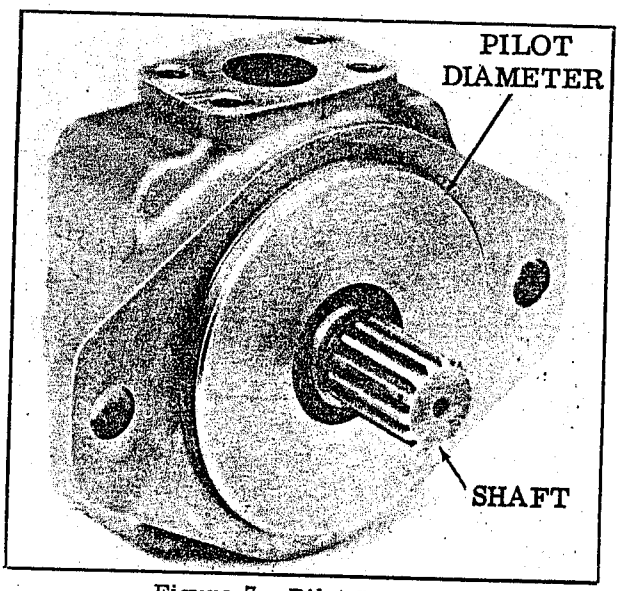

Figure 7. Pilot Diameter

2. Indirect Drive: Indirect drive is not recommended for these pumps.

C. SHAFT ROTATION

NOTE

Pumps are normally assembled for right hand (clockwise) rotation as viewed from the shaft end. A pump made for left hand rotation is identified by an "L" in the model code. (See Table 1.)

NOTE

If it is desired to reverse the direction of drive rotation, it is necessary to disassemble the pump and reverse the location of the cartridge inlet and the outlet support plates. Use rotational arrows on inlet plate for proper screw holes. (See section VI.)

CAUTION

Never drive a pump in the wrong direction of rotation. Scoring may result, necessitating extensive repairs.

D. PIPING AND TUBING.

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wirebrushing, and pickling.

NOTE

For instructions on pickling, refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, use only as many fittings and connections as necessary for proper installation.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

E. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic pumps. Any oil acceptable for use with pumps is acceptable for use with valves or motors.

Data sheets for oil selection are available from Vickers, Technical Publications, Troy, MI. For Mobile applications, order data sheet M-2950-S

The oil recommendations noted in the data sheet are based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers representative.

CLEANLINESS

To insure the hydraulic system is clean:

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

2. Filter each change of oil to prevent introduction of contaminants into the system.

3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

4. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.

5. Proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be overemphasized.

6. Good system and reservoir design will insure that aeration of the oil is kept to a minimum.

SOUND LEVEL

Noise is indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will slow the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir and air will be recycled through the system.

3. Aerated fluid can also be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

4. Contaminated fluids can cause excessive wear of internal pump parts, which may result in increased sound levels.

F. OVERLOAD PROTECTION

Relief valves must be installed in the system as close to the pump outlets as possible. The relief valves limit pressure in each system to a prescribed maximum and protects components from excessive pressure. Each relief valve pressure setting depends on the work requirements of the circuit being fed.

G. PORT POSITIONS

Port positions are shown in Figure 8. Refer to the model code (Table 1) for further information.

H. START-UP

Whenever it is possible to do so, fill the pump ports with system hydraulic fluid. This will make it easier for the pump to prime when it is first started.

Self Priming: With a minimum drive speed of 600 RPM, a pump should prime immediately. Failure to prime within a short length of time may result in damage due to lack of lubrication. Inlet lines must be tight and free from air leaks. However, it may be necessary to loosen a fitting on the outlet side of the pump to purge entrapped air.

No Load Starting: These pumps are designed to start up with no load on the pressure ports. They should never be started against a load or a closed center valve.

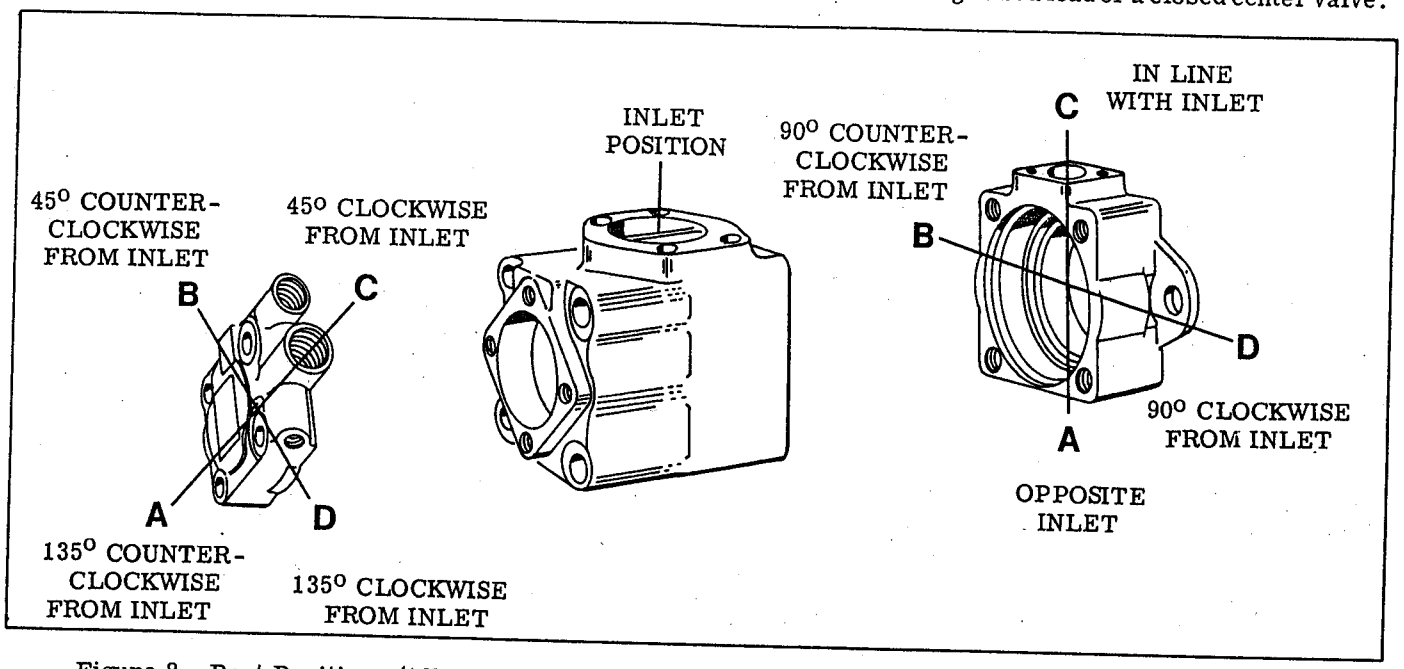

Figure 8. Port Positions (All VQ Series Except 4535VQ). See Model Code for 4535VQ Port Positions.

Section V - SERVICE, INSPECTION & MAINTENANCE

A. SERVICE TOOLS

Two special tools are required to service these pumps. A driver should be used to assure installation of the primary shaft seal without damage, and a "bullet" (or plastic tape) should be placed over the end of the shaft, to avoid damaging the seal lip, when the shaft is installed. Installation of the secondary seal does not require a driver. (See Figure 5)

The driver can be made from tubular stock as shown in Figure 9. The tool applies a uniform pressure to the recessed area of the seal, rather than to the lip of the seal. The inside diameter of the tool will not interfere with the garter spring located around the lip of the seal.

PUMP SERIES	LENGTH "A" (INCHES)	UNDERCUT "B" (INCHES)	O.D. "C" (INCHES)	I.D. "D" (INCHES)
2520VQ	3.500	.281	1.580	1.375
35**VQ	3.500	.331	1.765	1.622
45**VQ	3.750	.375	2.187	1.938

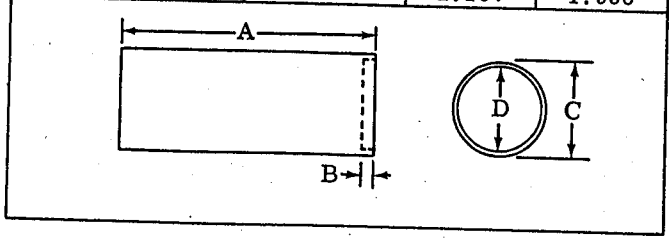

Figure 9. Primary Shaft Seal Driver.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminates. If the fluid becomes contaminated, the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in a partial or complete loss of filtration.

4. Air bubbles in the reservoir can ruin the pump and other components. If bubbles are seen, locate the source of the air and seal the leak. See Table 3.

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	DRIVEN IN THE WRONG DIRECTION OF ROTATION	The drive direction must be changed immediately to prevent seizure. Refer to section VI.D. for the correct ring position for each direction of rotation.
	COUPLING OR SHAFT SHEARED OR DISENGAGED	Disassemble the pump and check the shaft and cartridge for damage. (See Section VI.) Replace the necessary parts.
	FLUID INTAKE PIPE IN RESERVOIR RESTRICTED	Check all strainers and filters for dirt and sludge. Clean if necessary.
	FLUID VISCOSITY TOO HEAVY TO PICK UP PRIME	Completely drain the system. Add new filtered fluid of the proper viscosity.
	AIR LEAKS AT THE INTAKE. PUMP NOT PRIMING.	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening. Check the minimum drive speed which may be too slow to prime the pump.
	RELIEF VALVE STUCK OPEN. (MODELS WITH INTEGRAL RELIEF VALVE ONLY)	Disassemble the pump and wash the valve in clean solvent. Return the valve to its bore and check for any stickiness. A gritty feeling on the valve periphery can be polished with crocus cloth. Do not remove excess material, round off the edges of the lands or attempt to polish the bore. Wash all parts and reassemble the pump.
	VANE(S) STUCK IN THE ROTOR SLOT(S)	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. If necessary, flush the system and refill it with clean fluid.
INSUFFICIENT PRESSURE BUILD-UP	SYSTEM RELIEF VALVE SET TOO LOW	Use a pressure gage to correctly adjust the relief valve.
	LOSS OF FLOW FROM PUMP	Worn pump parts. Broken inlet or pressure line
PUMP MAKING NOISE	PUMP INTAKE PARTIALLY BLOCKED	Service the intake strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	AIR LEAKS AT THE INTAKE OR SHAFT SEAL. (OIL IN RESERVOIR WOULD PROBABLY BE FOAMY)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is above the intake pipe opening.
	PUMP DRIVE SPEED TOO SLOW OR TOO FAST	Operate the pump at the recommended speed.
	COUPLING MISALIGNMENT	Check if the shaft seal bearing or other parts have been damaged. Replace any damaged parts. Realign the coupled shafts.

TABLE 3 - TROUBLE SHOOTING CHART

5. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint from getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of the shaft coupling should be as specified by their manufacturers.

F. REPLACEMENT PARTS.

Reliable operation throughout the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and materials are used in the manufacturer of our parts. Substitutions may result in early failure. Part numbers are shown in the parts drawings listed in Table 2.

G. TROUBLE SHOOTING

Table 3 lists the common difficulties experienced with vane pumps and hydraulic systems. It also indicates the probable causes and remedies for each of the troubles listed.

It should always be remembered that many apparent pump failures are actually due to the failure of other parts of the system. The cause of improper operation is best diagnosed with adequate testing equipment and a thorough understanding of the complete hydraulic system.

Section VI - OVERHAUL

A. GENERAL

During disassembly, pay particular attention to identification of the parts, especially the cartridges, for correct assembly. Figure 10 is an exploded view which shows the proper relationship of parts for disassembly and assembly. Refer to Figure 1 and Figure 10 for the correct assembled relationship of the parts. Various steps in the overhaul process are shown in Figures 11 through 24.

WARNING

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure. Plug all removed units and cap all lines to prevent the entry of dirt into the system.

B. DISASSEMBLY

1. Basic Pump: Remove the foot mounting and shaft key (1) if used. Support the pump on blocks or clamp the body in a vise as shown in Figure 11. If a vise is used, use protective jaws to avoid damage to outlet body (15) and its machined surfaces. Mark the pump inlet, outlet and cover for correct reassembly. Remove the four cover screws (2) and lift cover (3) from the pump. This will expose the cover end cartridge (4). Discard square cut seal (18) and "O"ring (19).

2. Pull or pry cover cartridge (4) from the inlet housing. See Figure 12. Set aside for disassembly during step B.8.

3. Remove four screws (5) from the inlet housing (6). Separate inlet housing (6) and outlet body (15). Refer to Figure 13. This exposes shaft end cartridge (7). Discard square cut seal (18) and "O"ring (19). Refer to Figure 10.

4. Rotate shaft to loosen cartridge (7), then remove the cartridge from outlet body (15). Set aside for disassembly during step B.8.

5. Remove spirolox ring (8). Slide shaft (9) and bearing (12) from outlet body (15).

6. If bearing (12) is defective, remove retaining ring (11) and press bearing from the shaft with an arbor press. (Apply force to inner race of bearing).

NOTE

In the following step, secondary shaft seal (13) is used on double shaft seal models only and will not exist on standard units. See Table 1 and Figure 4.

7. Remove spacer (10) from the outlet body, then drive shaft seal (13) and (14) from the outlet body (15). Be careful not to damage the bore areas where the seals were located.

8. Disassemble the two cartridge kits one at a time. Follow the procedure noted in this step. Keep the parts separated from each other during inspection, repair, and assembly.

a. Remove "O"ring (17), back-up ring (16) and square sealing ring (18) from the outlet support plate.

b. Scribe a line across the outer surface of the cartridge kit. See Figure 14. The scribe marking will provide a reference for parts during assembly.

c. Place the cartridge on a flat surface (outlet support plate down) and remove the two socket head screws (20). See Figures 10 and 15.

CAUTION

DO NOT slide flex plates across the ring and rotor. Burrs on the ring or rotor can cause deep scratches in the soft bronze surface.

d. Slide inlet support plate (21) and seal pack subassemblies (22) off the cartridge. DO NOT allow the flex side plate (23) to slide with the support plate. See Figures 10 and 15.

e. Move flex side plate (23) off center just enough to lift up and away without sliding. See Figures 10 and 16.

f. Place a small clean piece of wood over the exposed ring and rotor. Reverse the position of the cartridge as shown in Figure 17.

g. Slide outlet support plate (24) and seal pack subassemblies (25) off flex side plate (26). DO NOT permit flex side plate (26) to move across the ring and rotor. See Figures 10 and 18.

h. Move flex side plate (26) off center just enough to lift up and away without sliding. See Figures 10 and 19.

i. Lift ring (27) away from the rotor (28) and vanes (29). Locate the arrow stamped into the rotor periphery. Remove the vanes and inserts in order, starting at the arrow. Keep them in order for inspection. See Figures 10 and 20.

NOTE

Do not remove cartridge locating pins (30) from the inlet support plate unless they are damaged. The pins are of a drive-loc type and can be difficult to remove.

NOTE

The following step concerns disassembly of the flow control cover used on **20VQ models. Refer to Figure 10. Omit this step if a standard cover is used.

j. Disassemble the flow control cover as follows:

1. Remove plug (31) and spring (32) from cover (3).
2. Remove plug (33) from the opposite end of the bore. DO NOT remove retaining ring (34) unless damaged.
3. Slide flow control and relief valve subassembly (35) from cover (3).

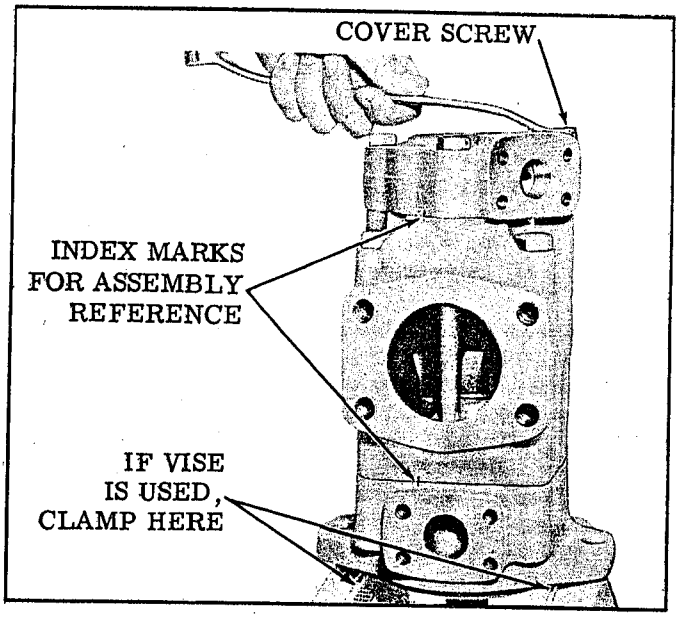

Figure 11. Removal of Cover Screws

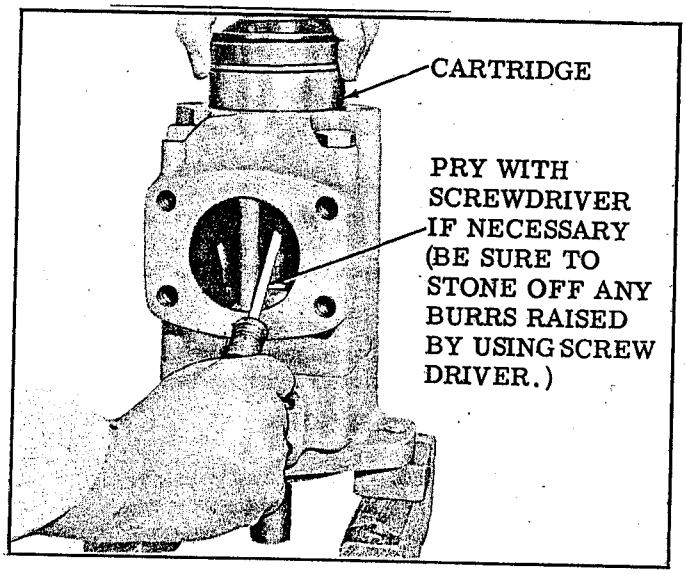

Figure 12. Removal of Cover End Cartridge

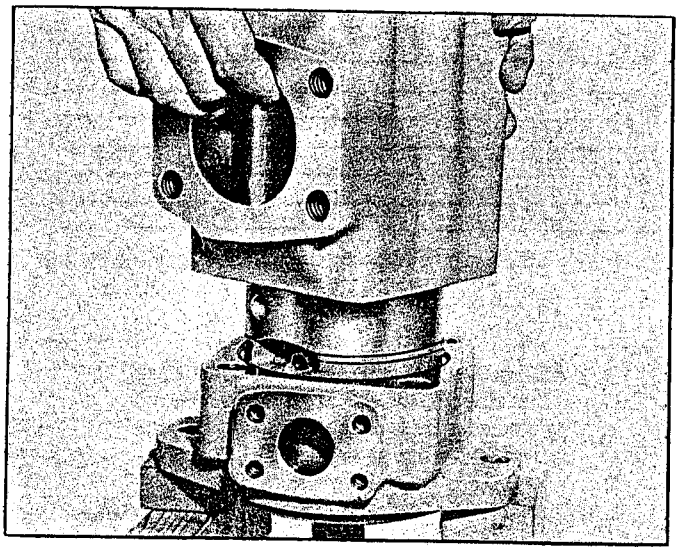

Figure 13. Removing Inlet Housing From Outlet Body

C. INSPECTION AND REPAIR

Cleaning: All parts must be throughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important. Clean all removed parts, using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination.

Discard the shaft seal(s), "O"rings, back-up ring, and seal pack subassemblies. Use a new seal kit for reassembly. Refer to parts drawings noted in Table 2 for kit numbers. Wash the metal parts, blow them dry with air, and place on a clean surface for inspection.

1. Check the cartridge wear surfaces for pickup, scoring and excessive wear. Slight heat discoloration of the flex side plate bronze surface is normal. Score marks deeper than 0.001 inch and scratches deeper than 0.002 inch indicate a new part is needed. Slight scoring and/or scratches can be removed with an oiled Arkansas stone.

CAUTION

DO NOT use a dry stone on the bronze surface or scratches will result.

2. Inspect both sides of each vane (29) and insert in order. If pickup, heavy wear, or scoring is found, inspect the appropriate rotor (28) slot. Replace scored parts. Refer to the parts drawings noted in Table 2 for part numbers.

3. Inspect ring (27) for vane chatter marks, wear and/or scratches. Replace if scoring is evident.

CAUTION

Replacement ring width must be identical to the ring being replaced or reduced life and/or output flow will result. The minimum ring to rotor clearance limits are noted in Table 4.

Model	Min. Clearance limit in inches
**20VQ	0.0007
**25VQ	0.0012
**35VQ	0.0015
25**VQ	0.0012
35**VQ	0.0015
45**VQ	0.0016

Table 4. Minimum Allowable Ring Rotor Clearance

NOTE

All cartridge kit parts must be free of burrs. Stone the mating surfaces of each part with an oiled Arkansas stone prior to assembly.

4. Vane to rotor wear can be checked by inserting the vane in the rotor slot and checking for excessive play. Replace rotor (28) and vanes (29) if wear is evident.

5. Rotate bearing (12) while applying pressure to check for wear, looseness and pitted or cracked races.

6. Inspect the seal and bushing mating surfaces on shaft (9) for scoring or wear. Replace the shaft if wear exceeds 0.005 diametrical change, or if marks cannot be removed by light polishing. If wear is found in the bushing area, a new bushing will be required.

NOTE

The following step concerns inspection of flow control cover parts. Omit if a standard cover is used.

7. Inspect flow control cover parts as follows:

a. Inspect the flow control valve bore located within cover (3) for wear, pitting, and burrs. If retaining ring (34) was removed, replace with a new part before proceeding. Use the flow control and relief valve subassembly (35) to check fit. Rotate the subassembly through 360° while moving it within the bore to check for bind. If the subassembly hangs up or binds, remove and stone the external surface lightly with 500 grit polishing paper or an oiled Arkansas stone. DO NOT round off sharp edges of the lands. Replace both the cover and flow control/relief valve if wear or bind is evident and cannot be repaired.

b. Inspect spring (32) for wear and squareness of the ends. Roll on a flat surface to check deformity of the spring. Replace spring if it does not pass these tests.

c. Inspect threaded holes in cover and threads on the plugs for a cross thread condition, burrs, etc. Replace the plugs or cover if defective.

D. ASSEMBLY

CAUTION

DO NOT DISASSEMBLE THE FLOW CONTROL/RELIEF VALVE SUBASSEMBLY. The subassembly is factory set and if disassembled may malfunction and cause bodily harm. If the valve subassembly is defective, replace with a new Flow Control/Relief Valve subassembly. Refer to Table 2 for parts information sheets.

NOTE

Coat all parts except seals and back-up rings with clean hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold the "o"rings in place during assembly.

IMPORTANT

During handling and shipping of precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges of new cartridge kit should be stoned prior to installation.

NOTE

To reverse direction of a new cartridge kit, simply reverse location of the inlet and outlet support plates, and realign the cartridge with a "V" block or fixture made from two pieces of hardwood nailed together as shown in Figure 24.

1. Cartridge: The direction of rotation is viewed from the shaft end; right hand rotation is clockwise; left hand counterclockwise.

NOTE

Assemble shaft end cartridge (7) in the direction of rotation noted by model code. See Table 1. Assemble cover end cartridge (4) in reverse of the shaft end cartridge. Ex. 2520VQ Right Hand Unit: Assemble shaft end cartridge for right hand rotation and cover end cartridge for left hand rotation.

NOTE

If locating pins (30) were removed from inlet support plate (21), install new pins with locking flutes located within the inlet support plate. Drive the new pins into the support plate, with a soft tip hammer.

a. Place the inlet and outlet support plates on a flat surface as shown in Figure 21. Install seal pack subassemblies (22 and 25) into cavities with seal retainer surface up. ("O" Rings facing downward into the cavities).

b. Place flex side plates (23 and 26) over each of the support plates with bronze wear surface facing up. Align scribe marks to make sure the correct flex side plate is used with the correct support plate. (Bronze wear surface must face rotor when assembled)

NOTE

Flex side plates develop a wear pattern with the rotor and vanes and should not be interchanged.

c. For right hand rotation units, set the rotor on a flat wooden board with the arrow pointing right. (For left hand rotation, the arrow should point left). Assemble the vanes and inserts into the rotor in reverse order. See Figure 20. Make sure the sharp chamfer edge of each vane leads in the direction of rotation. All vanes must move freely in the rotor slots with no evidence of bind.

d. Assemble the ring (27) over rotor (28) and vanes (29) with arrow pointing in the same direction as the rotor. Lubricate the top surface of the rotor and vanes liberally with system fluid.

e. Locate the scribe mark on ring (27), outlet support plate (24), and flex side plate (26). Hold the outlet support plate and flex side plate together and assemble over the ring and rotor with the scribe marks in-line.

f. Hold the cartridge together to prevent movement and turn the assembly over so the outlet support plate rests on a flat surface, and the wooden board is up. See Figure 22. Remove the wooden board.

g. Lubricate the exposed surface of the rotor and vanes with system fluid. Locate the scribe mark on inlet support plate (21) and flex side plate (23). Hold the inlet support plate and flex side plate together and assemble over the exposed ring, rotor and vanes. Make sure the scribe marks are in line. See Figure 23.

NOTE

The cast-in arrows located next to the socket head screws, indicate cartridge direction of rotation.

h. Thread two socket head screws (20) into the cartridge until snug (hand tight).

NOTE

The O.D. of all component parts of the cartridge kit must be in-line with each other or the cartridge will bind during assembly. Align the cartridge as follows:

i. Build a "V" block from hardwood (See Figure 24) or if a metal "V" block is available, use that. Place the cartridge into the "V" block on its side. Loosen socket head screws (20) enough to allow each section of the cartridge to come into alignment within the "V" block. Torque tighten socket head screws (20) as noted in Table 5. Recheck alignment after tightening.

CARTRIDGE SIZE	CARTRIDGE SCREW TORQUE
20	35 lb. in.
25	50 lb. in.
35	100 lb. in.
45	100 lb. in.

Table 5. Cartridge Screw Torque Requirements.

j. Check rotor (28) for bind by inserting the index finger through the shaft opening of inlet support plate (21). Hold the cartridge kit in a horizontal shaft position and lift the rotor with the finger. The rotor should move freely back and forth within the cartridge. If the rotor binds, open the kit, clean and stone all possible areas of bind, then reassemble using the aforementioned procedure. The rotor MUST move freely within the cartridge when assembled.

NOTE

Repeat step D.1. for the other cartridge kit.

2. Basic Pump: Clamp outlet body (15) in a vise or place on 2 x 4 wood blocks to facilitate assembly. See Figures 11 and 12.

a. Lubricate primary shaft seal (14) with petroleum jelly and place in position within outlet body (15), garter spring up. See Figure 5 for seal arrangements.

b. Use the seal installation tool shown in Figure 9 to prevent damage to the seal. Press seal (14) into the body until it bottoms out against the shoulder.

NOTE

Two shaft seal arrangements are available in the VQ pump series. See Figure 5 and Table 1. If the pump model code (Table 1) indicates that a secondary seal is required, perform following step.

c. Lubricate secondary seal (13) with petroleum jelly and place the seal in position against the shaft end of the body. See Figure 5.b. Use a small hardwood block to drive the seal evenly into the body. Installation is complete when the seal face is flush with the front of the body. DO NOT drive the seal past flush as it can block the body drain opening.

NOTE

If shaft bearing (12) was defective, install a new bearing as follows:

d. Press shaft (9) into the new bearing with an arbor press while supporting the bearing inner race. Refer to Figures 5 and 10 for correct location of bearing on the shaft. Install a small retaining ring (11) behind the bearing on the shaft.

e. Place the bearing spacer washer (10) over the shaft, against the front of the bearing. Use a "bullet" or plastic tape over the shaft end to prevent damage to the seal(s). Lubricate the "bullet" with petroleum jelly and carefully push the shaft through the seal(s) until the bearing and spacer are in location within the body. Install the large spirolox ring (8) into the outlet body retaining ring groove located just behind the bearing.

f. Install square cut sealing ring (18) into outlet body (15). See Figures 4 and 10 for location.

g. Install "o"ring (17) and back-up ring (16) on the cartridge outlet support plate hub. Refer to Figure 10.

h. Carefully install cartridge (7) over shaft (9) and into outlet body (15) with one of the chamfers on the ring in alignment with the outlet port.

i. Lubricate and install the large inlet housing (6) to outlet body (15) "o"ring (19) in place. (Locate in the "o"ring groove of the outlet body).

j. Install inlet housing (6) in position; move back and forth until the cartridge pins drop into the alignment holes located within the housing. Turn the inlet housing slightly until the alignment marks are in line and the large screw holes are aligned. Oil and install four screws (5) and torque tighten to the values indicated in Table 6. (All models except 4535VQ. 4535VQ screws will be installed later.)

MODEL	SCREW TORQUE
2520VQ	65-75 lb. ft.
3520VQ	140-160 lb. ft.
3525VQ	140-160 lb. ft.
4520VQ	255-275 lb. ft.
4525VQ	255-275 lb. ft.

Table 6. Inlet Housing to Outlet Body Attaching Screw Torque.

k. Turn pump shaft by hand to verify freedom of the cartridge.

l. Install a square sealing ring (18) into the outlet cover (3). Refer to Figures 4 and 10 for location.

m. Install "o"ring (17) and back-up ring (16) on the cover end cartridge outlet support plate hub. Refer to Figure 10.

n. Carefully install cartridge (4) over shaft (9) and into the inlet housing. Turn cartridge slightly to bring into alignment the pin holes and cartridge alignment pins.

o. Install outlet cover (3) to inlet housing (6) "o"ring seal (19) over the cartridge and up against the inlet housing.

p. Make sure square cut seal is in place within the cover. Orient the cover to agree with the alignment marks and gently slide the cover over the outlet cartridge. Be careful not to cut square cut seal (18) or pinch "o"ring (19) during cover installation.

q. Oil and install the cover inlet housing with four screws (2). Torque the screws to the value indicated in Table 7.

MODEL	COVER SCREW TORQUE
2520VQ	40-50 lb. ft.
3520VQ	40-50 lb. ft.
3525VQ	65-75 lb. ft.
4520VQ	40-50 lb. ft.
4525VQ	65-75 lb. ft.
4535VQ	255-275 lb. ft.
(NOTE: The 4535VQ unit should align all sections of the pump and torque screws to the value shown.)	

Table 7. Outlet Cover to Inlet Housing Attaching Screw Torque.

r. Turn the pump shaft to verify freedom of the cartridges.

NOTE

Units with a flow control cover will perform the following step. Omit this step if a standard cover is used.

3. Assemble the flow control cover parts as follows:

CAUTION

The hex end of Flow Control/Relief Valve must face the outside of cover (3) toward plug (31).

a. Lubricate and install flow control/relief valve subassembly (35) into cover (3) bore as shown in Figure 10.

b. Assemble spring over hex head of valve (35) and then oil and thread plug (31) loosely in the cover See Figure 10.

c. Thread plug (33) into outlet cover (3). Oil and torque to 45-50 lb. ft.

d. Torque plug (31) to 45-50 lb. ft.

Section VIII - TESTING

If test equipment is available, the pump should be tested at the recommended speeds and pressures shown on the installation drawing. See Table 2.

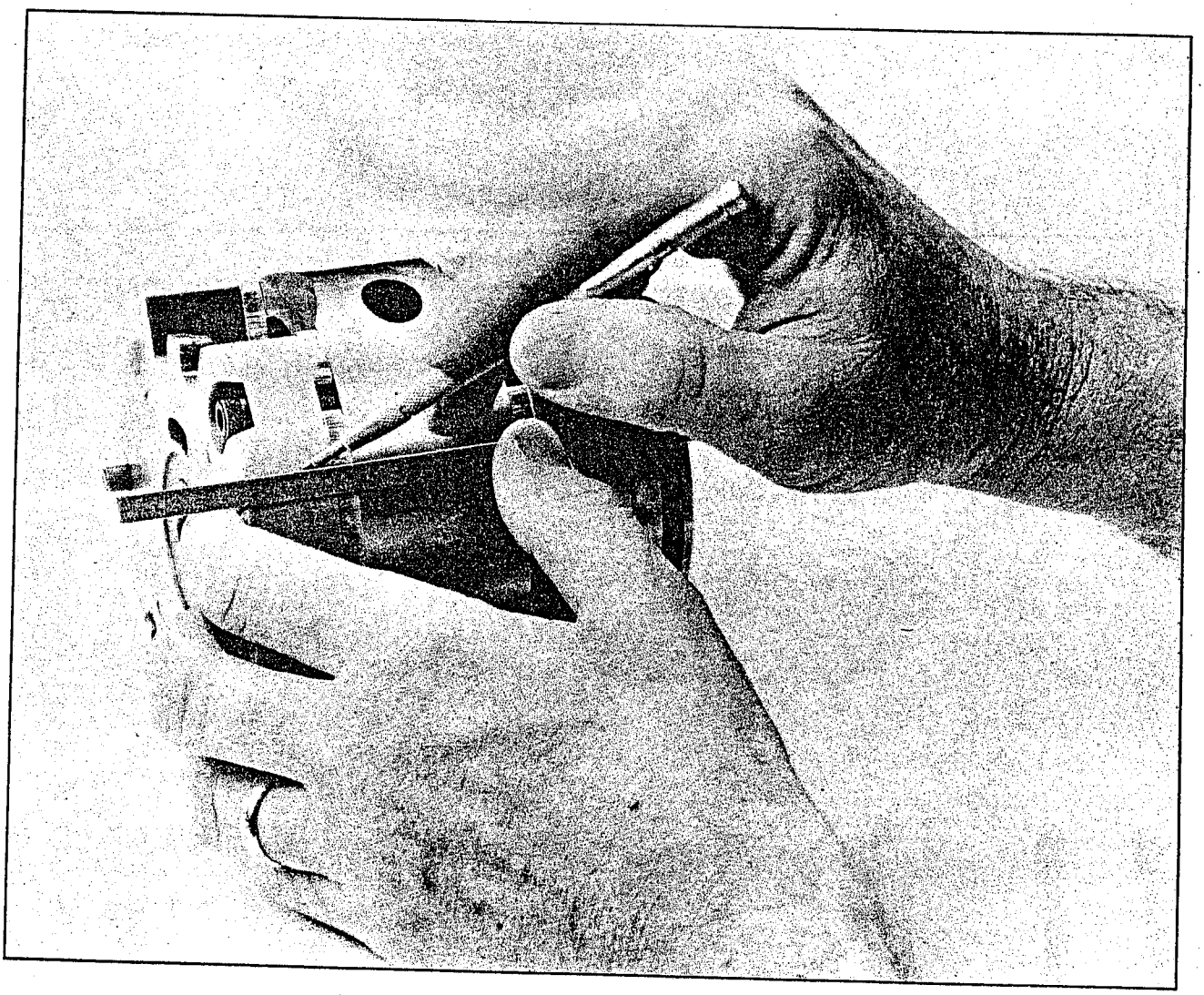

Figure 14. Scribing the Cartridge

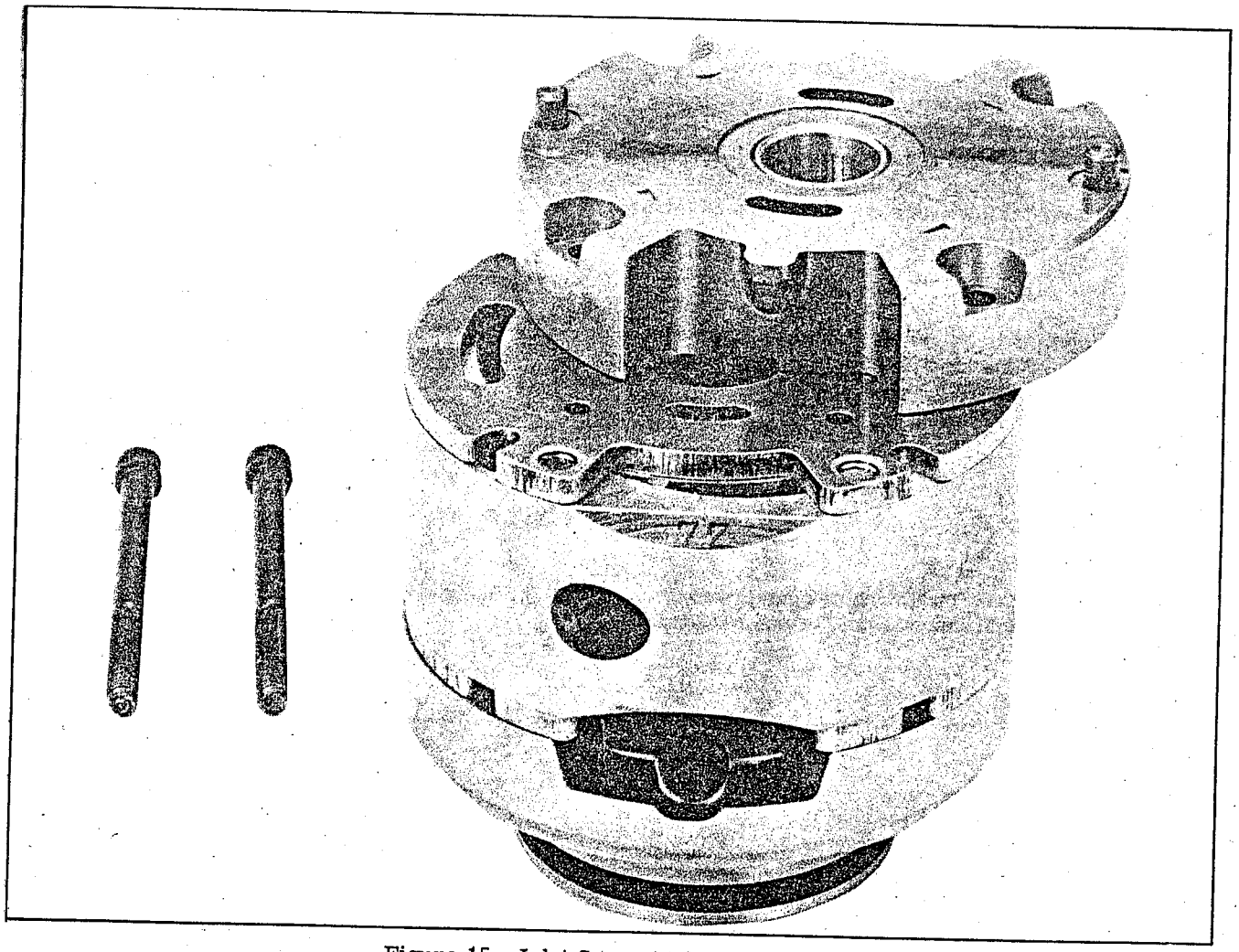

Figure 15. Inlet Support Plate Removal

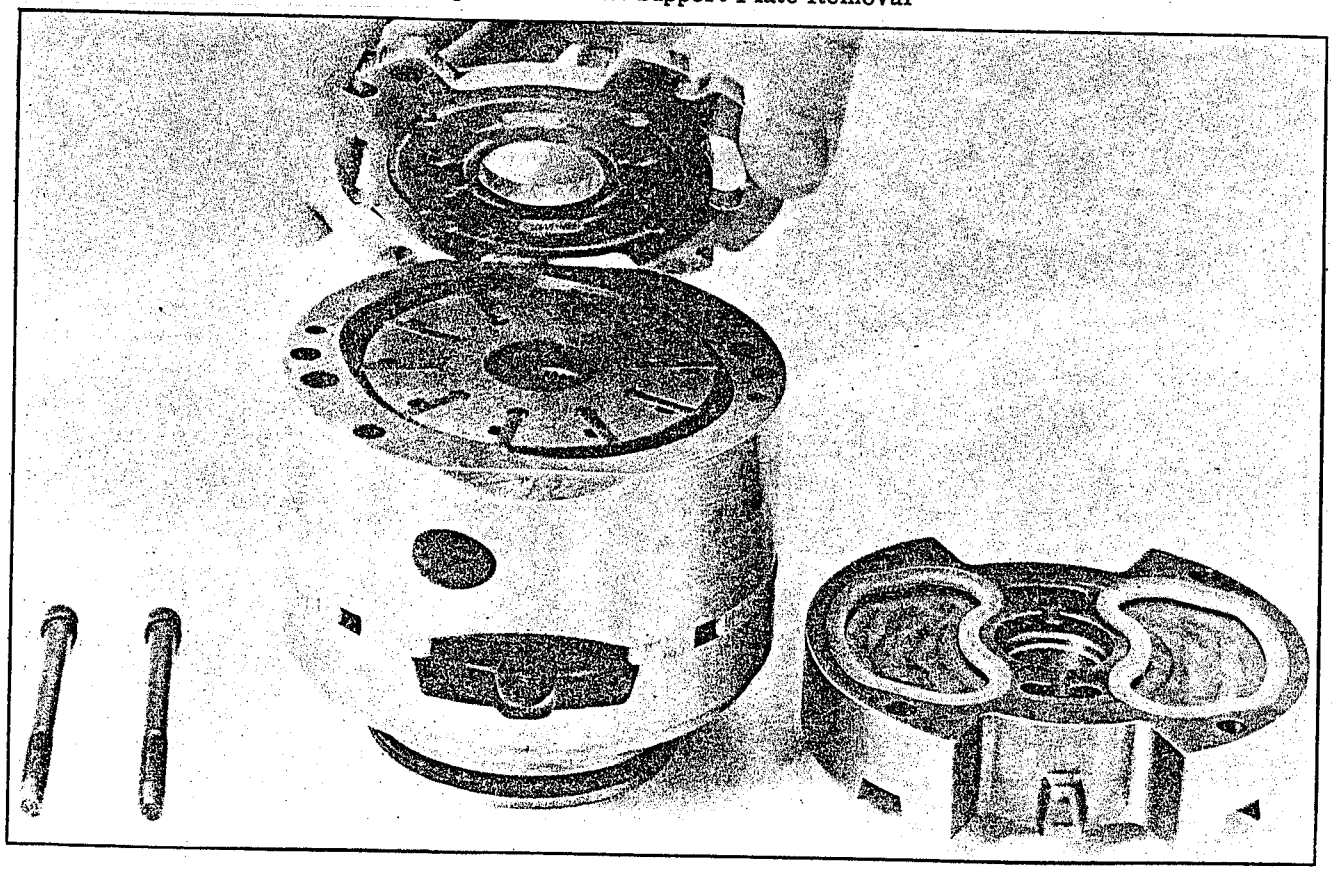

Figure 16. Inlet Flex Side Plate Removal

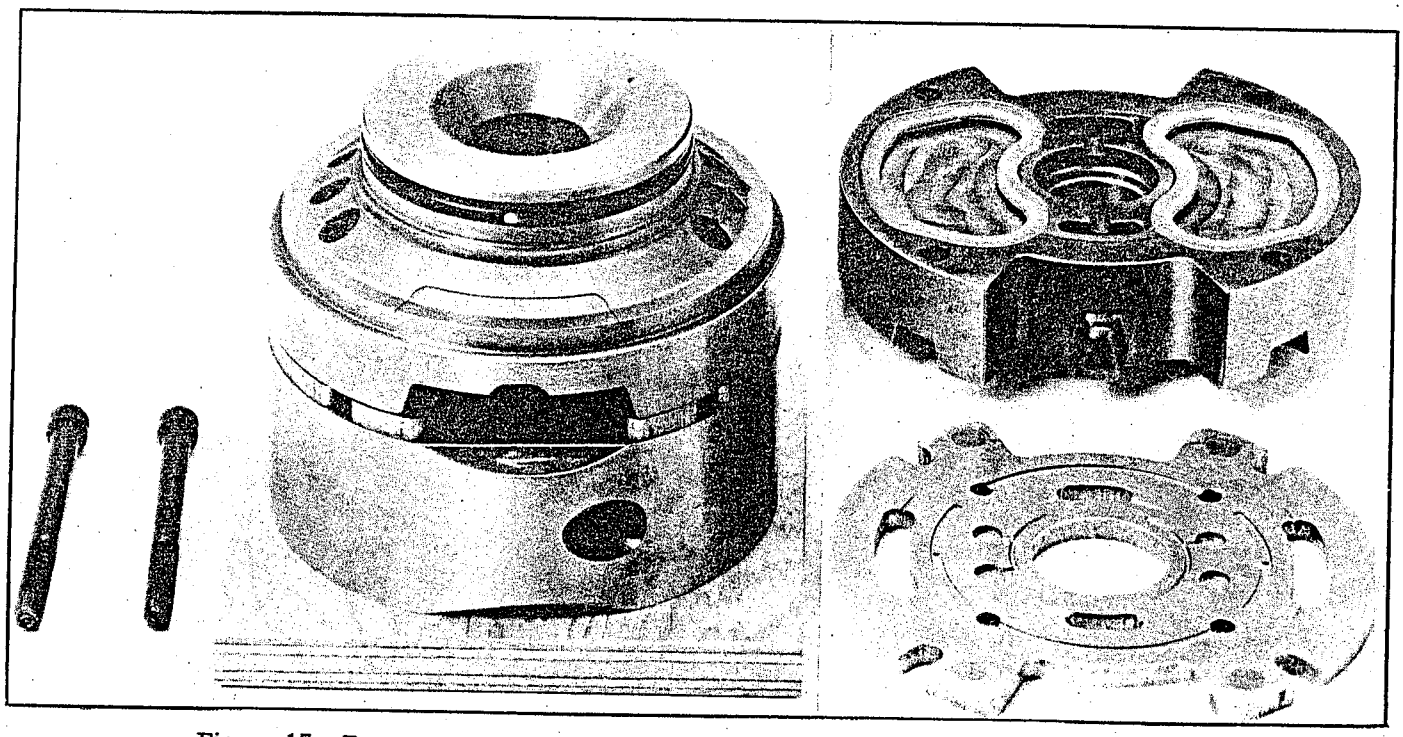

Figure 17. Reverse Cartridge, Use A Piece of Wood to Hold Ring, Rotor and Vanes

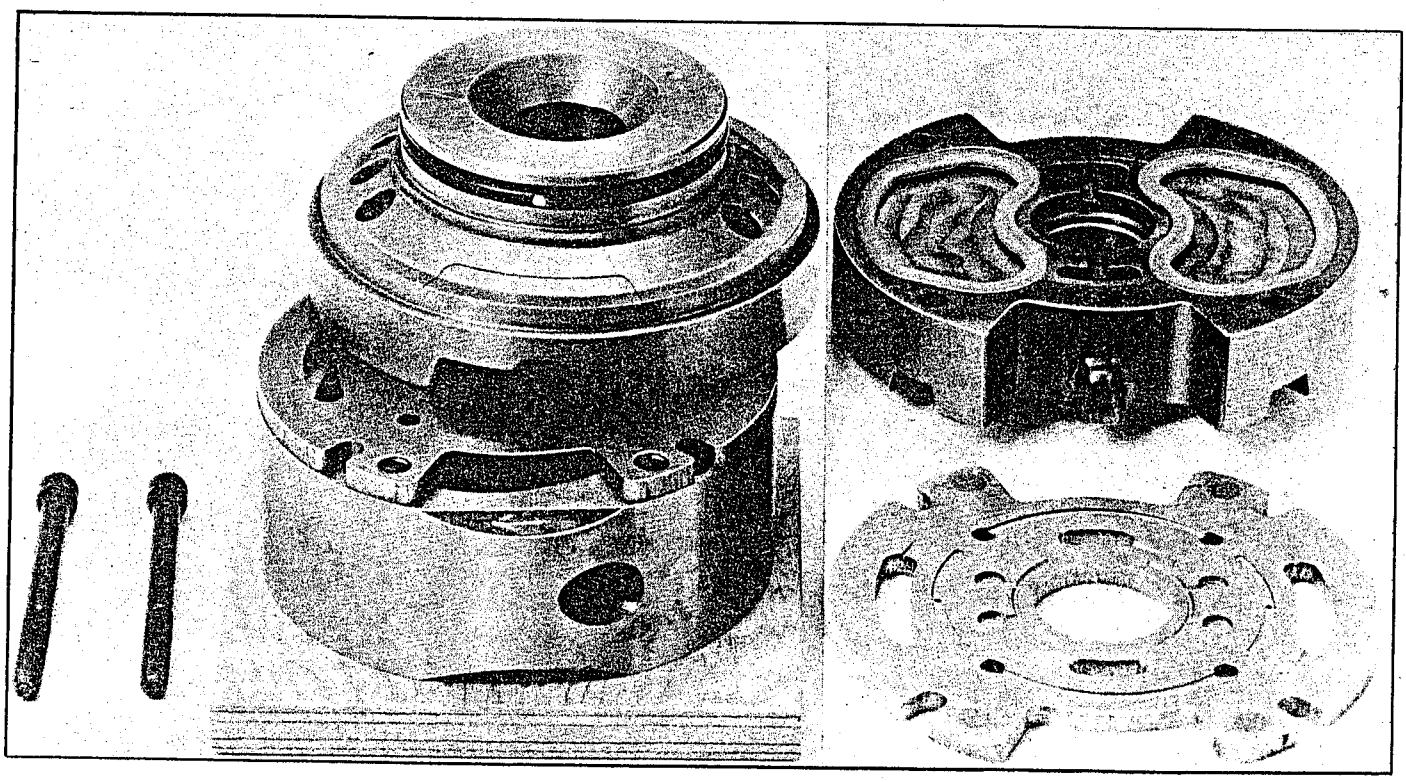

Figure 18. Outlet Support Plate Removal

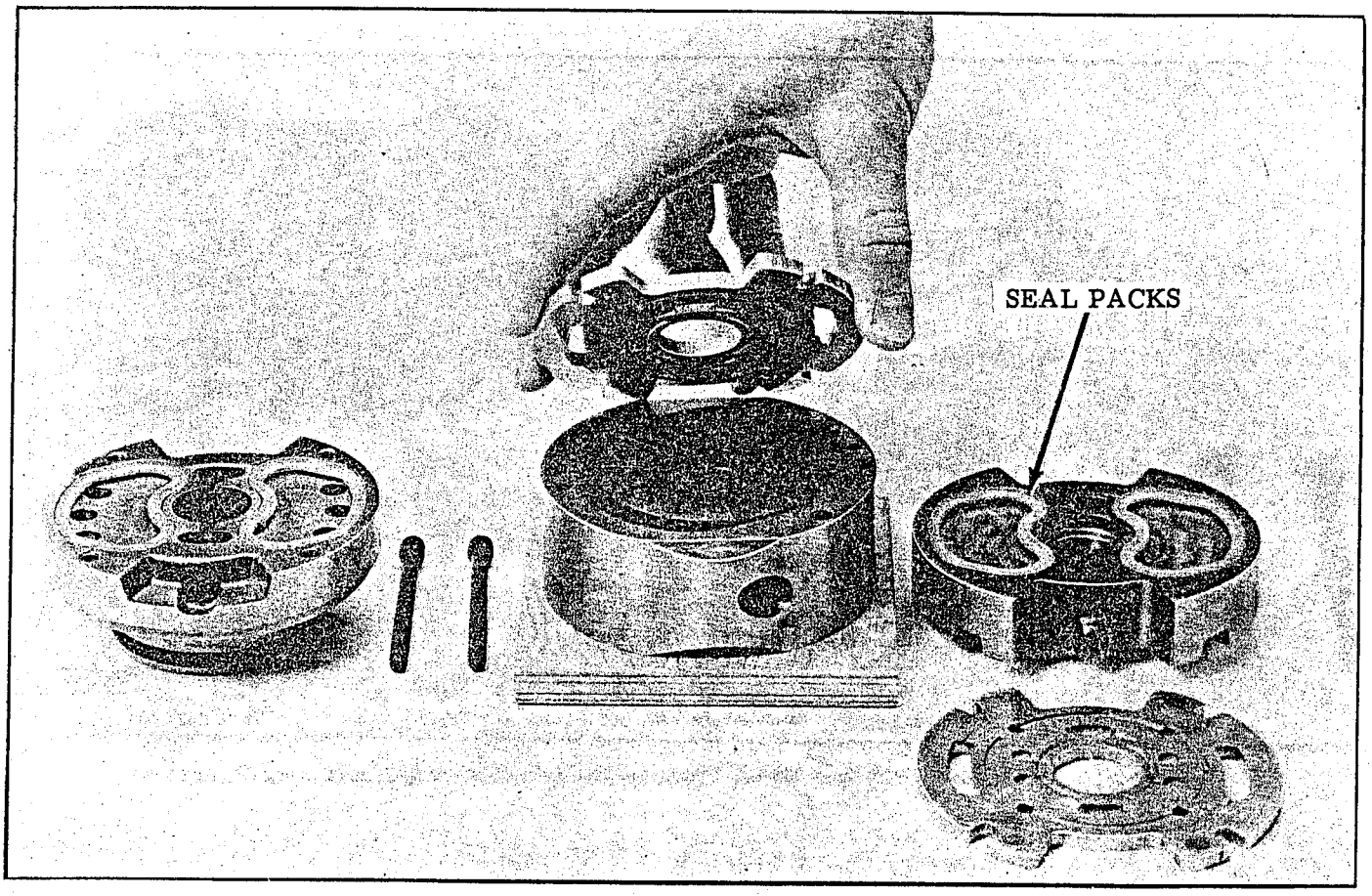

Figure 19. Outlet Flex Side Plate Removal

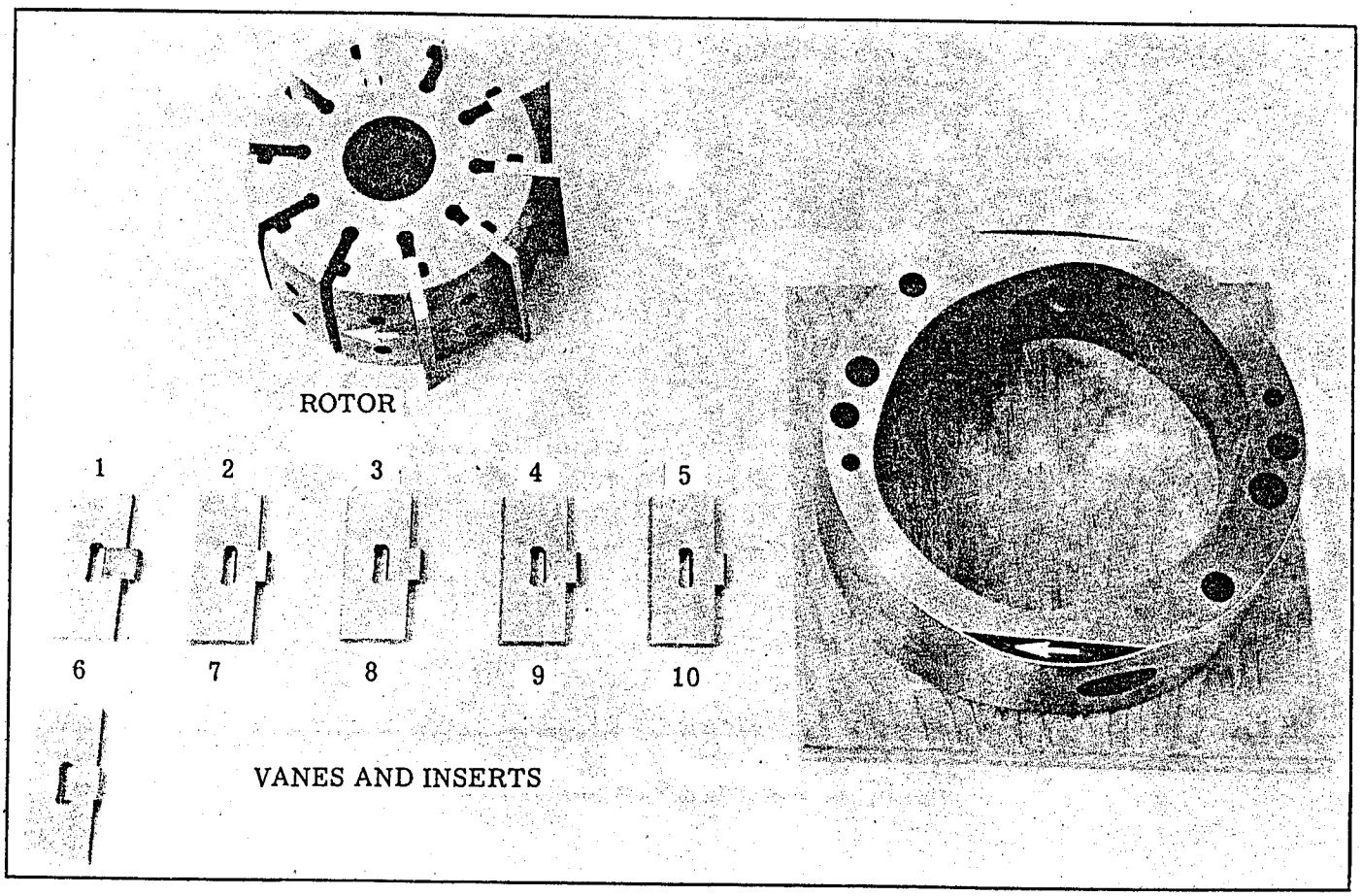

Figure 20. Sequential Removal of Vanes from Rotor. Starting at Arrow on Rotor.

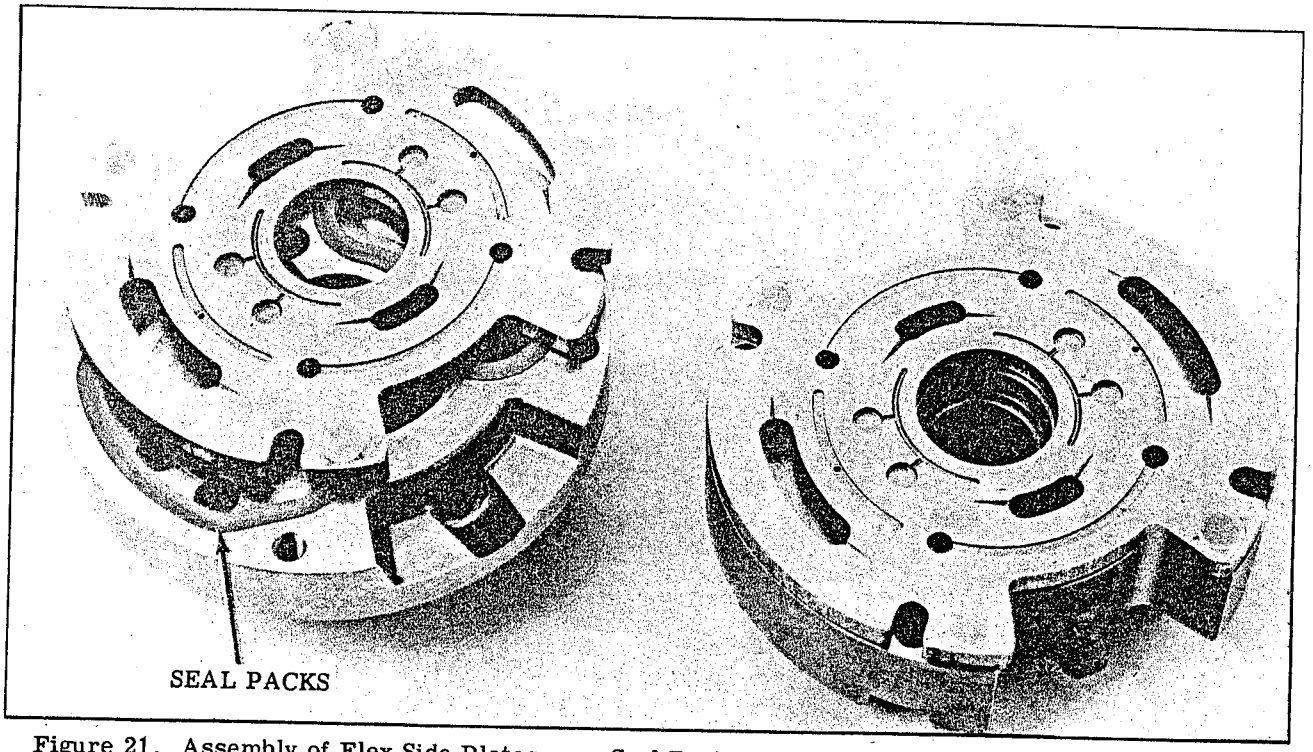

Figure 21. Assembly of Flex Side Plates over Seal Packs onto the Inlet and Outlet Support Plates.

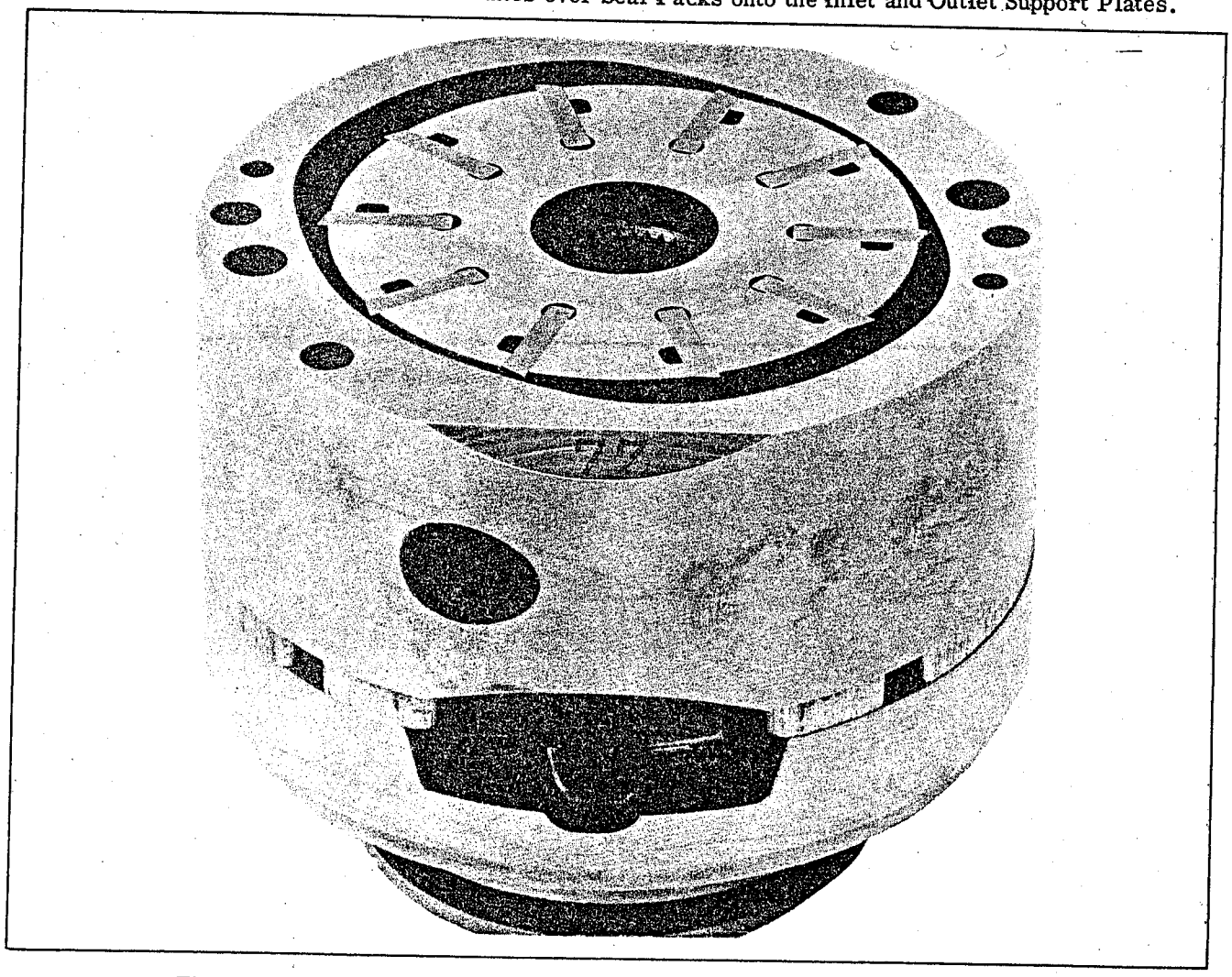

Figure 22. Outlet Support Plate and Flex Side Plate Assembled to Cartridge. Ready for Installation of Inlet Support Plate and Flex Side Plate.

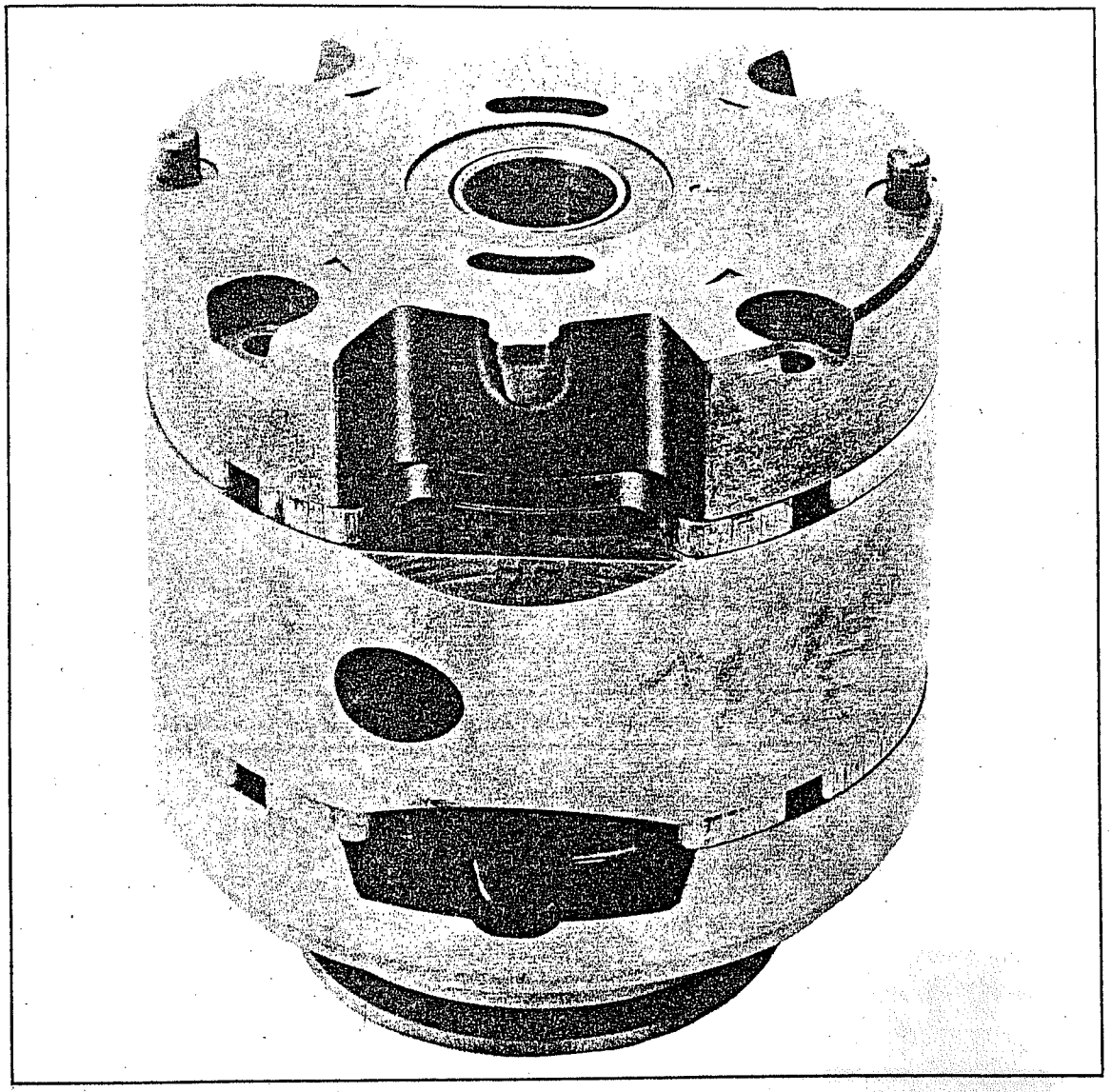

Figure 23. Cartridge ready for Installation of Socket Head Screws.

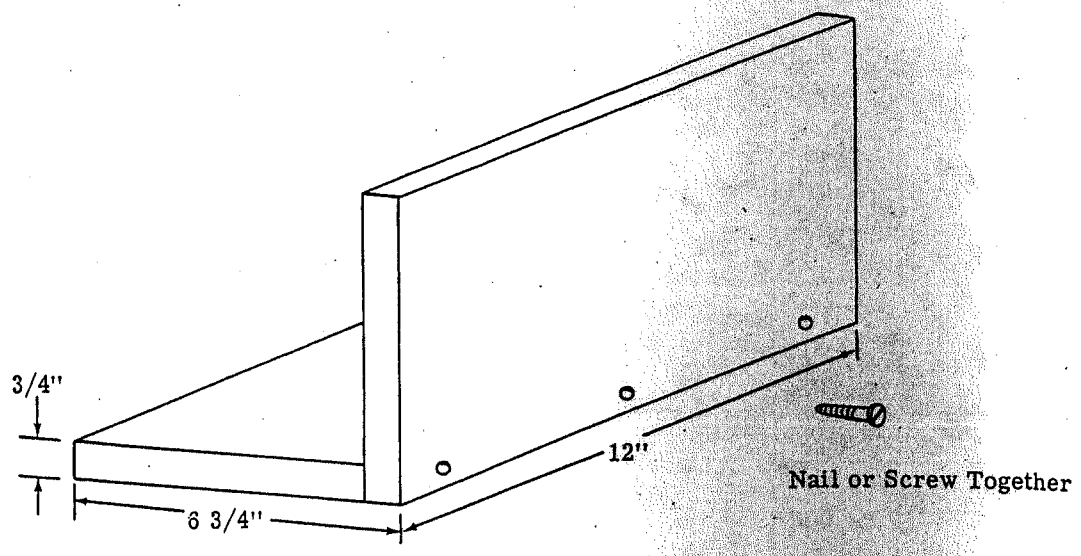

Figure 24. Home Made "V" Block for Alignment of Pump Cartridge Kit.
(Use clean wood with a smooth finish surface)