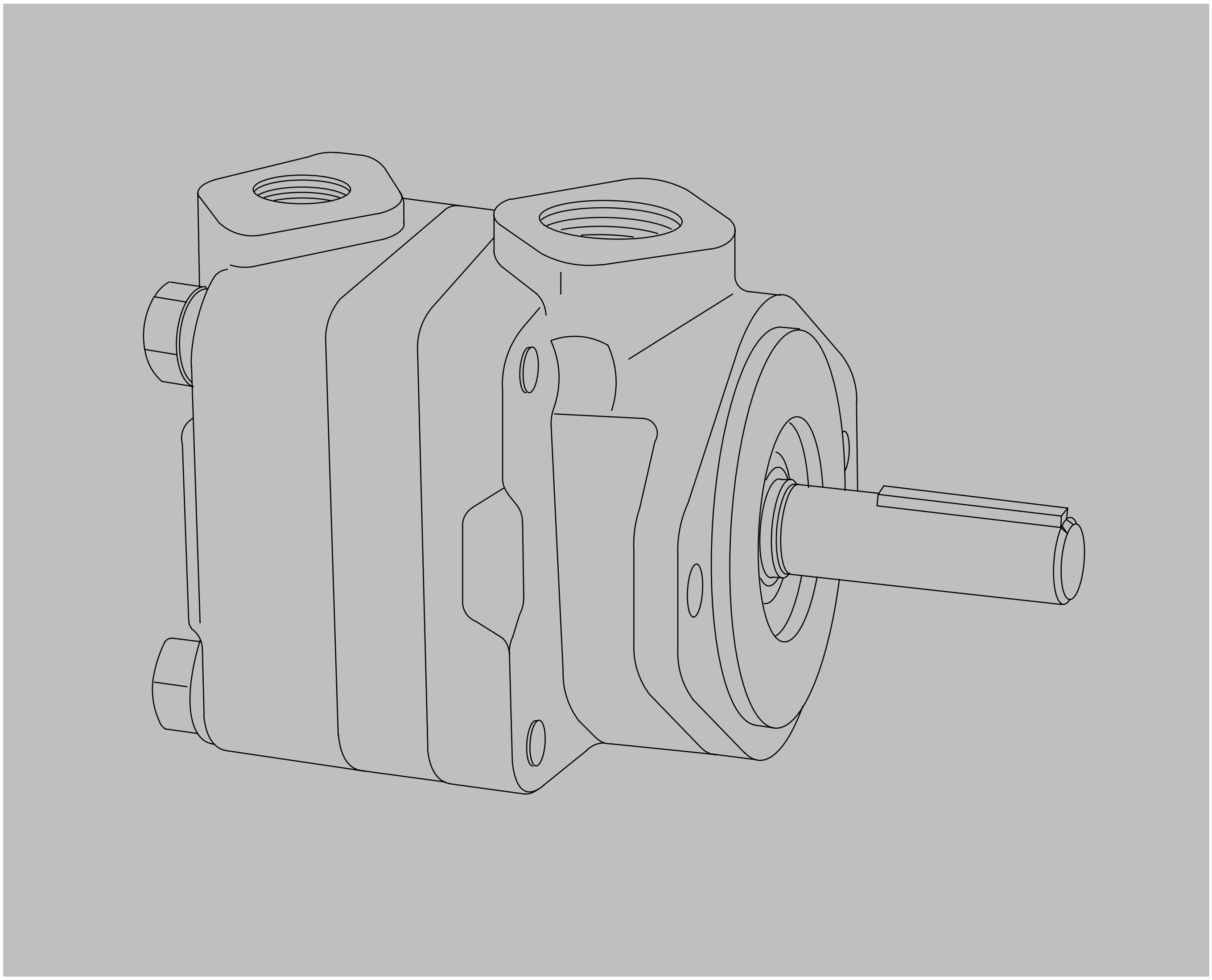
Overhaul Manual

Vickers®

Vane Pumps

Vane Pumps

V100, V200, V300, V400
V500 and V2P Series



VICKERS

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M–2000–S

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Section I – Introduction

A. Purpose of Manual

This manual has been prepared to assist the users of Vickers balanced vane type hydraulic single pumps in properly installing, maintaining and repairing their units. In the sections which follow, the single pumps are described in detail, their theory of operation is discussed and instructions are given for their proper installation, maintenance and overhaul.

The general series of models covered are V100, V200, V300, V400, V500 and V2P. The information given applies to the latest design configuration listed in Table 1. Earlier designs are covered only insofar as they are similar to the present equipment.

B. General Information

Related Publications – Service parts information and installation dimensions are not contained in this manual. The parts catalogs and installation drawings listed in Table 1 are available from Vickers.

Model Codes – There are many variations within each basic model series, which are covered by variables in the model code. Table 2 is a complete breakdown of the code covering these units. Service inquiries should always include the complete unit model number, which is stamped on the pump cover.

Model Series	Design No. (See Table 2)	Parts Catalog	Installation Drawing
V100	–10	M-2031-S	M-152060
V200	–12	M-2032-S	M-190082
V300	–11	M-2033-S	M-128797
V400			M-127065
V500	–10	M-1262-S	M-236696
V2P	–10	M-2002-S	M-289405

Table 1. Parts Catalogs and Installation Drawings

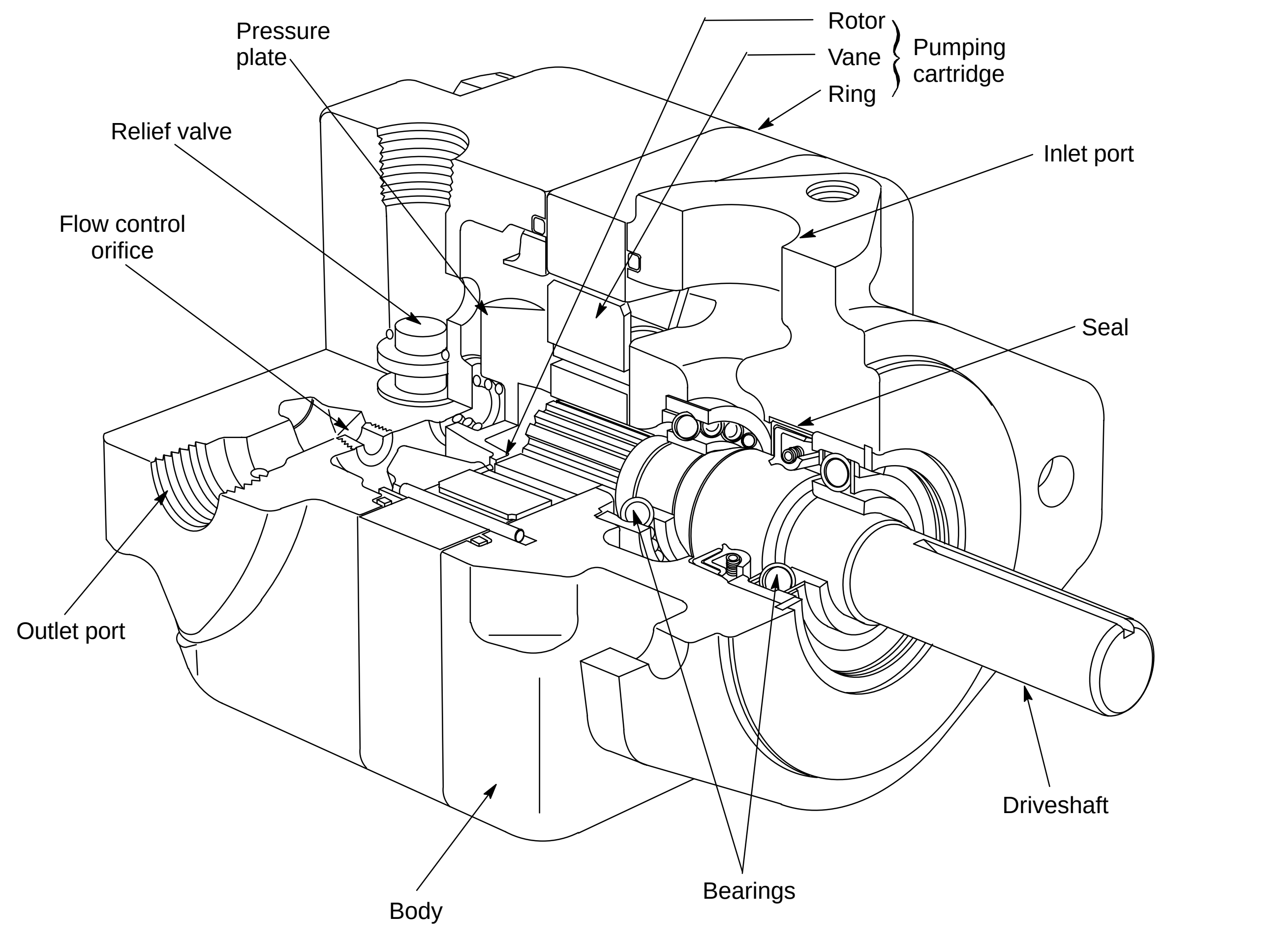


Figure 1.

Model Code

V 2 1 0 - 8 W - 1 F C - C 8 - 12 - L - *

(1) V, (2) 2, (3) 1, (4) 0, (5) 8, (6) W, (7) 1, (8) F, (9) C, (10) C, (11) 8, (12) 12, (13) L, (14) *

1 **Vane pump**

2 **Series**

3 **Body Type**

1 – Standard Threaded
2 – Standard Flange
3 – Face Threaded
4 – Face Flange
5 – Tapped Foot Threaded

4 **Mounting**

0 – None
4 – Foot
5 – Flange
7 – Power Take-off

5 **Capacity in GPM** (@ 1200 RPM)

6 **Wide Ring** (V200 only)

7 **Shaft Type**

1 – Straight with Square Key
3 – Threaded
6 – Straight Stub with Woodruff Key
7 – Six-tooth Spline
11 – Splined
24 – Tang Drive
34 – Woodruff Key Threaded (Special)
37 – InvoluteSpline (Special)

8 **Connection Flanges Supplied**

9 **Port Positions** (see Figure 6)

10 **Relief Valve Setting** (V200 only)

C – 750 PSI
D – 1000 PSI
E – 1250 PSI
F – 1500 PSI
G – 1750 PSI
H – 2000 PSI

11 **Controlled Flow Rate (GPM)** (V200 only)

12 **Design**

13 **Optional Left Hand Rotation**

14 **Special Features**

Table 2

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 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.

B. Assembly and Construction

The V200 series pump illustrated in the cutaway in Figure 1 is representative of all single pumps in this series. The unit consists principally of a ported body and cover, a drive shaft supported by two ball bearings, a pumping cartridge and a pressure plate. Components of the pumping cartridge are an elliptical cam ring, a slotted rotor splined to the drive shaft and twelve vanes fitted to the rotor slots.

As the rotor is driven by the driveshaft, the vanes generate fluid flow by carrying fluid around the elliptical ring contour (see Section III). Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate to the outlet port in the cover.

C. Flow Control and Relief Valve

V200 pumps are available with an integral flow control and relief valve in the pump cover. This limits the final flow in the system to a maximum prescribed rate and prevents excessive pressure buildup. Fluid not required in the system is recirculated to tank.

D. Application

Pump ratings in GPM as shown in the model coding are at 1200 RPM. For ratings at other speeds, methods of installation and other application information, Vickers application enginering personnel should be consulted.

Section III – Principles of Operation

A. Pumping Cartridge

As mentioned in Section II, fluid flow is developed by the pumping cartridge. The action of the cartridge is illustrated in Figure 2. The rotor is driven within the cam ring by the driveshaft, which is coupled to a power source. As the rotor turns, centrifugal force causes the vanes to follow the elliptical inner surface of the cam 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 cam ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher.)

This fluid is trapped between the vanes and carried past the large diameter or dwell section of the cam ring. As the outlet section is approached, the cam ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the cam ring during normal operation.

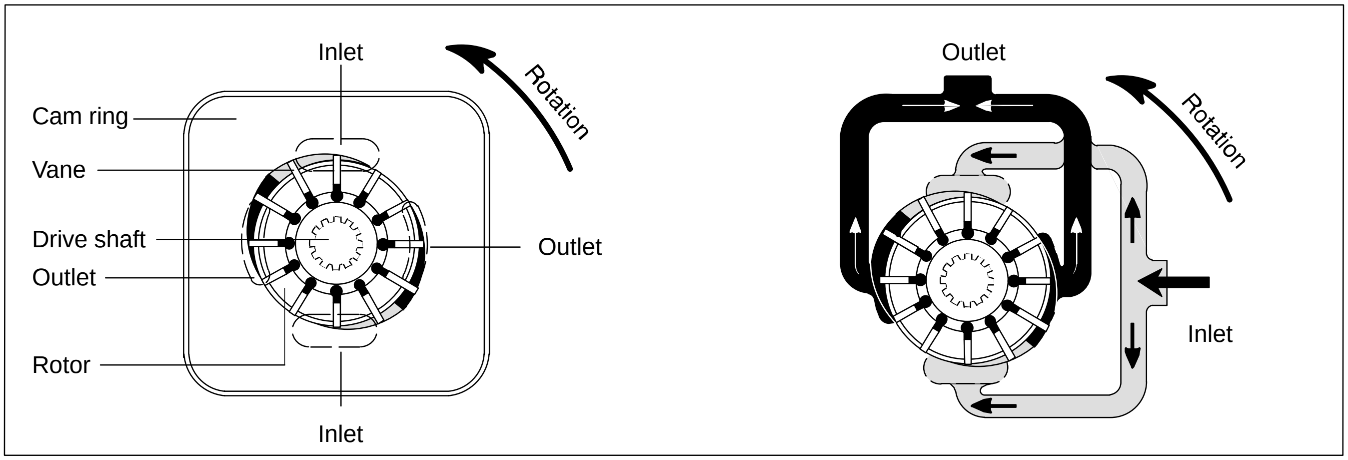


Figure 2.

B. Hydraulic Balance

The pump cam ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft are cancelled.

C. Pressure Plate

The pressure plate seals the pumping chamber as shown in Figure 3. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

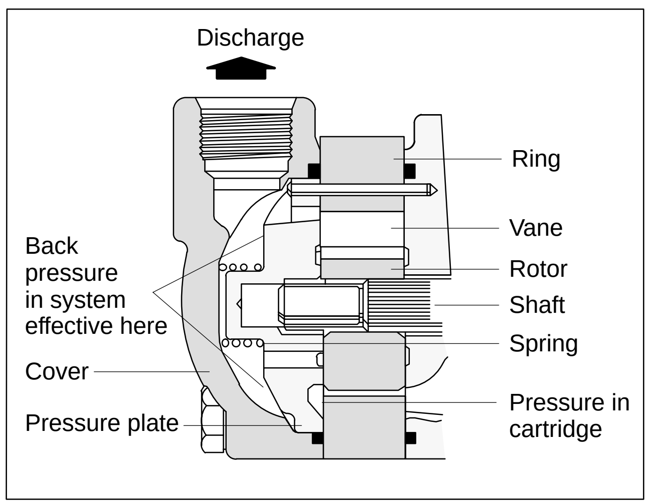


Figure 3.

D. Flow Control and Relief Valve

1. Maximum flow to the operating circuit and maximum system pressure are determined by the integral flow control and relief valve in a special outlet cover used on some V200 pumps. This feature is illustrated pictorially in Figure 4. An orifice in the cover limits maximum flow. A pilot operated type relief valve shifts to divert excess fluid delivery to tank, thus limiting the system pressure to a predetermined maximum.

2. Figure 4A shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure plus spring load in this chamber slightly exceeds pressure at the other end of the relief valve spool and the spool remains closed. Pump delivery is blocked from the tank port by the spool land.

3. When pump delivery is more than the flow rate determined by the orifice plug, pressure builds up across the orifice and forces the spool open against the light spring. Excess fluid is throttled past the spool to the tank port as shown in Figure 4B.

4. If pressure in the system builds up to the relief valve setting (Figure 4C), the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to tank. This flow causes a pressure differential on the spool, shifting it against the light spring. All pump delivery is thus permitted to flow to tank.

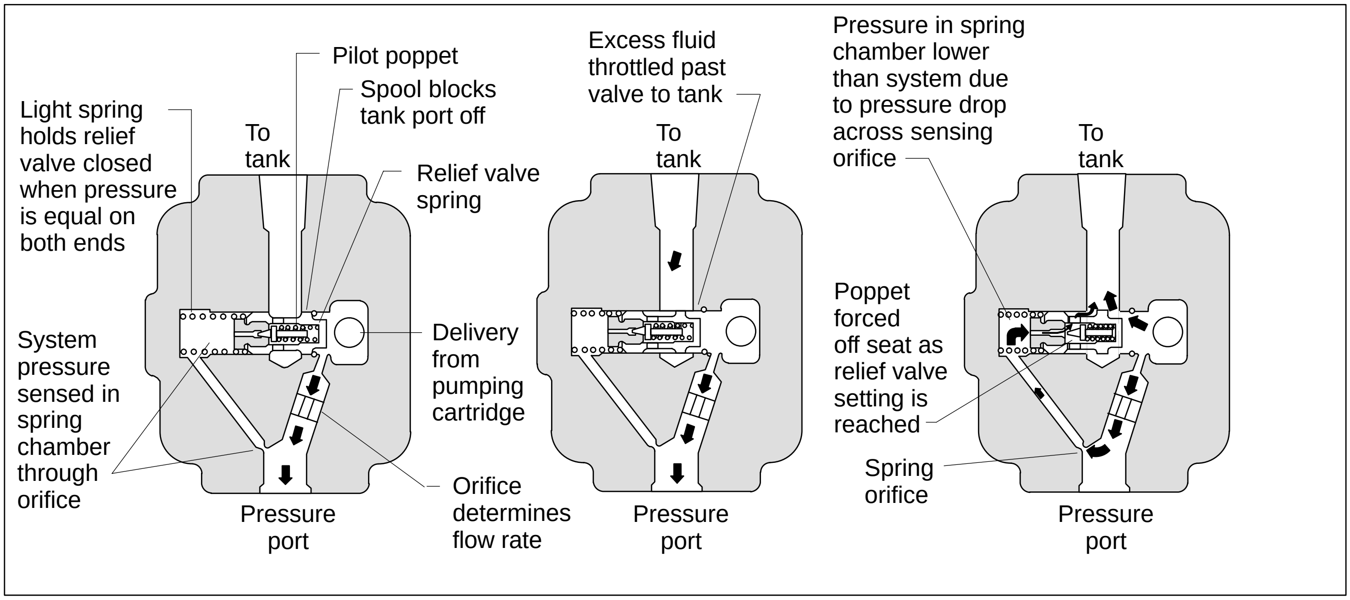


Figure 4A
Low Drive Speed – All Pump Delivery to System

Figure 4B
Normal Operation

Figure 4C
Excessive Pressure Build-Up in System

Section IV – Installation and Operating Instructions

A. Installation Drawings

The Installation Drawings listed in Table 1 show the correct installation dimensions and port locations.

B. Drive Connections

CAUTION

Pump shafts are designed to be installed in couplings, pulley, etc., with a slip fit or very tight tap. Pounding can injure the bearings. Shaft tolerances are shown on pump installation drawings. (See Table 1.)

1. Direct Mounting – A pilot on the pump mounting flange (Figure 5) assures correct mounting and shaft alignment. Make sure the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening the mounting screws to prevent misalignment.

If gaskets are used, they should be installed carefully and should lay flat. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

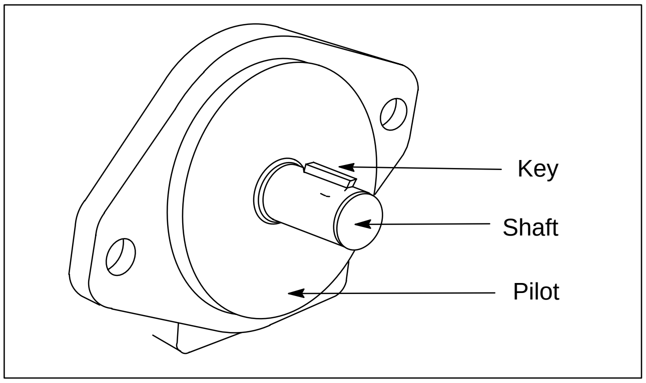


Figure 5

2. Indirect Drive – Chain, spur gear or v-belt pulley drives may also be used with these pumps. Flat belt drives are not recommended because of the possibility of slipping.

To prevent excessive side loads on pump bearings, it is important to check for correct alightment and guard against excessive belt or chain tension.

C. Shaft Rotation

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 2).

NOTE

These pumps must be driven in the direction of the arrows cast on the pump ring. If it is desired to change the direction of drive rotation, it is necessary to reverse the ring (see Section VI, B–D and Figure 9).

CAUTION

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

D. Piping and Tubing

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sand blasting, wire brushing and pickling.

NOTE

For instructions on pickling refer to instruction sheet M-9600.

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

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. Recommended radius for bends is three times the inside diameter of the tube.

E. Hydraulic Fluid Recommendations

Fluid 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 fluid assures satisfactory life and operation of system components with particular emphasis on hydraulic pumps. Any fluid selected for use with pumps is acceptable for use with valves or motors.

Three important factors in selecting an oil are:

1. <u>Viscosity</u> – Viscosity is the measure of fluidity. In addition to dynamic lubricating properties, oil must have sufficient body to provide adequate sealing effect between working parts of pumps, valves, cylinders and motors, but not enough to cause pump cavitation or sluggish valve action.

Optimum operating viscosity of the oil should be between 80 SSU and 180 SSU. During sustained high temperature operation viscosity should not fall below 60 SSU.

2. <u>Viscosity Index</u> – Viscosity index reflects the way viscosity changes with temperature. The smaller the viscosity change, the higher the viscosity index. The viscosity index of hydraulic system oil should not be less than 90. Multiple viscosity oils, such as SAE 10W-30, incorporate additives to improve viscosity index (polymer thickened). Oils of this type generally exhibit both temporary and permanent decrease in viscosity due to the oil shear encountered in the operating hydraulic system. Accordingly, when such oils are selected, it is desirable to use those with high shear stability to insure that viscosity remains within recommended limits.

3. <u>Additives</u> – Research has developed a number of additive agents which materially improve various characteristics of oil for hydraulic systems. These additives are selected to reduce wear, increase chemical stability, inhibit corrosion and depress the pour point. The most desirable oils for hydraulic service contain higher amounts of antiwear compounding.

Suitable types of oil are:

1. <u>Crankcase Oil</u> meeting API service classification MS (most severe). The MS classification is the key to proper selection of crankcase oils for Mobile hydraulic systems.

2. <u>Antiwear Type Hydraulic Oil</u> – There is no common designation for oils of this type. However, they are produced by all major oil suppliers and provide the antiwear qualities of MS crankcase oils.

3. Certain other types of petroleum oils are suitable for Mobile hydraulic service if they meet the following provisions:

a. Contain the type and content of antiwear compounding fould in MS crankcase oils or have passed pump tests similar to those used in developing the antiwear type hydraulic oils.

b. Meet the viscosity recommendations shown in Table 3.

c. Have sufficient chemical stability for Mobile hydraulic system service.

The following types of oil are suitable if they meet the above three provisions:

– Series 3 Diesel Engine Oil
– Automatic Transmission Fluid Types A, F and DEXRON
– Hydraulic Transmission Fluid Types C-1 and C-2

Table 3 summarizes oil types recommended for use with Vickers equipment in Mobile hydraulic systems by viscosity and service classification.

Hydraulic System Operating Temperature Range (Min.* to Max.)	SAE Viscosity Designation	American Petroleum Institute (API) Service Classification
0°F to 180°F	10W	MS
0°F to 210°F	10W-30**	MS
50°F to 210°F	20-20W	MS

* Ambient start-up temperature
** See paragraph on Viscosity Index

Table 3. Oil Recommendations

The temperatures shown in Table 3 are cold start-up to maximum operating. Suitable start-up procedures must be followed to insure adequate lubrication during system warm-up.

Arctic conditions represent a specialized field where extensive use is made of heating equipment before starting. If necessary, this, and judicious use of SAE 5W or SAE 5W-20 oil in line with the viscosity guide lines shown in the table, may be used. Dilution of SAE 10W (SM) oil with maximum of 20% by volume of kerosene or low temperature diesel fuel is permissible. During cold start-up, avoid high speed operation of hydraulic system components until the system is warmed up to provide adequate lubrication. Operating temperature should be closely monitored to avoid exceeding a temperature of 130°F with any of these light weight or diluted oils.

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

Cleanliness

Thorough precautions should always be observed 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.

5. During usage, proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be over emphasized.

F. Overload Protection

A relief valve must be installed in the system, unless it is an integral part of the pump. The relief valve limits pressure in the system to a prescribed maximum and protects the component from excessive pressure. The setting of the relief valve depends on the work requirements of the system and the maximum pressure ratings of the system components.

G. Port Positions

The pump cover can be assembled in four positions with respect to the body. A letter in the model code (Table 2) identifies the cover position as shown in Figure 6.

Disassembly and assembly procedures are in Section VI, B and D.

H. Start-Up

With a minimum drive speed of 600 RPM, a pump should prime almost immediately, if provision is made to initially purge the air from the system. Failure to prime within a reasonable 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 crack a fitting on the outlet side of the pump to purge entrapped air.

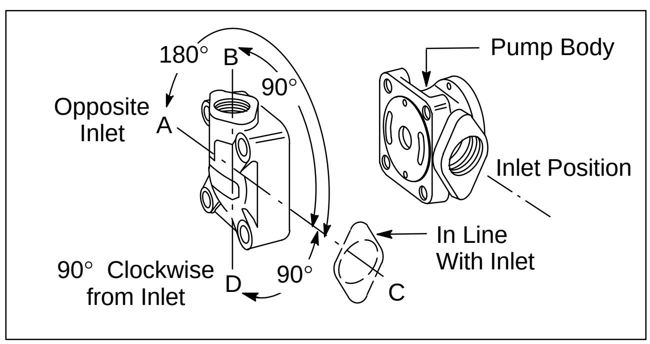


Figure 6.

Section V – Service, Inspection and Maintenance

A. Service Tools

No special tools are required to service these pumps.

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 contaminants. If the fluid becomes contaminated, the system should be 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. 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 the system, it should always be poured through a fine wire screen, 200 mesh or finer.

It is important that the fluid be kept clean and free from any substance that may cause improper operation or wear to the pump and other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint from entering 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 couplings should be as specified by their manufacturers.

F. Replacement Parts

Reliable operation throughout the specified operating range is assured only if genuine parts are used. Sophisticated design process and material are used in the manufacture of our parts. Substitutes may result in early failure. Part numbers are shown in Table 1.

G. Product Life

The longevity of these products is dependent upon environment, duty cycle, operating parameters and system cleanliness. Since these parameters vary from application to application, the ultimate user must determine and establish the periodic maintenance required to maximize life and detect potential component failure.

H. Troubleshooting

Table 4 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 the failures 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.

Troubleshooting

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. Figure 9 shows 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 part 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.
	Worn parts causing internal leakage of pump delivery	Replace pump cartridge.
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 drain 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.

Figure 4. Troubleshooting Chart

Section VI – Overhaul

NOTE

Complete cartridges are available in service kits for rebuilding these pumps. Refer to catalogs listed in Table 1 for part numbers.

A. General

Plug all removed units and cap all lines to prevent the entry of dirt into the system. During disassembly, pay particular attention to identification of the parts, especially the cartridges, for correct assembly.

Pump bearings are pressed in the bodies or on the shafts and should not be removed unless defective. Figure 7 is an exploded view which shows the proper relationship of the parts for disassembly and assembly. Refer to Figure 1 and Figure 7 for the correct assembled relationship of the parts.

B. Disassembly

1. Disassembly of Basic Pump – See Figure 7. If a foot bracket is used, remove before dismantling the pump. Clamp the pump body in a vise (not too tightly), cover end up, and remove the four cover screws. Note the position of the cover port with respect to the body port before lifting off the cover and “O” ring. (See paragraph 2 for disassembly of flow control covers).

Remove the pressure plate and spring. Note the position of the ring for correct reassembly. Lift off the ring and remove the locating pins. Separate the vanes from the rotor and remove the rotor from the shaft.

Turn the pump body over, then remove the shaft key and the snap ring which retains the bearing. Tap with a soft hammer on the splined end of the shaft to force the shaft out of the body. Support the bearing inner race and press the shaft out of the bearing. Pull the shaft seal out of the body with a suitable hooked tool and press out the inner bearing.

2. Disassembly of Flow Control and Relief Valve Covers – See Figure 7. If a screen is used in the cover, remove the plug and pull out the screen. Do not remove the orifice plug unless it is necessary. Check whether there is a plug at each end of the relief valve bore. If the bore is blind, remove the plug and the snap ring to release the valve and spring as shown in the inset view, Figure 7. If the bore is through the cover, remove only the one plug to release the spring and valve. Leave the snap ring and the other plug in the cover.

C. Inspection and Repair

1. Discard the used shaft seal and all “O” rings. Wash the metal parts in mineral oil solvent, blow them dry with filtered compressed air and place them on a clean surface for inspection.

2. Check the wearing surfaces of the body, pressure plate, ring and rotor for scoring and excessive wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.

3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the rotor if the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races.

5. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

6. Check the relief valve sub-assembly for free movement in the cover bore. Remove burrs from the valve by polishing, but *do not* round off the corners of the lands. *Do not* attempt to rework the valve bore. If the bore is damaged, replace the cover.

D. Assembly

Coat all parts with hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold “O” rings in place during assembly.

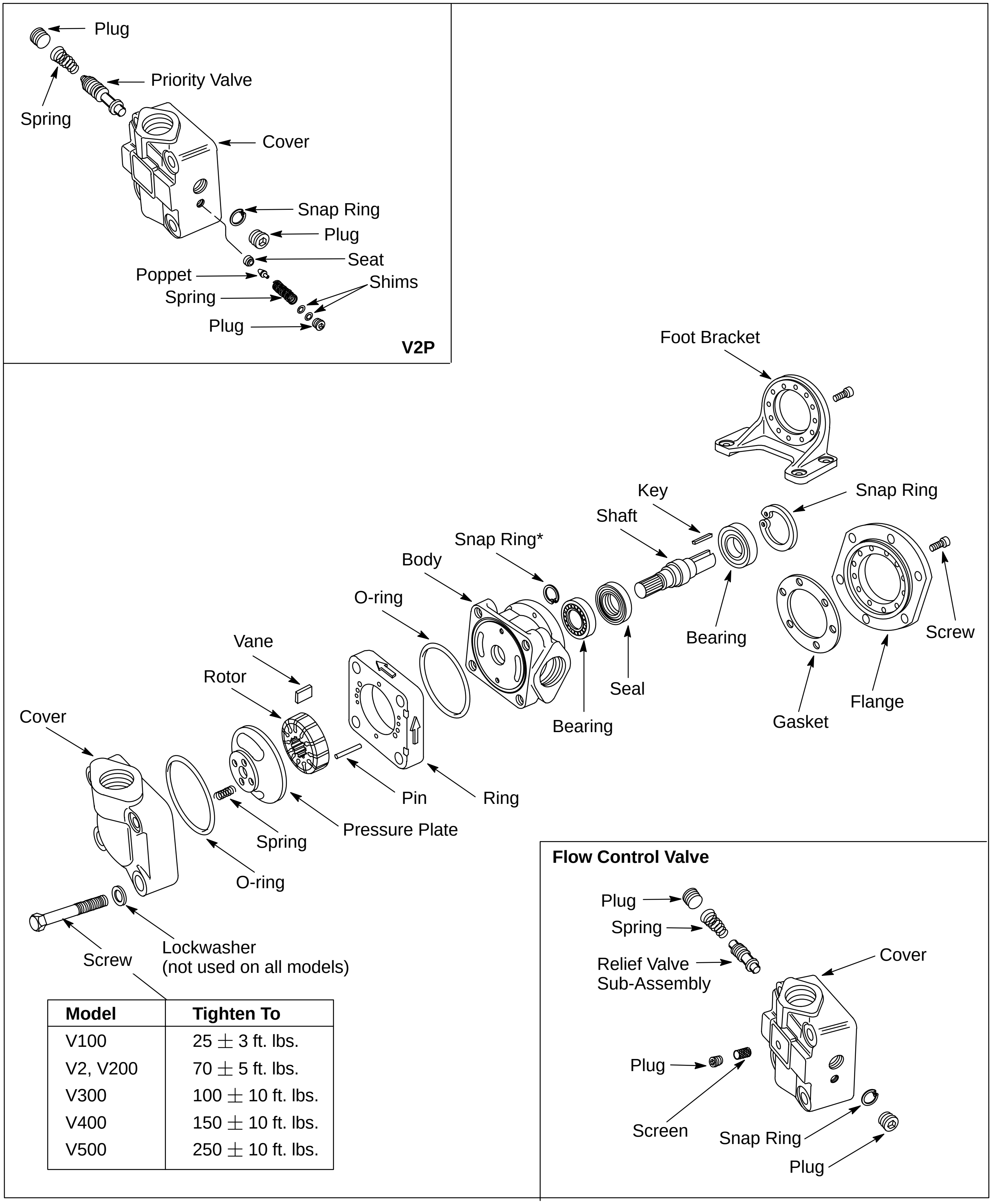
IMPORTANT

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

1. Assembly of Flow Control Cover – See Figure 7. If the cover has a through bore, insert the valve in the bore, small land first. Then install the spring and pipe plug. For models with the blind bore, first install the spring, then the valve, with the hexagon head end first. Follow this with the snap ring (being certain it is firmly seated in the groove) and the pipe plug. Install the screen and the plug which retains it.

2. Assembly of Priority Valve Cover – See Figure 8. If the relief valve seat was removed, a new seat must be pressed into the body. Lubricate and insert the new seat chamfered end first into the cover opening. Align square and press into place. Use a short length of brass rod as a pressing tool, to prevent seat damage. Clean the relief valve bore to remove chips and filings. Insert the poppet into the bore, align square and lightly tap the stem of the poppet to mate the poppet and seat. Install the spring, shims and plug into the cover. Be sure to check the pressure setting of the relief valve against the model code. If the setting is out of tolerance, readjust by removing or adding shims. (Removing shims reduces pressure while adding shims increases pressure.)

Priority Valve – Install the snap ring within the priority valve cover bore; make sure the snap ring is seated within its groove. Insert the priority valve spool, small land first, into the bore. Install plugs at each end of the bore and secure. Refer to Figure 7 for spool orientation.



Model	Tighten To
V100	25 ± 3 ft. lbs.
V2, V200	70 ± 5 ft. lbs.
V300	100 ± 10 ft. lbs.
V400	150 ± 10 ft. lbs.
V500	250 ± 10 ft. lbs.

Figure 7.

3. Assembly of Pump – See Figure 7. Begin assembly by pressing the shaft into the front bearing while supporting the bearing inner race. Next, press the inner bearing into the body, using a driver which contacts the outer race only. Be certain both bearings are firmly seated.

NOTE

Before assembling the shaft seal, determine the correct position of the sealing lip. (See Figure 8.) Double lip seals are assembled with the spring toward the pumping cartridge. Single lip seals have two pressure holes, which are assembled toward the shaft end of the pump.

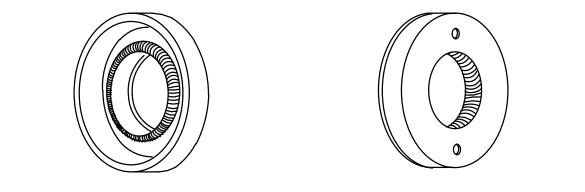


Figure 8

Press the seal firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid. Slide the drive shaft into the body until the bearing is seated. Tap lightly on the end of the shaft is necessary. Install the snap ring.

Install new "O" rings in the body and cover. Insert the ring locating pins in the body and assemble the ring so that the arrow on the perimeter points in the direction of rotation. Check the assembly against Figure 9. Install the rotor on the shaft and insert the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring.

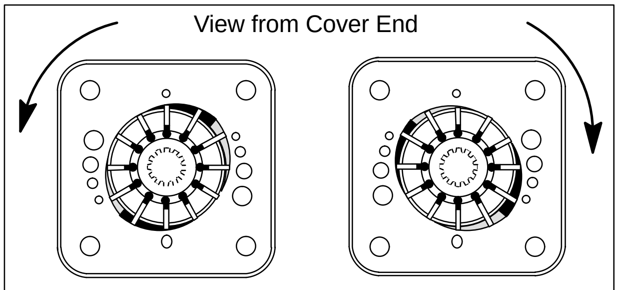


Figure 9

Place the pressure plate on the locating pins and flat against the ring. Use a small amount of petroleum jelly or grease to stick the spring in the recess in the pressure plate. Carefully install the cover with the outlet port in the correct position. Tighten the cover screws to the torque shown in Figure 8. Turn the shaft through by hand to insure that there is no internal binding. Install the shaft key.

Assemble the pump to its mounting flange or foot mounting. If a gasket is used, be certain it is flat to avoid misalignment of the shaft.

Section VII – Testing

If a test stand is available, the pump should be tested at the recommended speeds and pressures shown in the installation drawing (see Table 1). If a test stand is not available, use the machine or vehicle start-up procedure and follow the general information outlined in section IV.H.

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