BLACKMER
VARI-FLO EQUIPMENT

INSTRUCTIONS NO. 685/B

Section	600
Effective	Mar., 1969
Replaces	New

PUMP MODELS: VNP, VNPJ

SIZES 2, 3,

1½ AND 4 INCH MODELS
NO LONGER AVAILABLE

These models are obsolete. Parts availability will be limited.

Also all Models combining the above Types with the letter 'M', which indicates that the unit is a liquid motor or was built for proportioning.

GENERAL INFORMATION

USES AND RECOMMENDED LIMITATIONS

A Vari-Flo can be applied as a power-driven pump to transfer liquid over a wide range of flow rates, determined by the Vari-Flo's control dial setting (see page 3). A Vari-Flo can also be applied as a liquid motor to produce power when it is driven by the stream of liquid passing through it.

A Blackmer proportioner consists of a Vari-Flo combined with another Vari-Flo or with a fixed displacement liquid motor. Every revolution of a proportioner positively displaces an exact amount of liquid through each Vari-Flo or liquid motor which is a part of the unit. Therefore a proportioner will maintain a constant ratio between the flow rate in one liquid line and that in another. This ratio can be varied by changing the Vari-Flo's displacement with the control dial.

No attempt should be made to assemble a proportioner from standard Vari-Flo pumps. The Vari-Flo's or fixed displacement liquid motors supplied in a proportioning unit are especially built for this type of service and can only be obtained as part of a Blackmer-engineered proportioning system. Factory experience in proper integration of the proportioner with its controls and other system components is essential to dependable, accurate operation on a specific application.

The Vari-Flo's features and range of applications are more fully described in Bulletin 600.

VNP models have internal metalized graphite bearings and teflon asbestos packing. Full size composition vanes are standard and suitable for most liquids such as gasoline, fuel oil, solvents, etc. Extra clearance vanes and stainless steel valve springs should be used for high temperatures. Iron and bronze vanes are available.

VNPJ models have internal metalized graphite bearings. Teflon asbestos packing, extra clearance iron vanes are standard. Bronze vanes are available. The main use of the jacketed heads is to allow the use of steam (up to 125 psi) or hot liquid for "thawing out" a Vari-Flo before handling sticky or highly viscous liquids which "set up" between moving parts when the unit is not in operation, e.g. asphalt, molasses, heavy bunker oils.

Vari-Flos in the VNP and VNPJ Series were designed for handling clean liquids (containing no abrasive materials) within the following limitations:

Model Size	Maximum* Differential Pressure	With Non-metallic Vanes		With Iron or Bronze Vanes	
		Max. Speed	Max. Visc.	Max. Speed	Max. Visc. *
1½	125 psi	1,750 rpm	5,000 SSU	900 rpm	100,000 SSU
2	150 psi	640 rpm	5,000 SSU	520 rpm	100,000 SSU
3	150 psi	640 rpm	5,000 SSU	520 rpm	100,000 SSU
4	150 psi	520 rpm	5,000 SSU	400 rpm	100,000 SSU

* In most cases the maximum viscosity or maximum pressure will require reduced Vari-Flo speed (see Bulletin 600). Application of a Vari-Flo at viscosities higher than the maximum indicated above may be approved after review by the Blackmer engineering staff. (Be sure to furnish complete application data with such referrals.)

MAXIMUM LIQUID TEMPERATURES	
With Standard Size Vanes and Standard Valve Spring	240°F.
With Extra Clearance Vanes and Stainless Steel Valve Spring	500°F.

DELIVERY RATINGS

The delivery of each Model Size is controlled by the Vari-Flo dial setting. The range of delivery rates in GPM (Gallons-Per-Minute) for each size is listed in Bulletin 600.

Delivery at a particular dial setting will be dependent on the operating conditions of the application since variation in differential pressure or viscosity may contribute to internal "slip", resulting in some reduction of delivery. Characteristic curves are available for all Vari-Flo models, sizes, and speeds, showing approximate delivery rates for each dial setting at different viscosities and differential pressures.

INSTALLATION AND OPERATION

PRE-STARTING CHECKS

Before installing the Vari-Flo, be sure to read over "General Instructions Page One".

After installation and before starting, *check the coupling alignment* of pump to drive.

Unbolt pipe flanges or break union joints to *check for strain on the unit;* pipes should not spring away or drop down. *Check the rotation* of the Vari-Flo's shaft; it should be the same as the indicating arrow on the casing. *Check the location of the control dial. It should always be on the low pressure side of the Vari-Flo.*

Before putting new jacketed Vari-Flos into service for the first time, all capscrews should be tightened twice — once before and once after steam is applied to the jackets. Gaskets tend to shrink and screws and other metal parts expand when heat is applied.

All jacketed heads are provided with a means for draining off water to prevent damage from freezing (lower tapped connection).

PERFORMANCE CHECKS

Before starting, it is advisable to insert a pressure gage at the outlet port and a combination pressure and vacuum gage at the inlet port. Proper fittings are provided on the Vari-Flo casing for these gages so that discharge pressure and suction condition can be checked when the unit is operating. (Proper suction condition for a Vari-Flo pump is discussed under 'Noise'.

After starting, check the difference in gage reading from the inlet to the outlet port. This difference is referred to as the 'differential pressure.' When a Vari-Flo is applied as a pump, the pressure-control valve setting should be at least 10 psi more than the normal differential pressure.

Also, check the general performance of the unit; gallons-per-minute delivered, noise level (if any), signs of overheating, vibration, leakage, etc. If there is any malfunction, refer to the section "Troubles and Their Cures."

Be sure that the liner lock screw is snugly tight when operating the Vari-Flo at a particular dial setting . . . if it is loose, the liner may change position and cause error in delivery. However, be careful never to overtighten the lock screw — the use of one hand with a small wrench should always be sufficient.

PACKING

Shaft packing is Teflon-impregnated asbestos. Avoid overtightening of the packing glands as this will result in excess heat and possible damage to the packing and pump shaft.

Tighten packing gland a very small amount at a time. Never tighten packing without checking for several minutes afterward for signs of overheating. Never exert strong pressure on gland nuts. If leakage cannot be controlled by very light pressure, packing should be replaced.

A STRAINER IS IMPORTANT

Unless the liquid to be handled will always be completely free of foreign matter, *a low-pressure drop strainer should be installed in the intake line to protect each Vari-Flo unit.* Since, with a given size of strainer, the pressure loss will increase in proportion to liquid viscosity, the net area of the strainer screen should be adequate to keep the loss within reasonable limits at the highest viscosity of the liquid to be handled. Pressure losses may rise beyond reasonable limits if the strainer screen is not removed periodically for cleaning. Inspections of the screen should be regular and frequent enough to permit discovery of clogging *before* it causes a change in the pressure gage reading at the inlet port.

PRESSURE-CONTROL-VALVE

A pressure-control-valve is normally attached to Vari-Flo models which are used as power-driven pumps. Pressure setting should be approximately 10 psi higher than the normal operating differential pressure. To change the setting, remove the cap, loosen the locknut, and turn the adjusting screw inward (clockwise) to increase the pressure setting or outward (counterclockwise) to decrease the pressure setting. To check the valve setting, use the pressure gage at the discharge side of the pump by checking its reading with the discharge valve completely closed.

TO CHANGE ROTATION

Direction of rotation is determined by viewing the pump from the drive shaft side. If the shaft turns clockwise, the rotation is right-hand — if it turns counterclockwise, the rotation is left-hand. To reverse the rotation of a Vari-Flo from right-hand to left-hand (or vice versa), it is necessary to remove both heads from the casing. Turn the rotor-and-shaft assembly end for end so that the drive end of shaft protrudes from the opposite side.

Remove the liner lock screw, lock shoe from one head and the threaded plug and seal washer from the other head.

Replace the heads on the proper side of casing (See Fig. 11 reassembly instruction "F").

Put liner lock shoe, lock screw and threaded plug and seal washer in proper position.

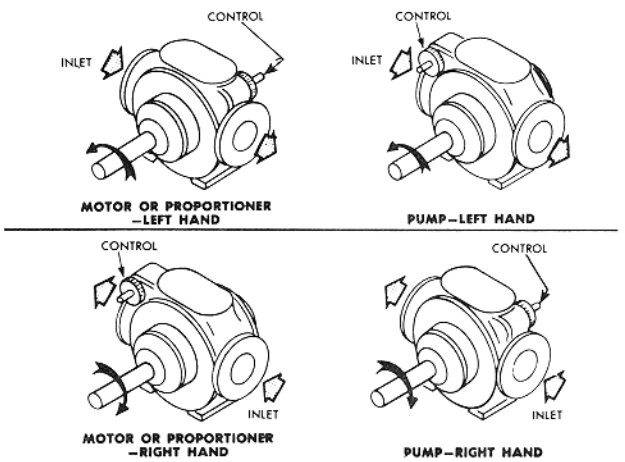


Fig. 1 — Direction of Rotation (Viewing Drive Shaft Side).

ADJUSTMENT AND USE OF THE VOLUME CONTROL

When the volume-control-dial is turned up to as high a setting as it will go, finger tight (this should be a setting of 100 on the standard control dial or approximately 2000 on the micro control counter), the liner is in "full flow" position (see Figure 2), with adequate running clearances left between the liner and the rotor. The Liner Stop in the end of the gear segment is pre-set at the factory to limit the control dial from turning the liner any further (preventing the liner from binding against the rotor). *If this Stop setting has been changed, it should be re-set according to the instructions given* in the section on "Setting the Liner Stop" (on Page 4).

Reverse flow will occur when the control dial is turned to a low setting; the exact reading where neutral flow occurs, and below which flow is reversed, varies and depends on the pressure, liquid temperature, and viscosity of the application (refer to characteristic curves).

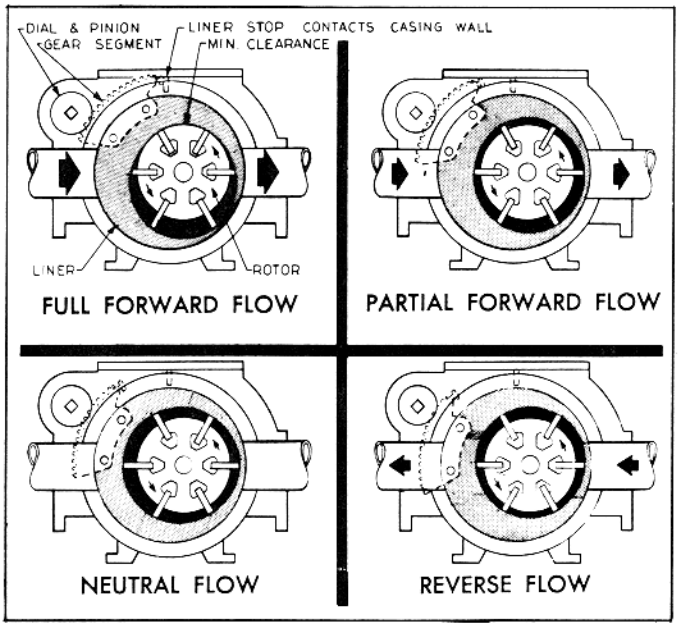
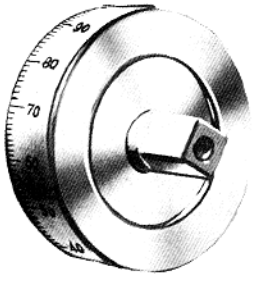


Fig. 2 — Heavy arrows indicate direction of liquid flow for power-driven pump. Flow for a liquid motor or Vari-Flo in a proportioner unit would normally be in opposite direction of these arrows. Remember this basic rule: the control dial of a Vari-Flo must always be on the low pressure side of the liquid flow.

A. STANDARD DIAL



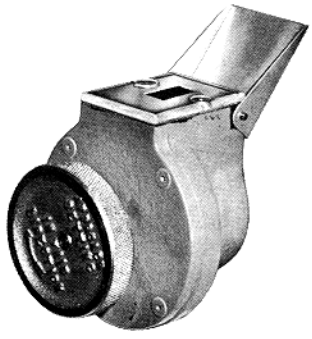
The standard volume-control-dial is graduated from 0 to 100. Each mark represents approximately 1% (sizes 3 and 4) or 2% (sizes 1½ and 2) of total flow range.

When setting the standard volume control-dial, always *approach the setting in a counterclockwise direction* (turning from a lower setting to the one desired, in direction indicated by arrow on retainer). For the most accurate settings, change the dial while shaft is not rotating. *Always lock liner with lock screw on head after changing dial setting.*

To match the dial reading with the proper liner position, loosen the liner lock screw on the head and turn dial counterclockwise toward 100, turning it as far as it will go. If the index mark on the retainer does not line up with 100 on the dial, loosen the set screw holding dial to control shaft, align the marks, and retighten the set screw.

B. MICRO-CONTROL NO LONGER AVAILABLE

(See separate Micro-Control Parts List and Instruction Page for complete information).



The micro-control can be mounted directly on the Vari-Flo unit or it can be mounted remotely, connected to the unit with an extension shaft and two universal joints, or connected with a chain and sprocket drive.

When setting the counter of the micro-control, always *approach the setting in a clockwise direction* (indicated by arrow on control knob). For the most accurate settings, change the dial while shaft is not rotating. *Always lock liner with lock screw on head after changing the counter setting.*

To match the counter reading with the proper liner position, loosen the liner lock screw on the head and turn the micro-control knob clockwise as far as it will go, finger tight. Counter should read to within 5 or 6 digits from 2000. If it does not, remove the plexiglass top, control knob, and front cover from the micro-control housing. Loosen setscrew in gear hub and slide gear back on the control shaft, disengaging it from pinion on the control counter (Figure 3). Turn counter to read 2000, re-engage gear, and tighten setscrew. Replace front cover and plexiglass top.

Double-check the corrected setting by backing off the counter approximately 100 digits and then turning micro-control knob clockwise as far as it will go, finger tight. Counter reading should be 2000.

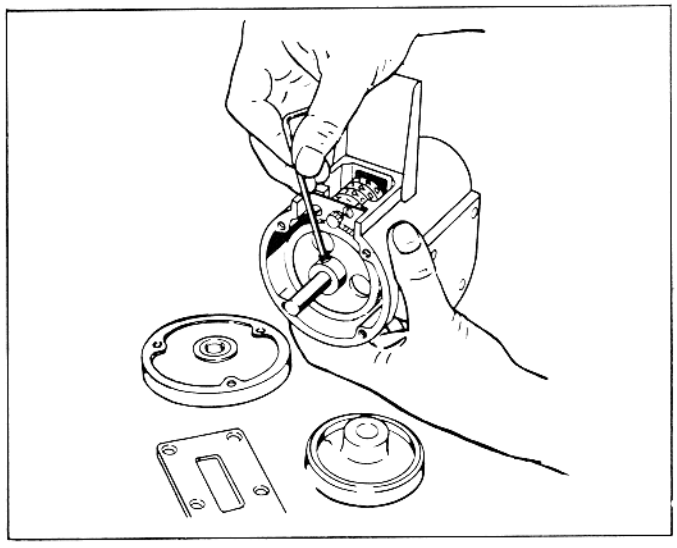


Fig. 3 — Loosening Setscrew in Micro Control Gear.

SETTING THE LINER STOP

The pressure-control-valve assembly (or blanking plate if model is not equipped with valve) must be removed from the top of the Vari-Flo to permit easy access to the area of the liner screw stop.

A. STANDARD DIAL

1. Release locknut on liner stop and screw stop all the way in. (See fig. 6)
2. Rotate the liner until it touches the rotor (point where shaft cannot be rotated from outside by hand).
3. Lock liner in place with liner lock screw on head. Loosen the control dial and line up index mark on retainer with 100 on dial. Retighten dial setscrew.
4. Release liner lock and turn dial back to approximately 75. Now turn dial back up to the setting indicated as proper in the table below. Then lock the liner.

Vari-Flo Size	For Standard Clearance * (.006 ± .0002)	For Extra Clearance (.018 ± .002)
1½	96	86
2	97	91
3	97	93
4	98	96

* As a general rule, extra clearance setting should be used if the liquid viscosity will be above 10,000 SSU at any time when the control dial is set for full flow at 100. Allowance for extra clearance is important if the liquid to be handled will congeal between the rotor and the liner at ambient temperatures (when the pump is not operating), e.g. asphalt, Bunker C oil, etc.

5. Screw liner stop out until it touches the pump casing. Tighten locknut.
6. Again loosen the control dial and line up 100 on dial with index mark on retainer. Retighten dial set-screw. Release liner stop, and the control dial is ready to be set for desired flow rate.

B. MICRO-CONTROL

1. Release locknut on liner stop and screw stop all the way in. (See fig. 6)
2. Rotate the liner until it touches the rotor (point where shaft cannot be rotated from outside by hand).
3. Lock liner in place with liner lock screw on head. Remove the plexiglass top, control knob, and front cover from the micro-control housing. Loosen set-screw in gear hub and slide gear back on the control shaft, disengaging it from pinion on the control counter (Fig. 3). Turn counter to read 2,000, re-engage gear, and tighten setscrew.
4. Release liner lock and turn counter to approximately 1800. Now turn the counter up, *in direction of arrow,* to setting indicated in table below and *lock the liner.*

Vari-Flo Size	For Standard Clearance * (.006 ± .002)	For Extra Clearance (.018 ± .002)
1½	1960	1900
2	1985	1950
3	1985	1950
4	1980	1960

* Extra clearances should always be used for jacketed type pump (those with a 'J' in the model designation, such as a Model NVGAJ3); as a general rule for non-jacketed types, extra clearance setting should be used if the liquid viscosity will be above 10,000 SSU at any time when the control dial is set for full flow at 100. Allowance for extra clearance is important if the liquid to be handled will congeal between the rotor and the liner at ambient temperatures (when the pump is not operating), e.g. asphalt, Bunker C oil, etc.

5. Screw liner stop out until it touches casing and lock in place with locknut.
6. Loosen the counter gear and disengage with counter. Set counter at 2000, engage gear, tighten setscrew.

MAINTENANCE

DISASSEMBLY

A. HEADS AND PACKING

Before removing the head, check to see if the head and the casing have matching bar and groove (figure 10). If not, it is advisable to paint a matching mark on both heads and either side of the casing *before disassembly* to assure that the heads will be reassembled in exactly the same position.

To take off either head assembly remove the head capscrews and tap the head loose with a lead hammer or pry it loose with a screwdriver. After drawing the head assembly from the shaft and removing the gland nuts, it should be possible to easily remove the gland and packing by hand.

B. VANES

Removal of outboard head assembly (on side opposite the shaft coupling side) allows convenient access for withdrawing vanes. If only vanes are to be replaced, remove old vane from top slot; replace with new vane; turn rotor so next vane is in top position; replace it, and proceed to replace the others in the same manner.

If the vanes are swollen or jammed in their slots, withdraw the rotor-and-shaft from pump and drive them out with a suitable blunt instrument (see "Damaged Vanes" for causes of swollen vanes). Removal of push rods also requires taking the rotor-and-shaft out of the pump.

C. LINER AND GEAR SEGMENT

Before the liner can be pulled from the pump casing, it is necessary to remove one of the head assemblies and the gear segment.

Access to the gear segment can be obtained by removing the blanking plate (or pressure-control-valve assembly). Loosen

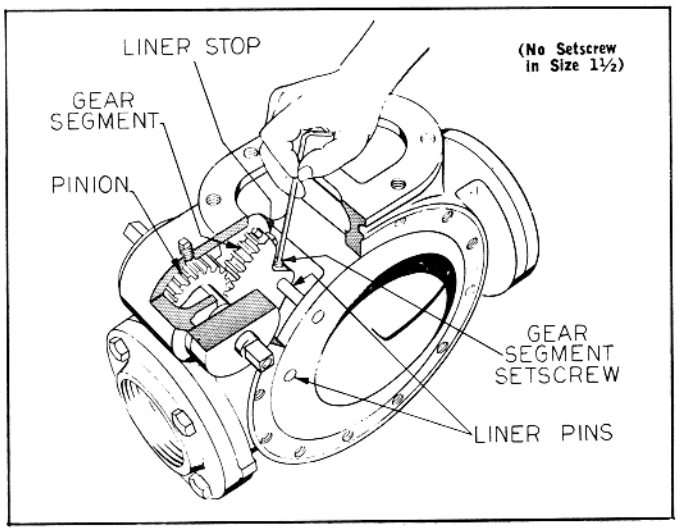


Fig. 4 — Loosening Set Screw in Gear Segment.

the setscrew (Figure 4) that holds the gear segment to upper liner pin. (On older Vari-Flo models this setscrew may be on the lower liner pin and will have to be reached through the port below control dial.)

The two liner pins will then slip endwise out of the liner and the gear segment can be removed through the opening in top of pump. Loosened segment may have to be freed from mesh with pinion by rotating control dial. The liner will now slip out easily.

D. PINION

The pinion is a slip fit on the dial control shaft and (after removal of the liner and gear segment) can be easily released from a standard dial by 1) loosening dial setscrew and removing dial, 2) removing retainer screws and sliding retainer off shaft, and 3) pulling control shaft out of Vari-Flo casing.

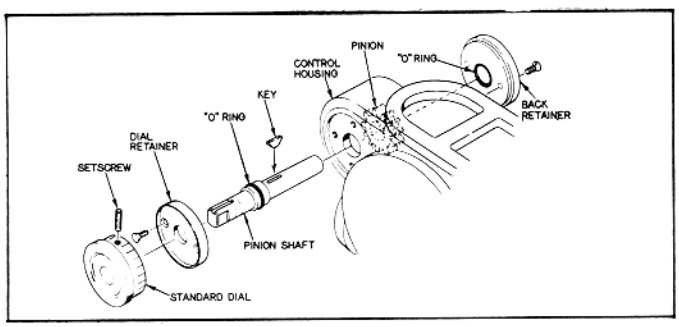


Fig. 5 — Standard Dial Control Assembly.

The pinion can be released from a micro-control by 1) removing micro-control from Vari-Flo casing according to instructions on separate parts list for the micro-control, and 2) pulling control shaft out of Vari-Flo casing.

REASSEMBLY

A. PINION

Place key into position on the control shaft and insert shaft into the control housing of pump casing, holding the pinion by hand inside. After starting shaft into pinion, rotate shaft until key engages keyway in pinion, then push the shaft home into back retainer as far as it will go. Attach front retainer and standard dial or micro-control.

B. LINER AND GEAR SEGMENT

Liner and gear segment are easier to replace and locate in position properly if the *inboard head* (less packing and gland) is replaced first. (Carefully read section F below for instructions on reassembling head to Vari-Flo.) The packing and gland for this head should be replaced later, after the liner, the rotor-and-shaft, and the outboard head are in position.

Insert liner so pin holes are alongside the control dial, taking care that the wide rib is at the top and narrow rib is at the bottom, as shown in Figure 6. Then lower the gear segment through opening in top of cylinder so that setscrew of segment will lock against the upper liner pin (as mentioned in "Disassembly," older models may have the setscrew lock against the lower liner pin).

The control dial may have to be rotated to permit segment to mesh with pinion and drop into place. Insert liner pins through liner flange holes and through holes in segment. With liner pins flush to outer faces of liner, adjust the position of the gear segment along pins for proper meshing alignment with pinion, and tighten setscrew.

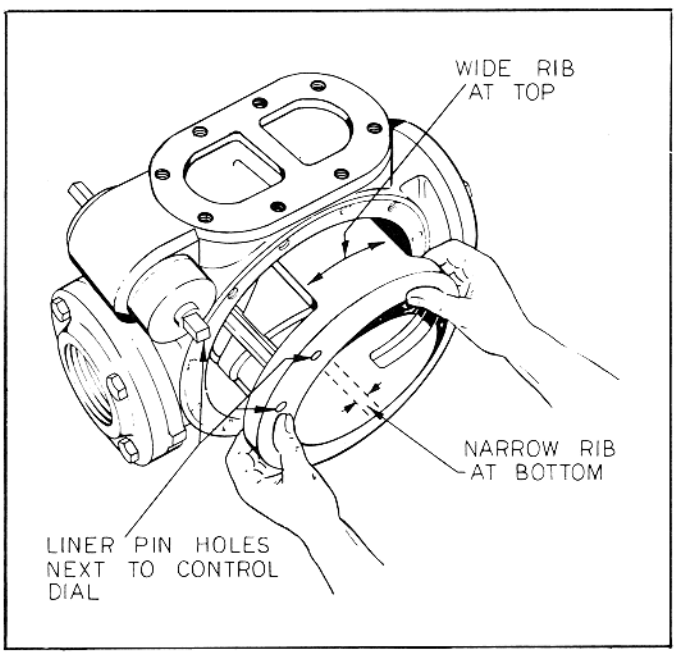


Fig. 6 — Correct Positioning for Replacement of Liner.

Be sure, after completing assembly of the Vari-Flo as described on this page, to reset the liner stop of the gear segment in accordance with the instructions given at the top of page 4.

C. VANES

If the rotor-and-shaft has been withdrawn from the pump, place the bottom three vanes in slots, cupping rotor in hand, and insert all the push rods.

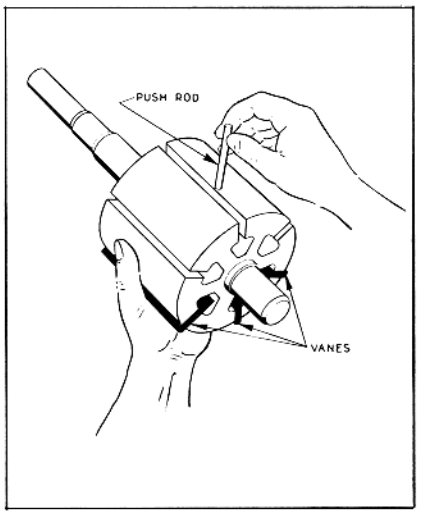


Fig. 7

Be sure that the wearing edge of the vanes (rounded or beveled edge is outward to contact the bore of the liner. Slide the rotor-and-shaft assembly into liner chamber, taking care that the shaft does not strike and damage face of opposite head when locating it in bearing hole. Insert remaining three vanes.

D. PACKING

1. Remove all old packing and clean stuffing box.
2. Check shaft in stuffing box area for scoring. If badly worn the rotor-and-shaft must be replaced.
3. Install the packing washer next to bearing.
4. Apply grease to each ring of packing and install each ring separately using the packing follower to push it in place. *Be sure to install each ring so that the joints are staggered, that is, not lapping over or near the joint of the preceding ring* (figure 8).

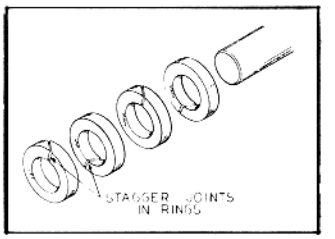


Fig. 8

5. Use only the number of rings furnished for a full set of new packing. Never add rings to old packing.
6. After last ring has been installed insert gland into stuffing box. Tap packing lightly into place using brass or lead hammer against gland.
7. Tighten gland nuts firmly against gland. DO NOT USE FORCE.
8. If gland leakage appears after pump has been running for some time, tighten gland nuts but very little. After tightening, always check stuffing box for overheating. If it starts to get hot, back off gland nuts.

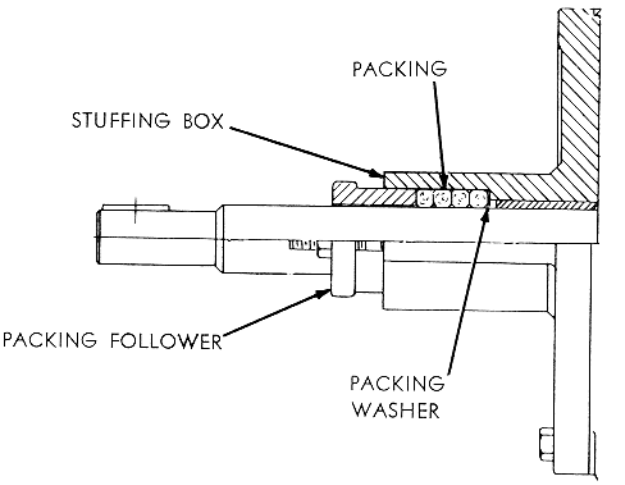


Fig. 9 — Packing

E. TO REMOVE AND REPLACE BEARINGS

After removing the head assemblies from the pump, remove the bearing cover from the outboard head and the packing from the inboard head. The bearings are a press fit in the head. Graphite bearings must be replaced with an arbor press. They are apt to crack if hammered in place. A simple tool made from a piece of bar stock, with one end turned down to the inside diameter of the bushing for a guide, will facilitate this operation. Heating the head in an oven to 200 - 250°F. before installing bearing will help prevent damage to bearing.

Press metallized graphite bearing in one continuous stroke until it is in proper position. Starting and stopping the pressing operation may result in a cracked bearing.

When installing new bearings, coat them with grease or heavy oil. Align the bearing so that the notch in the end will match the groove on the inside of the head. See Fig. 10. Press the bearing from the inside face until it is flush with or slightly below the inside of the head.

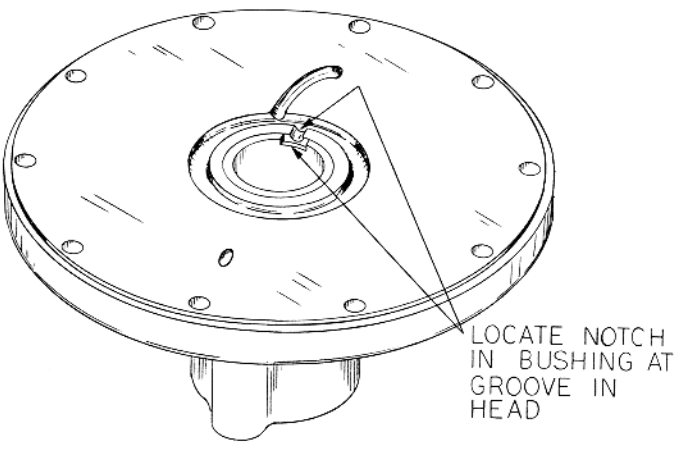


Fig. 10 — Sleeve Bearing.

F. HEADS

Size 1½:
Replace the head "O" ring before assembling head to pump.
Size 2, 3 and 4:

Before replacing either head, clean off the old sealing compound from the side that faces the cylinder and inspect this face carefully for burrs, dirt, or surface imperfections which might prohibit a tight seal. Apply a thin coat of new sealant such as Casoila, being careful to avoid excessive use of sealant (which may flow between the liner and pump casing, causing difficulty in turning the liner with the control dial).

Place the head on the pump casing, *making sure it is replaced in exactly the same position as it was before.* These heads are cast with a groove on the edge of head which should match a bar in the pump casing. (Figure 11).

These external reference points for head location on the casing are stressed carefully for two very important reasons: 1) since the bearing hole center is offset from the head center, it can be moved out of proper alignment with the shaft by rotating head in either direction before placing on casing, and, 2) the pressure grooves *must* lead toward the port of high pressure side for the Vari-Flo to function properly.

After the head is properly positioned, tighten the capscrews firmly while rotating the shaft by hand to check binding. If the rotor does not turn freely, loosen the head capscrews and tap the edges of the head with a lead hammer while rotating the shaft until the binding is relieved. Retighten the capscrews.

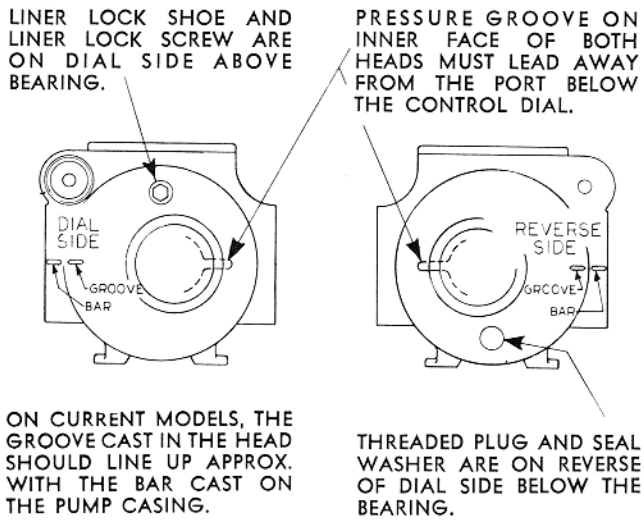


Fig. 11 — Correct Positioning for Replacement of Heads on Casing.

TROUBLES AND THEIR CURES

LEAKAGE

After rebuilding a Vari-Flo, if leakage appears from between the casing and the head, the head should be removed, sealing compound cleaned off, and the inner face inspected for burrs, dirt, or other surface imperfections. Reassemble using fresh coat of sealing compound on the faces. It is advisable to allow compound to dry for two hours before operating the unit if possible.

Leakage around the shaft should be controlled by proper adjustment of the packing glands; if leakage is excessive even with proper adjustment or the glands overheat when the leakage is controlled, packing should be removed and completely replaced.

NOISE OR EXCESSIVE VIBRATION

When a pump has been completely drained and is full of air, some noise may occur when the pump is restarted and the air is purged out of the system. The noise, although seldom present, is usually of short duration and causes no damage. With proper pumping conditions, the pump will be quietest with the dial set at 100. As the dial setting is decreased, it is normal for the noise to increase somewhat.

If the pump is run at speeds exceeding the recommended maximum, the noise may be abnormal. If the pump is run for extended periods of time with closed discharge on a vaporous liquid, the liquid will begin to vaporize (because it becomes heated by the bypass re-circulation), causing increased noise.

Abnormal noise is most frequently caused by a "starved" suction condition . . . that is, the pump must create an excessive vacuum to "pull" the liquid to it through the intake piping, causing cavitation or vaporization of the liquid. The point of suction vacuum where noise becomes critical (accompanied by rapidly decreasing delivery) depends largely on the volatility of the liquid being handled. The figures below are cited as examples of maximum recommended vacuum gage reading at the inlet port of a Vari-Flo to avoid noise and vibration):

Cold gasoline	8 to 10 inches Hg
Cold Fuel Oil	12 to 14 inches Hg
Cold Lube Oil	20 to 22 inches Hg

There are several possible causes of "starved" suction:

— The suction piping may be too small in diameter or too great in length.
— Plug valves or globe valves installed in the suction line have an excessively high friction loss.
— The strainer may be dirty or plugged.
— If the pump is used to load from underground tanks, the lift may be too high.
— Pump may be handling liquid at a viscosity and rate higher than the system was designed for. (This can usually be corrected by reducing dial setting.)

If the vacuum is not excessive, and the pump is still abnormally noisy, the vanes should be examined for possible damage.

DAMAGED VANES

Non-metallic vanes can be damaged by pumping abrasive liquids, by foreign objects entering the pump, or by pumping liquids of too high a viscosity. Swelling of the vanes may be caused by excessive heat (resulting from overspeeding unit), or by liquids which dissolve or soften the resin in the vanes. See section on "Uses and Limitations."

LOW DELIVERY

As explained in the section "on Delivery" the accuracy of delivery with respect to particular dial settings is dependent on the operating conditions of the application. Refer to characteristic curves for approximate normal delivery. Inaccurate or abnormally low pumping rate may be caused by too low a pressure-control-valve setting, excessive suction requirement, too much restriction in the discharge line, air leak in the intake line, or by damaged parts in the pump.

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