

KINNEY® KD™ SERIES

Rotary Piston Vacuum Pumps

Models KD-30 KD-50

INSTALLATION OPERATION MAINTENANCE REPAIR **MANUAL**



WARNING

DO NOT OPERATE
BEFORE READING MANUAL



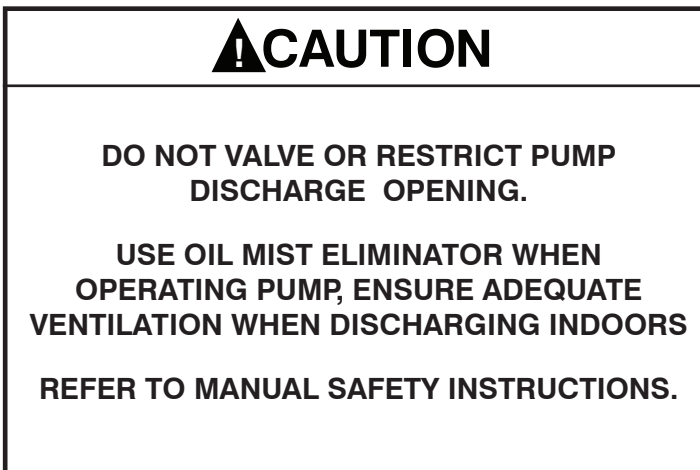
4/2008

LEADING THE SEARCH FOR NEW SOLUTIONS



TUTHILL
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NOTICE

The above safety instruction tags were permanently affixed to your pump prior to shipment.
Do not remove, paint over or obscure in any manner.

Failure to heed these warnings could result in serious bodily injury
to the personnel operating and maintaining this equipment.

SAFETY PRECAUTIONS FOR ROTARY PISTON PUMPS

Please read the following safety information on this page before operating your vacuum pump.

- Do not operate the pump without the beltguard properly attached.
- Disconnect the pump from the electrical supply at the main disconnect before removing the beltguard. Replace the beltguard before reconnecting the power supply. Operating the pump without the beltguard secured in place exposes people in the vicinity of the pump to risk from rotating drive parts.
- Do not operate the pump with oxygen enriched gas in the suction line, where the proportion of oxygen exceeds 20%, unless the pump has been prepared with an inert fluid suitable for the application. Pumping oxygen enriched gases with mineral oil or other non-inert fluids can cause an explosion in the pump, resulting in damage or injury.
- Take precautions to avoid prolonged or excessive exposure to oil mist or process materials from the discharge of the pump. Do not allow the pump to discharge into a closed room, or a room without adequate ventilation. Always use a discharge oil mist eliminator unless the pump discharge is vented to the open air. Venting the outlet of the oil mist eliminator to the open air is highly recommended.
- Do not restrict the pump discharge line in any way, or place any valves in the discharge line. The vacuum pump is a compressor and will generate high pressures without the motor stalling when operated at low suction pressures. Excessive pressure build up could cause damage or injury.
- Disconnect the pump from the electrical supply at the main disconnect before dismantling or servicing the pump. Make sure the pump is completely reassembled, the beltguard is replaced, and all drain and fill valve and plugs are closed before reconnecting the power supply.
- Accidental starting or operation of the pump while maintenance is in progress may caused injury or damage.
- Lift only with the lifting eyebolts supplied with the pump. Do not lift equipment attached to the pump with the eyebolts supplied.
- Do not touch hot surfaces on the pump. In normal operation at low pressures surface temperatures will not normally exceed 180°F. Prolonged operation at 200 torr may cause surface temperatures up to 220°F.

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DESCRIPTION

GENERAL

The visual difference between the two pumps is in the oil separators. Internally, the pistons, cams and slide pins of the Model KD-50 are treated to be able to tolerate the increased speed. Both pumps are air-cooled rotary piston type, consisting of two rotary pistons pumping in parallel. The pumps attain a low ultimate pressure of less than 10 microns (10 x 10⁻³ torr McLeod Gauge). The rugged, simple, design ensures dependable service under the most severe applications without costly or complicated maintenance. The ruggedness of the pump is evidenced by the cast iron shaft bearings and the sealed exterior drive bearing. The mechanical shaft seal contains viton elastomer which is suitable for most chemical as well as high temperature operations.

PUMP COMPONENTS

All components are easily serviced and no special tools are required. The reliable, leak-free, shaft seal requires no adjustment or maintenance. The gas ballast valve regulates the vapor handling capacity of the pump, decelerates contamination buildup in the oil, and quiets the discharge valve noise of the pump. The oil separator of the KD-30 is equipped with a mist eliminator to provide filtering of the exhaust thereby resulting in a cleaner pump area. The KD-50 has provision for a mist eliminator filter which is optional. The pump specifications are shown in Figure 1.

TABLE OF SPECIFICATIONS (Figure 1)		
	KD-30	KD-50
Free Air Displacement (CFM)	33	52
Inlet Connection (NPT)	1-1/2"	1-1/2"
Discharge Connection (NPT)	1-1/4"	1-1/4"
Pump Speed (RPM)	571	900
Motor Speed (RPM)	1725	1725
Motor Horse Power	1-1/2"	2
Oil Capacity (Kinney AX) (Quarts)	4	12
Weight (LBS) Complete Pump	200	230
Height (Inches)	27	32-1/2
Width (Inches)	20-1/2	20-1/2
Length (Inches)	27-7/8	28-5/8
Typical Noise Level @ 10 Torr	75 dbA	79 dbA

The two rotary pistons pump in parallel and are driven by two eccentric cams keyed to a shaft (see Figure 3). Each rotary piston has a hollow extension (slide) that moves through a slide pin. The hollow extension has ports which form an inlet valve with the slide pin. The ends of the cylinder are enclosed by an open head, through which the shaft extends, and a closed head. The shaft has a mechanical seal on the open head end to prevent leakage around the shaft. Spring loaded discharge valves are located at the discharge side of the pistons. An oil separator oil mist eliminator is mounted on top of the pump and connected to the discharge of the pump. A sight gauge in the oil separator is provided for checking the oil level and when pumping at low inlet pressure the oil level should be in the center of the sight gauge.

NOTE: that the oil level will change with large changes in pump inlet pressure.

OPERATING CYCLE

The operating cycle is shown in Figure 2. Gas from the system enters the pump through the inlet and from there it passes through the hollow piston-slide and out the slide port into the space being created between the piston and cylinder wall. As the piston rotates, this space increases and more gas is drawn in while at the same time the gas taken in and trapped on the previous revolution is on the compression side of the piston and slide. Here the gas is compressed and forced out through the discharge valves along with a small amount of oil and then into the oil separator where the oil is

separated from the gas. The gas is discharged to the atmosphere and the oil drains back into the reservoir. The KD-30 pump has a filter to remove visible fumes from the discharged gas. This filter for the KD-50 pump is optional.

SEALING AND LUBRICATING

The oil flows through the pump by means of differential pressure between atmosphere and the pump inlet and is drawn into the pump at each head through the shaft bearings. The cylinder walls, pistons, and slide pin are lubricated and sealed against the backflow of gas by a film of oil which fills the close running clearances. The cylindrical part of the piston almost touches the pump cylinder at a line along the length of the piston and as the piston continues to rotate, oil builds up ahead of this line and seals the space between the piston and cylinder wall. The excess oil is discharged with the gas and is returned to the oil reservoir. At low pressures the air becomes mixed with the oil and the solution is discharged on the compression stroke.

OIL TYPES

The ability of the KD - 30 and KD - 50 pumps to obtain and hold pressures in the low micron range depends basically on the use of the proper sealing and lubricating oil. AX Vacuum Oil is recommended as it has characteristics necessary to obtain a dry, low vapor pressure fluid, with suitable viscosity. Other applications such as oxygen pumping may require changing oil to Tricresyl Phosphate or Kinlube, or silicone fluids where low temperatures are likely to be encountered. Other special fluids used are polyglycols, fluorocarbons and FDA approved lubricants. Consult the factory before changing from the recommended oil to insure that the new fluid and present seals are compatible.

INSTALLATION

GENERAL

The pump site selected should allow enough room for maintenance and service to the pump. The pump should be secured to a level, rigid, support, and spring vibramounts can be used if sufficiently flexible connectors are used in the manifolding.

V-BELT DRIVE

To install the v-belts, loosen the motor mounting screws and slide the motor toward the pump. Position the v-belt on the pump with the slack side on the top of the drive. Move the motor away from the pump to tighten the drive and refer to Step 2 to check the tension of the v-belts. Before attempting to tension any v-belt drive it is imperative that the sheaves be properly aligned. The sheaves should be positioned so as to allow the belt to be placed in the grooves rolling them onto the sheaves.

The following tensioning steps can be safely followed for all belt types, cross sections, number of belts per drive, or type of construction:

1. With the belt properly in the groove, adjust the sheaves until all slack has been taken up.
2. Start the drive and continue to tension the v-belt(s) until only a slight bow on the slack side of the drive appears while operating under load conditions as shown in Figure 3.
3. After 24 to 48 hours of operation the belt will seat itself in the sheave grooves. Further tensioning is then necessary as described in Step 2.

Insufficient tensioning is often evidenced by slipping (squealing) at start up. Belt dressing should not be used on v-belts. Sheaves and v-belts should remain free of oil and grease. Tension should be removed from the belt if the drive is to be inactive for an extended period of time. For more specific information consult the drive manufacturer.

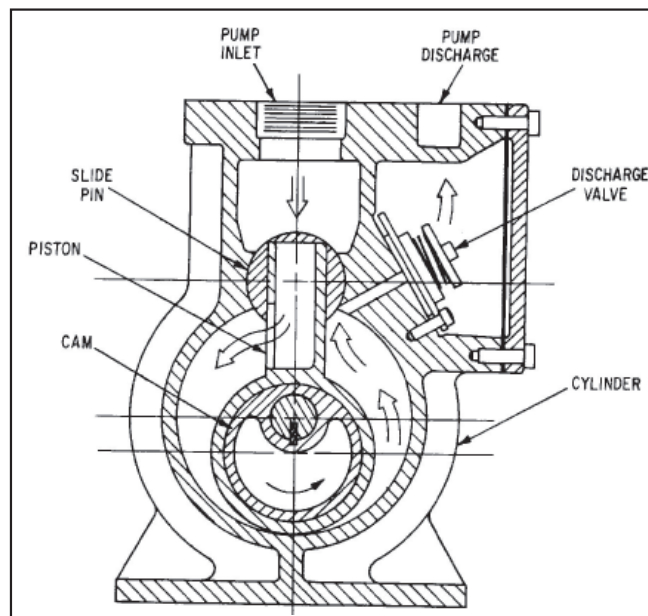


Figure 2. Operating Cycle

DISCHARGE PIPING

It may be desirable to connect discharge piping from the oil separator to the outside to dispose of exhaust gases and vapors (see Figure 4). When connecting discharge piping, place a dropout trap adjacent to the oil separator to trap the condensate which would otherwise drain back into the oil. If the condensate is water, it should be drained as necessary to prevent it from flowing back into the reservoir. A flexible connector, such as a rubber hose, at the discharge of the pump is necessary to make the piping flexible and to provide a convenient disconnect point for servicing. The outside end of the discharge line should be turned down to prevent entry of precipitation.

INLET PIPING

The inlet piping should be sized and designed with three objectives in mind:

- To prevent undue gas flow restriction
- To prevent pump fluids from splashing into the process chamber
- To protect the pump from injection of particulate matter.

Usually the vacuum piping to the pump inlet should be as large in diameter and as short in length as possible and no smaller in diameter than the pump inlet. See Figure 4 for recommended arrangement of vacuum manifolding.

As with all rotary mechanical pumps, it is necessary to install a flexible member in the suction manifold of the pump to avoid alignment problems and to reduce the possibility of transmitting vibration to and from other components. Self-supporting, bellows-type, flexible connectors are recommended and are available from Tuthill Vacuum & Blower. The connector used must be flexible enough to prevent vibration transmission and yet rigid enough to prevent collapsing under high vacuum.

Before connecting the manifolding to the pump, pour a pint of oil into the inlet connection to ensure proper lubrication at initial start-up. When all inlet connections are made, check that the pressure of the system is near the pump blank-off pressure. The demountable joints should be O-ring sealed or threaded connections made with teflon sealing tape or other sealing compound. Loctite 567 is available from Tuthill Vacuum & Blower as a compound for thread sizes up to 1" in diameter or Titeseal (Radiator Specialty Company) for larger thread sizes. Install a vacuum isolation valve between the system and the pump with a means for connecting a vacuum gauge on both sides of the valve. The gauge connections should face vertically down for self draining and should be free from the splash of the pumping action. An air admittance valve on the pump side of the isolation valve is recommended. With such an arrangement it is possible to check either the system or the pump for leaks without

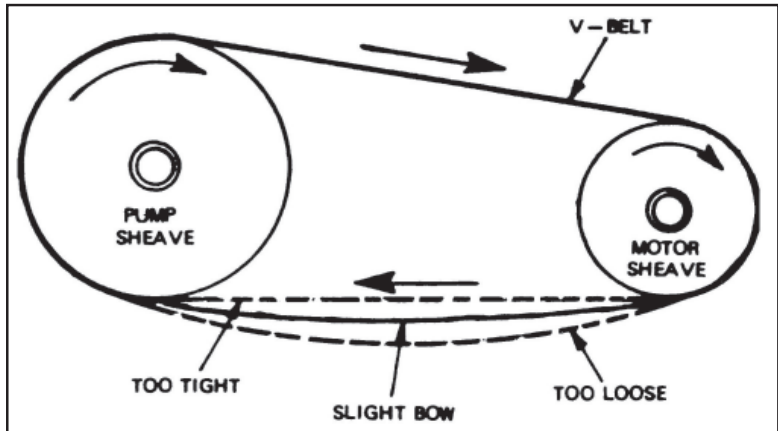


Figure 3. V-Belt Tensioning

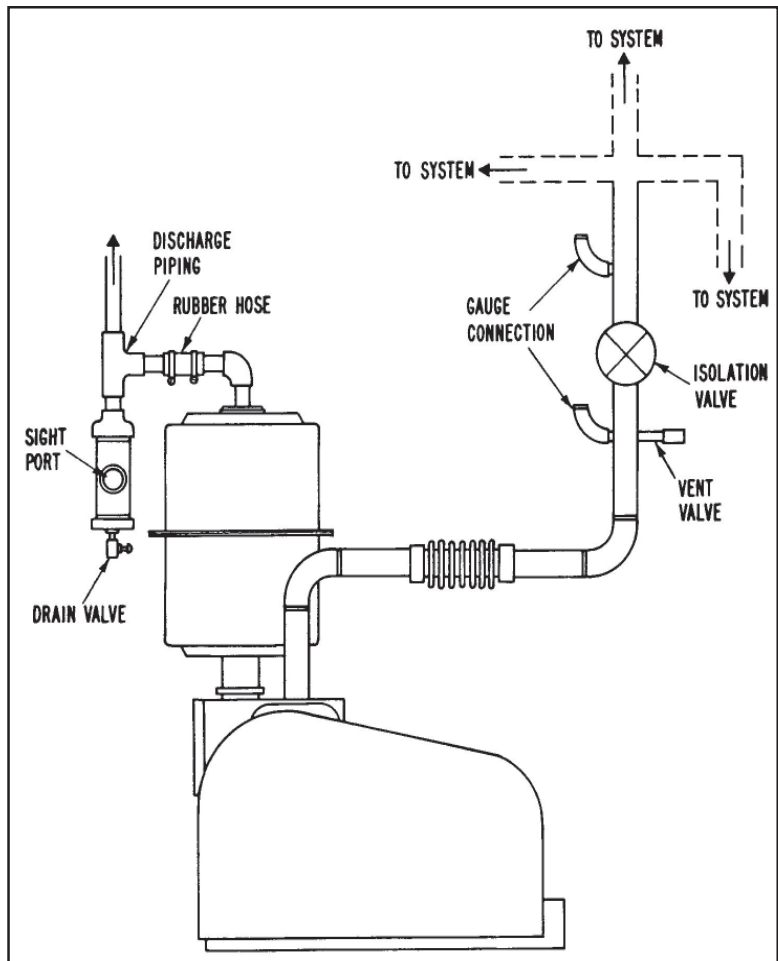


Figure 4. Typical Manifold Arrangement

disconnecting the vacuum piping. This isolation valve will also allow the system to be kept under vacuum while the pump is not running, or the pump operating while the system is open to atmospheric pressure.

VACUUM GAUGES

Two general types of vacuum gauges are used for testing vacuum equipment; total pressure reading types such as Thermistor or Thermocouple gauges and partial pressure reading McLeod gauges. The McLeod gauge indicates the partial pressure of a gas and does not indicate the component of pressure due to condensable vapors such as water vapor. Partial vapor pressure has little effect on the McLeod gauge readings until it becomes quite high, therefore, a McLeod gauge is most useful in confirming pump performance and for determining the absence or presence of real leaks. Thermistor or Thermocouple gauges are preferable for leak checking and when used in conjunction with a McLeod gauge the contamination level can be determined.

A high Thermistor or Thermocouple gauge reading may indicate that the pump is contaminated, that it leaks, or both. A high McLeod gauge reading means that a real leak is present.

If operating at pressure above one Torr, a dial type gauge is recommended over any other gauge. A 0-26 Torr or 0-1 00 Torr gauge covers most applications at medium vacuum.

ELECTRICAL CONNECTIONS

WARNING: Disconnect pump from source of electrical power prior to making repairs or adjustments to any electric component of the unit.

Check the operating voltage of the motor by comparing the lead connections with the markings on the motor. Wire to the proper power source through necessary switching and safety equipment. Connect the solenoid valve so that it is energized when the motor is started. The valve is normally closed and will open when energized. See Figure 6 for dual voltage wiring information.

The motor must turn in the direction of the arrow cast on the pump. If the motor turns in the wrong direction, reverse any two of the three wires leading from the motor to the power source. Standard pumps are designed to run clockwise when facing the pump pulley.

OPERATION

WARNINGS:

- ***The belt guard must be properly secured to the pump at all times while the pump is running.***
- ***When operating the pump in an enclosed area it is necessary, for health reasons, to have the area well ventilated. If ventilation is not adequate, the pump discharge should be filtered or piped to open air.***
- ***Do not block or restrict the flow of gas from the pump discharge. Back pressure within the pump could cause severe damage.***

GENERAL

Each pump has been thoroughly tested and is ready for operation as soon as it is installed and filled with oil. If the vacuum system is free of leaks, including the connections to the pump, the ultimate system pressure should be close to that obtained with pump inlet closed off.

FILLING PUMP WITH OIL

When installing the pump, a pint of oil is poured into the pump inlet before connecting the inlet piping. Thereafter, the total required quantity of oil is poured into the oil separator.

PRESTART CHECKS

The following prestart checks should be performed if maximum pumping conditions are required.

1. Check that the suction lines are tight and absolutely free of all foreign matter.
2. Add oil as necessary to bring the oil level midway on the sight gauge.
3. Check that the pump can be turned over by hand without mechanical interference. With the inlet at atmospheric pressure, turn the pump and note that more turning force is required when the pump discharges. This indicates that the discharge valves are seating properly.
4. Check the v-belt tension as shown in Figure 3.

STARTING

Perform the prestart checks and do not start the pump until the oil temperature is above 40°F.

1. Depress the motor start button and allow the pump 10 minutes to warm up, at blank-off, before starting process work.
2. Open the gas ballast valve as necessary (see Gas Ballast).

The oil level will change with the pumping pressure. When the pump is first started the oil will rise and as the inlet pressure is reduced the oil level will drop and should stabilize midway on the sight gauge when the pump pressure approximates blank-off.

STOPPING

1. If a vacuum valve is provided between the pump and the process equipment, place this valve in the closed position.
2. Turn off the power to the pump motor and vent the pump to atmosphere. The gas ballast valve can be used for this purpose if a vent valve has not been provided. Venting the pump prevents flooding which makes starting the pump difficult; see paragraph on Flooding. The gas ballast valve should not be used for venting connected (process) volumes but for venting the pump casing and a short length of manifold only.

GAS BALLAST

Gas ballast is an operating mechanism which is used to prevent the condensation of vapor in a vacuum pump. Vapor present in the gas being pumped can condense during the vacuum pump compression cycle and mix with the oil. As the oil is circulated through the pump, the condensate is carried with the oil and allowed to reevaporate, causing poor pump performance and making frequent oil changes necessary. By using gas ballast most vapors can be passed through a vacuum pump without condensing and then discharged with the pump exhaust.* Unless lowest possible pressure is necessary, the pump should be operated with gas ballast.

In addition to preventing vapor condensation, the use of gas ballast also reduces discharge valve noise to a low level. It is generally possible to eliminate valve noise with a small gas ballast flow which does not seriously increase the ultimate pressure. If the resulting pressure is tolerable, this is a preferred method of operation since it also helps to keep the oil clean. The setting of the gas ballast valve is best determined by trial and error because the amount of condensable vapor as well as the system operating conditions vary with different processes. The motor power consumption and the ultimate pressure will rise in proportion to the increase in gas ballast flow.

Gas ballast can be used in the following two ways:

1. Continuous gas ballast can be regulated to flow into the pump while processing. To regulate the gas ballast valve, while dead ended, slowly open the valve until the pressure is slightly below that needed for process work. Operate the pump at this setting to keep oil contamination to a minimum.
2. Intermittent gas ballast can be used when pressure requirements do not permit the use of continuous gas ballast. Running the pump overnight with full gas ballast is recommended for cleaning the oil of contamination. The condition of the oil can be estimated by observing the pump blank-off pressure with the gas ballast valve closed.

Run the pump with the gas ballast valve open for a timed period (15 to 20 minutes) and observe the blank-off pressure change. When there is no further change in pressure, the oil is clean. This pressure change vs. time can be used to estimate the required time to clean the oil.

** For a detailed discussion on gas ballast, see Vacuum Science and Engineering - Dr. C.M. Van Atta (McGraw-Hill 1965).*

MAINTENANCE

GENERAL

Check the oil level daily for the first week of operation and weekly thereafter. The oil level should be about midway on the sight gauge when operating at low inlet pressures, however, the oil level rises as the inlet pressure goes up. A good check of the oil passage circuit is to change the inlet pressure or open the gas ballast valve and watch the oil level which should rise as the inlet pressure goes up. Check the condition of the oil periodically by draining a small quantity into a clean container and visually inspecting it for solid or liquid contaminants. Change the oil when contamination is present after making full use of gas ballast to clean the oil. The oil should be changed when the pump has logged 750 hours of operating time or more often if an inspection of the oil dictates.

Pump repair services are available at our factory in Springfield, MO, our Northeast Repair Center in the Boston, MA area and our West Coast Service Center in the Los Angeles, CA area. Call (800) 825-6937 for a location nearest you for more information.

CHANGING OIL

Run the pump until the oil is warm ($>100^{\circ}\text{F}$), then open the G.B. valve for a 1-2 minutes. Then stop the pump and open the drains in both the pump and reservoir. (See Figure 1 for drain locations.) Fill the pump with oil as directed under the OPERATION section, "Filling Pump with Oil". If the pump oil is badly contaminated, additional changes may be necessary with a 10 minute operating period between changes to check the pump blank-off pressure. Several oil changes may be necessary under extreme conditions.

V-BELTS

To change the v-belt, loosen the motor mounting screws and slide the motor toward the pump until the old belt can easily be slipped from the pulleys. The motor must be close enough to the pump to enable the new belt to be slipped onto the pulleys without rolling or stretching. When the belts are in place, pull the slack of both belts to the same point and tension the belts as shown in Figure 4. Belts should not slip under full load, i.e. when starting, if the proper tension is maintained, however, too much tension will place an undue strain on the shaft bearings. New belts should have the tension adjusted after 24 to 48 hours of operation.

OIL SEPARATOR

All the KD-30's and KD-50's built since 10/84 are fitted with Oil Mist Eliminators in the oil separator. If the oil separator has a filter, it will be necessary to periodically replace the filter element and remove any sludge accumulation.

The frequency of this is dependent upon the following conditions:

1. Visual inspection shows element to be blocked by foreign matter. A back pressure through the filter element in excess of 6 PSIG indicates that the filter element is unduly restricting the gas flow and should be changed.
2. Motor current exceeds manufacturer's specifications.
3. A ruptured element or the gaskets not sealed allowing mist to be discharged.

The oil separator of Model KD-30A and KD-50B pumps are equipped with an oil drain back device to return oil to the reservoir that has penetrated the filter element. The check type drain back closes to prevent the exhaust gas from bypassing the filter when the inlet pressure is high and opens to allow the oil to drain back as the inlet pressure is reduced. If the pump is operated at high inlet pressures, over 5 Torr, for time periods exceeding several hours, no drain back can occur and filter efficiency is reduced. Under such conditions the pump should be isolated from the system with the main isolation valve, and run at blank off pressure for 15-30 minutes to allow the oil to drain back. If the pump is always operated with lengthy high pressure, then runs an external oil return line can be installed as follows.

A return line can be installed to return oil that collects in the filter area back to the pump. The successful operation of this arrangement is dependent upon having the oil return to the pump at a point, which is compatible with the pump operating pressure level (see Figure 5). Generally, oil has to be returned to a low pressure point. The oil separator has an oil return valve that allows oil flow back when operating at pressures below 5 Torr.

One of the following two areas can be selected for the oil to return to the pump when operating above 5 Torr:

1. If the pump operating range is between 5 and 150 Torr, the returning oil should enter the pump through the gas ballast valve in which case the valve must be left open.
2. When the operating range is above 150 Torr, the returning oil should enter the pump at the suction port area.

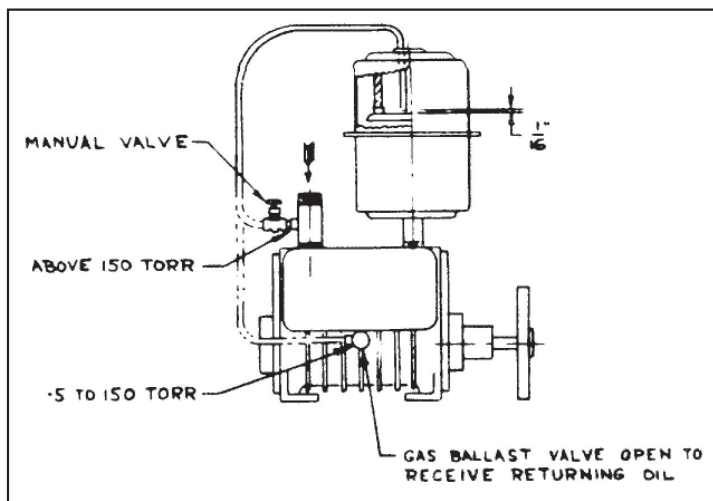


Figure 5. Return Line

An alternative to the above arrangements is to drain the collected oil into a container and periodically return it to the pump through the oil fill.

This arrangement is preferred if the collected oil contains a substantial amount of water. In this event the oil should be left to stand until the oil and water separate at which time the water will be decanted before returning the oil to the pump. With this arrangement special care must be taken to keep the oil clean.

STARTING TROUBLES OR STALLING

Pump starting troubles or stalling may be due to loose or broken belts, lack of lubrication, obstruction inside the pump, temperature too low, the pump flooded with oil, locked drive bearing, or lack of electrical power. If the problem is loose or broken belts, see V Belts. If stalling is due to insufficient lubrication, this can be due to blocked oil lines, malfunction of the solenoid valve, or low oil level. If the oil supply is depleted it is probably caused by a ruptured oil line. If the pump is not free to turn by hand it should be dismantled to remove the obstruction. If the pump is flooded turn the pump over by hand before energizing to force the oil out into the separator. If the pump is too cold to start, use an immersion heater in the oil, or live steam on the exterior of the pump until the oil is warmed to a temperature of a minimum of 40°F. If there is no electrical power to the motor check the fuses or relays for signs of overloading.

TROUBLESHOOTING

CHECKING PUMP PERFORMANCE

If the processing time increases or the ultimate pressure becomes poor with no recent changes in the process or in system configuration, test the pump to determine if the trouble is in the pump or the connected process equipment. To check the condition of the pump, measure the blank off pressure using a McLeod gauge and if available, take a Thermistor or Thermocouple gauge reading. Refer to Figure 8 for a listing of common symptoms in the system.

Average blank off readings are 5 to 25 microns with a McLeod gauge and 10 to 100 microns with a Thermocouple gauge. The specification pressure is 10 microns (10 x 10⁻³ Torr) McLeod Gauge reading. To obtain a blank off reading, the pump must be isolated from the process equipment. Connect a vacuum gauge to the pump side of the isolation valve (see Figure 4) and operate the pump to allow it to attain the lowest pressure.

If the McLeod gauge reading is low and the thermocouple gauge reading is high the pump oil is contaminated. Change the oil and check the blank off pressure again. Additional oil changes may be necessary to flush all traces of contamination from the pump. After eliminating oil contamination as a possible cause of poor pump performance, recheck the blank off pressure. If both the McLeod and Thermocouple gauge readings are high, this would indicate that the pump is leaking. Proceed as directed in "Pump Leaks."

PUMP LEAKS

If the pump is suspected of leaking after eliminating oil contamination as the cause of poor performance use a plastic sealing compound such as Apiezon to seal suspected areas. Apply the compound while the pump is running and monitor the gauge for sudden pressure drop as the leaks are sealed temporarily. Carefully check around the head to cylinder joints, securing bolts, plugs, and generally any penetration into the pumping area. Loctite 515 is available from Tuthill Vacuum & Blower to permanently seal the leaks once they have been found. If leaks are still indicated, check the shaft seal for defects such as cracked carbon ring, hardened rubber components, or scratches on the face of the seat and change the seal if it shows signs of being defective.

PROCESS LEAKS

If the blank off test shows that the vacuum pump is functioning properly but that the process equipment is faulty, the trouble can be isolated further by applying the following procedure:

1. Attach a vacuum gauge on the process side of the isolation valve.
2. Clear the process chamber of all material, which could give off vapors, which would change the reading.
3. Run the pump to obtain the lowest possible pressure and close the isolation valve.
4. Observe the pressure and if greater than required or if the pressure does not hold to a reasonable rise rate, the leaks must be found and sealed. If a leak detector is not available, proceed as directed in "Leak Checking Techniques" and make permanent repairs to the leaks found.

LEAK CHECKING TECHNIQUES

If a leak detector is available, probe all areas of penetration into the pumping chamber while monitoring the gauge for pressure changes. If a leak detector is not available, use the following method to locate leaks:

1. Cover suspected leaks with a low vapor pressure sealing compound such as Apiezon Q manufactured by James Biddle Co. or Shell Company, Ductseal by Johns Mansville Company, or Plasticine manufactured by F.W. Woolworth Company. Do this while pumping on the equipment and monitoring the pressure. A sudden decrease in pressure indicates that a leak has been covered.
2. Large leaks can be detected by pressurizing the unit and painting with a soap solution. Bubbles will indicate leaks and when pressurizing the unit keep the pressure low (1 to 2 PSIG) for easy detection of bubbles.
3. To locate small leaks it may be necessary to use a fast acting Thermocouple or Thermistor gauge in conjunction with a probing media such as Acetone, Alcohol, Freon or Helium. Position the vacuum gauge head downstream from the suspected leak area and reduce the pressure until the gauge registers. Apply the probing media using a brush or squirt gun and watch the gauge for sudden pressure rise or fall as the media comes in contact with the leak area. Seal the area temporarily with Ductseal, Loctite 515, or Glyptal and continue probing until the desired pressure is obtained. Permanently repair the leak areas with Loctite 515.
4. If leak checking fails to disclose the leaks, disassemble and remake all demountable joints and connections using new gaskets and sealing compound such as Loctite 515. Re-check pressure using blank off plate after addition of each segment of the vacuum manifold.

CAUTION: Compound applied too thick may be squeezed into the pump where it could cause damage.

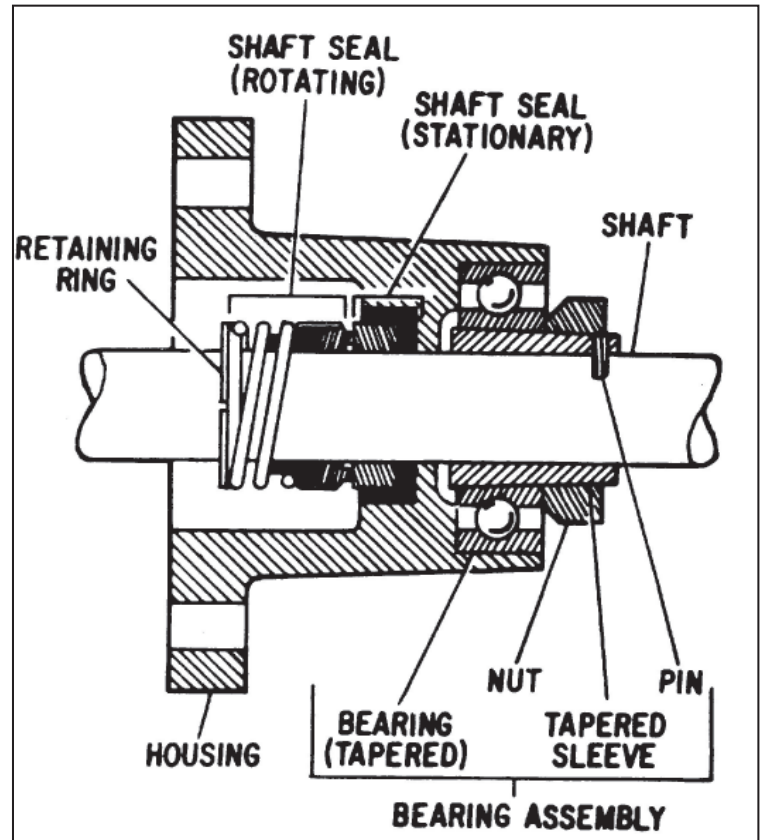


Figure 6. Shaft Seal

OIL CONTAMINATION

When the pressure has been satisfactory for some time and then the pressure gradually increases, this indicates oil contamination. When this happens clean the oil by using gas ballast or change the oil. Discolored oil does not necessarily indicate contamination; conversely, vapors may contaminate oil and not show any color change. Oil drying can be checked by the crackling method (few drops of oil on an aluminum household foil heated by a match). If crackling does not occur the oil is dry to better than a few PPM of water.

DISCHARGE VALVES

When the cause of poor pump performance is not due to leaks or oil contamination, the next step is to inspect the discharge valves. The discharge valves (See Figure 7) are located at the exhaust ports and could malfunction due to foreign matter preventing them from sealing or they may be worn to the point that they no longer function correctly. When the pump is operating without gas ballast, a sharp clicking noise generally indicates proper valve closing. To gain access to the valves, drain the oil and remove the cylinder cover. Remove the screws from the holddown plate and the valve can be removed. Check each valve by lifting the disc and check the surfaces between the disc and seat for foreign matter, which may have lodged there. Release the disc and a firm pressure should close the valve and the two parts should mate so as to form a seal between them.

Check for guide wear by moving the disc laterally. There should be little play at any valve lift position. No burrs can be tolerated. The valve can be disassembled for cleaning if necessary, however, assembly must be with the six springs arranged in pairs with each pair positioned 120° from the other two pairs, the spring tongues facing the stop and free end facing the disc. When completed reassemble the pump, fill with oil and test per "Checking Pump Performance", on page 11.

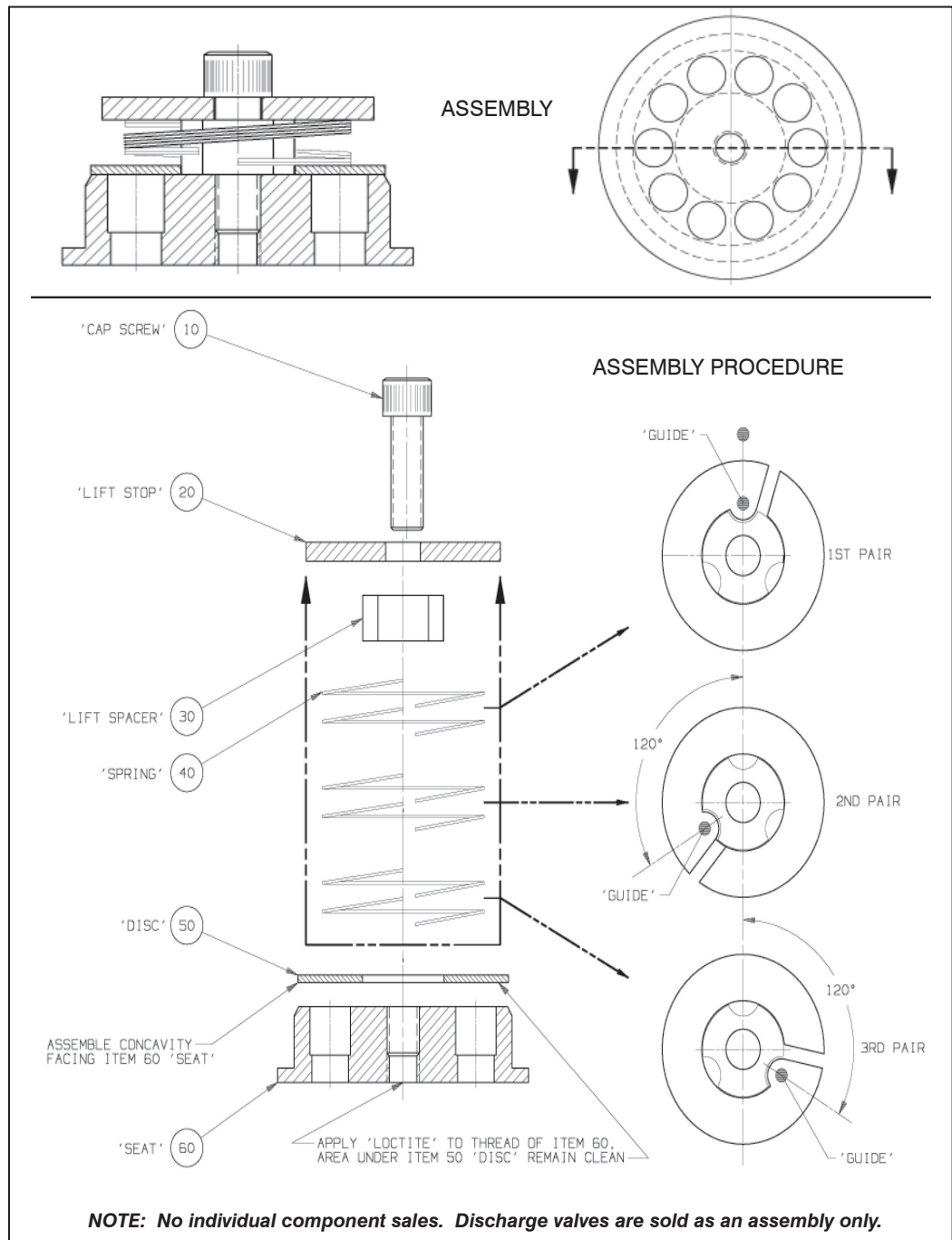


Figure 7. Discharge Valve

SHAFT SEAL

Under normal conditions the shaft seal shown in Figure 6 has a long trouble-free life. It may become worn or scratched on the sealing surfaces by contaminated oil or it may be damaged by overheating. Proceed as follows to inspect or replace the seal:

1. Rest the pump on the closed head to prevent the oil from draining out. Use blocks to prevent the oil line from supporting the pump weight.
2. Remove the belt guard, belts, sheave and drive key from the pump.
3. Remove the bearing assembly by unscrewing the locking nut. Lift the dowel pin out of the shaft from the slot in the bearing sleeve. Tap the sleeve to break the bond between sleeve and bearing. Remove four screws from the housing and remove housing from shaft. The ceramic (non-rotating) portion of the seal will remain in the housing and the boot with carbon ring (rotating) portion will remain on the shaft. The bearing will remain in the housing.
4. Inspect the ceramic portion in the housing for signs of trouble such as a cracked seat or deterioration of the elastomer seal between the seat and the housing. Check that the rotating portion of the carbon washer is not cracked and that the face is smooth. The boot should fit firmly to the shaft and will bond to the shaft when it has been run for a few hours. Do not break this bond unless it is necessary to replace the rotating part of the seal.
5. When replacing the shaft seal, clean the shaft and housing areas where the seal was located and lubricate the seal, housing, and shaft with grease. Press the non rotating part of the seal into the housing and slide the rotating part onto the shaft. Be careful when sliding the seal over the shaft that the keyway does not cut the boot. Reassemble the pump and test per "Checking Pump Performance", on page 10.

TROUBLESHOOTING <i>(Figure 8)</i>		
SYMPTOM	PROBABLE CAUSE	REMEDY
System ultimate pressure excessively high	System contaminated by volatile material	Clean equipment with acetone, alcohol or ether
Pump ultimate pressure excessively high	Oil is contaminated	Pump down using full gas ballast overnight
	Process equipment leaks, vacuum pump leaks	Leak check
	Oil flow blocked	Clean Oil Lines
	Discharge valve malfunctioning	See "Discharge Valves", on page 12
	Shaft Seal Leaking	See "Shaft Seal", on page 12
	Internall parts worn or damaged	Disassemble pump and inspect parts for wear or damage.
Pump noise at low pressure	Hydraulic Slap	Increase gas ballast valve opening
Pump will not start or stalls	Locked Drive Bearing	Replace Bearing
	Loose or broken belts	See "Starting Troubles or Stalling", on page 10
	Lack of lubrication	
	Obstruction inside the pump	
	Temperature too low	
	Flooding with oil	
	Loss of Electrical Power	

DISASSEMBLY

The pump should be disassembled only to the extent necessary to repair it. Reference is made to the open and closed head ends of the pump. The open head is on the end through which the shaft extends.

1. Drain the oil by opening the oil drain valves. Remove the belt guards and belts.
2. Disconnect the piping and electrical connections to the oil solenoid.
3. Remove the pulley and drive key.
4. Remove the gas ballast valve and oil lines.
5. Remove the oil separator tank.
6. Remove the pump from base and position it on a workbench.
7. Remove the cylinder cover, gasket and discharge valves.
8. Unlock the bearing from the shaft by removing the locking nut. Lift the dowel pin from the shaft and tap the tapered sleeve axially to break the bond between the sleeve and the bearing. Remove the bearing housing, rotating part of the shaft seal, and the retaining ring from the shaft.
9. Unscrew the cap screws and remove the open head, piston, and slide pin. Mark the slide pin and piston so as to reassemble as before.
10. Remove the closed head, piston, slide pin, and cam. Remove the cam by tapping the shaft, with a soft-faced hammer, until the cam is free from the shaft. (Disassemble only if cam and shaft replacement is necessary).
11. A press is necessary to remove the open head cam from the shaft.
12. Inspect the solenoid valve seat, plunger, and spring but first slip off the coil from the stem.

REASSEMBLY

Before starting to reassemble the pump, inspect all parts for wear or damage, and replace as necessary. Parts must be clean and free of old sealing compound. A recommended solvent for cleaning the parts is trichloroethylene, other solvents such as kerosene or carbon tetrachloride can only be used if facilities are available to vapor degrease the parts after cleaning. Dry the parts and coat with vacuum oil to aid in assembling and provide lubrication on initial startup.

The reassembly steps are as follows:

1. Replace the bearings in the pump heads.
2. Replace the cam key and press the open head cam onto the shaft. Carefully slide the shaft through the center wall. Install the open head with two screws to position the shaft.
3. Insert the cam key and tap the closed head cam onto the shaft snug against the shaft shoulder.
4. Position the closed head piston with the inlet ports of the piston slide facing away from the discharge valve side of the pump. Place the closed head slide pin over the piston slide with the scalloped edge up. Slide the piston over the cam and the slide pin into the slide pin recess in the cylinder.
5. Apply a thin coat of Loctite 515 to the sealing faces of the cylinder and head. **CAUTION: Do not allow Loctite 515 to be squeezed into the pump, as it will cause working parts to stick and obstruct oil flow.**
6. Position the closed head on the dowel pins of the cylinder and install the securing screws.
7. Remove the open head. Install the open head piston and slide pin as described in Step 4 and secure the head as in Steps 5 and 6. Rotate the shaft to check for binding. If binding occurs a few gentle taps on one end and then the other of the shaft will slide the cams into their proper running positions.
8. Coat the O-ring with vacuum oil and place the O-ring and cap on the closed head and secure with screws.
9. Install the shaft seal as described In "Shaft Seal" and lubricate the bearing housing O ring with vacuum oil and

slide the housing onto the shaft and secure with the O-ring in place. Slide the bearing onto the taper sleeve with the tapered surface of the sleeve mating with the tapered surface of the bearing. Slide the sleeve bearing onto the shaft with the slotted, threaded end of the sleeve outboard. Tap the outer race of the bearing with a soft faced hammer until the bearing is flush with the housing. Align the slot of the sleeve with the hole in the shaft and insert the dowel pin. Install and tighten the bearing lock nut using a 6" spanner without benefit of a handle extension. Over tightening the lock may cause the bearing to become distorted.

10. Install the discharge valves and replace the cylinder cover and gasket.
11. Return the pump to the base and replace the pulley, belts, and belt guard.
12. Replace the oil separator and gas ballast valve and connect the oil lines and electrical wiring.
13. Close the oil drain valves and fill the pump with oil. Test the pump per “Checking Pump Performance.”
14. Reconnect the manifolding to the pump.

REPLACEMENT PARTS

GENERAL

The graphics on the following pages and their parts lists cover all parts in the KD-30 & KD-50 pumps, any of which are available as spare parts. Always include the model and serial number of the pump when ordering parts.

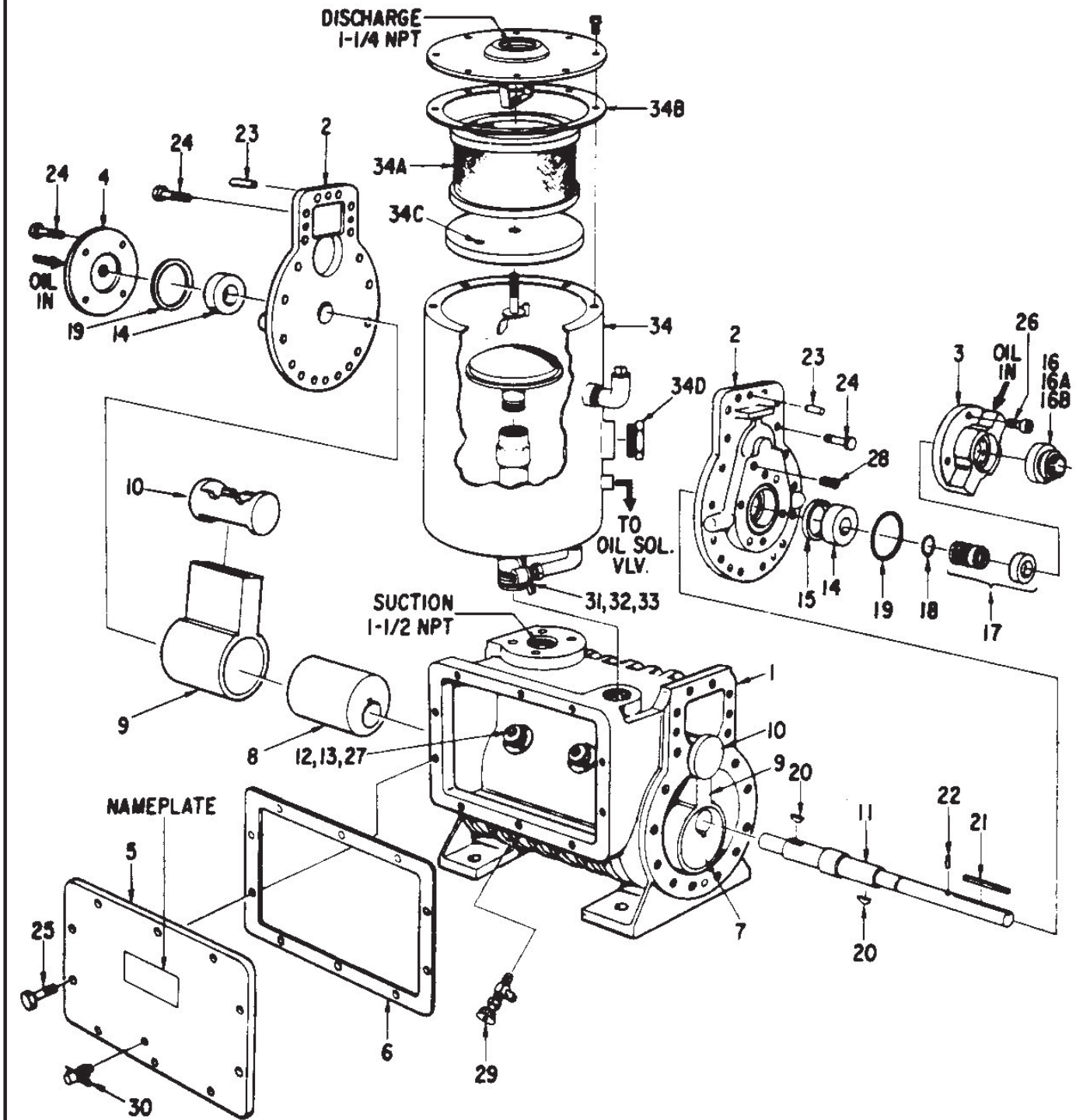
SPARE PARTS

Recommended spare parts are indicated on the parts list by an asterisk, which include gaskets, O-rings, shaft seal, and discharge valves. The recommended spare parts are intended to support the pump until a more extensive stock of spare parts can be developed based upon usage data as parts are replaced. The number of pumps in operations plus the degree of importance of keeping the pumps in ready condition are factors to be considered when developing a stock of spare parts. An adequate supply of AX Oil and Loctite 515 should be maintained and a vacuum gauge should be available for checking pump performance.

NOTES: _____

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KD-30A FINAL ASSEMBLY

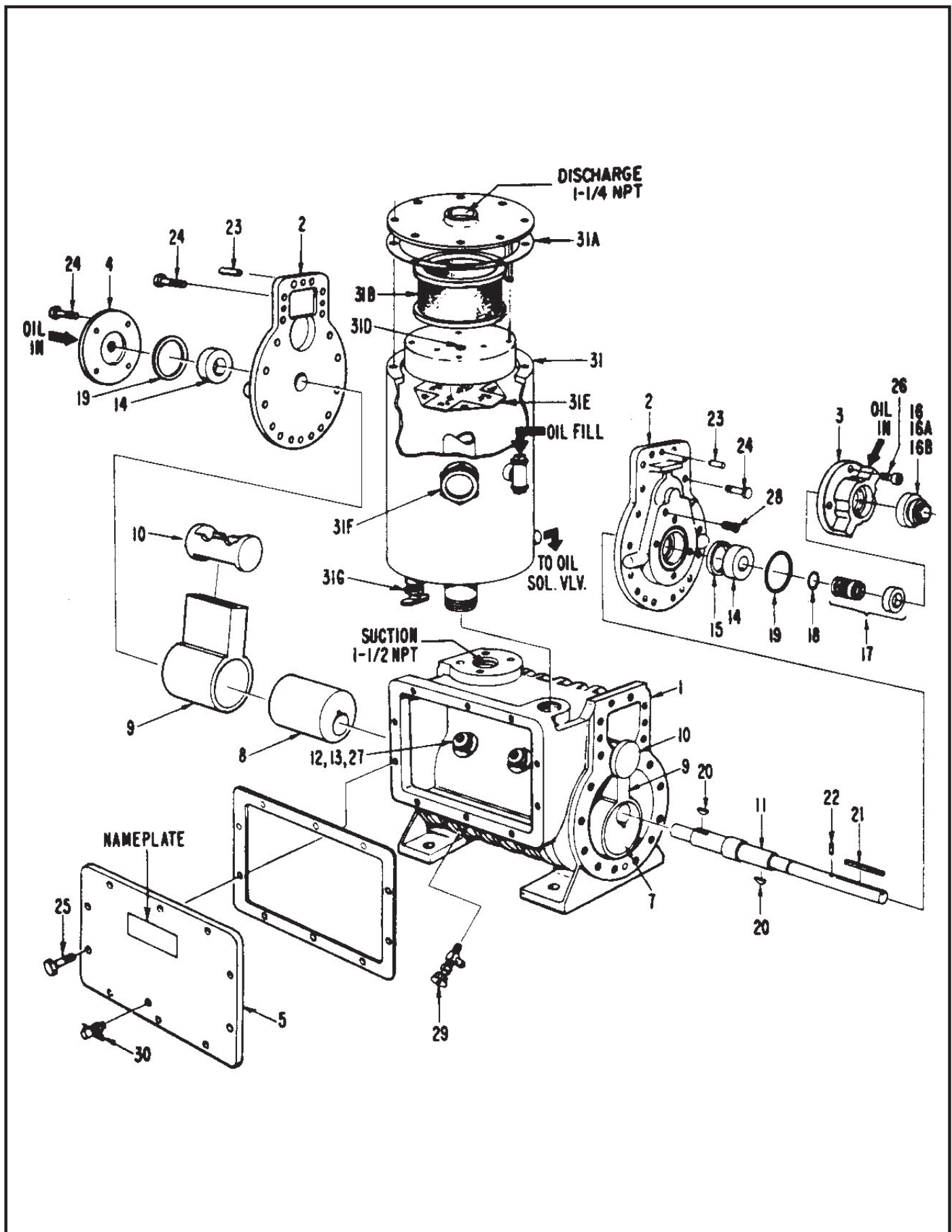


KD-30A FINAL ASSEMBLY

ITEM #	DESCRIPTION	QTY
1	Cylinder	1
2	Head, Open & Closed End	2
3	Housing, Shaft Seal & Bearing	1
4	Cap, Closed End	1
5	Cover, Cylinder	1
6**	Gasket, Cylinder Cover	1
7	Cam, Open End (Heavy)	1
8	Cam, Closed End	1
9	Piston	2
10	Slidepin	2
11	Shaft	1
12**	Discharge Valve	2
13	Plate, Valve Hold Down	2
14	Bearing, Head	2
16	Spacer, Bearing, Open Head	1
16	Bearing Assmbly, Out.	1
16A	Ball Bearing w/ ID Taper	1
16B	Bearing Adapter	1
17**	Shaft Seal, 3/4 Viton	1
18**	Retaining Ring, .75 Ext.	1
19**	O-Ring, 2-27 Buna-N	2
20	Key, Cam, Woodruff 13	2
21	Key, Drive, 3/16 sq. x 1-1/4 lg	1

ITEM #	DESCRIPTION	QTY
22	Dowel Pin 1/8 dia. x 1/2 lg.	1
23	Dowel Pin 5/16 dia. x 7/8 lg	4
24	Hex Head Capscrew, 5/16-18 x 3/4 lg.	36
25	Hex Head Capscrew, 5/16-18 x 7/8 lg.	10
26	Socket Head Capscrew 5/16-18 x 7/8 lg.	1
27	Socket Head Capscrew 5/16-18 x 5/8 lg.	6
28	Pipe Plug, Hex Sock, 1/8 NPT	2
29	Gas Ballast Valve	1
30	Drain Cock, Oil, 1/4 NPT	1
31	Drain Cock, Oil, 3/8 NPT	1
32	Street Elbow, 3/8 NPT	1
33	Coupling, 3/8 NPT	1
34	Discharge Separator Tank	1
34A	Oil Mist Filter Element	1
34B**	Gasket, OME	1
34C**	Check Disc, OME	1
34D	Sightglass	1
35*	Solenoid Valve 240/480V	1
36*	Pump Sheave, Special Unbal.	1
37*	V-Belt 3VX355 (w/ FR 56 motor)	1
37*	V-Belt 3VX450 (w/ FR145T motor)	1
<p>* Item Not Shown ** Item included in repair/maintenance kit.</p>		

KD-50B FINAL ASSEMBLY



KD-50B FINAL ASSEMBLY

ITEM #	DESCRIPTION	QTY
1	Cylinder	1
2	Head, Open & Closed End	2
3	Housing, Shaft Seal & Bearing	1
4	Cap, Closed End	1
5	Cover, Cylinder	1
6**	Gasket, Cylinder Cover	1
7	Cam, Open End (Heavy)	1
8	Cam, Closed End	1
9	Piston	2
10	Slidepin	2
11	Shaft	1
12**	Discharge Valve	2
13	Plate, Valve Hold Down	2
14	Bearing, Head	2
16	Spacer, Bearing, Open Head	1
16	Bearing Assmby, Out.	1
16A	Ball Bearing w/ ID Taper	1
16B	Bearing Adapter	1
17**	Shaft Seal, 3/4 Viton	1
18**	Retaining Ring, .75 Ext.	1
19**	O-Ring, 2-27 Buna-N	2
20	Key, Cam, Woodruff 13	2
21	Key, Drive, 3/16 sq. x 1-1/4 lg	1
22	Dowel Pin 1/8 dia. x 1/2 lg.	1

ITEM #	DESCRIPTION	QTY
23	Dowel Pin 5/16 dia. x 7/8 lg	4
24	Hex Head Capscrew, 5/16-18 x 3/4 lg.	36
25	Hex Head Capscrew, 5/16-18 x 7/8 lg.	10
26	Socket Head Capscrew 5/16-18 x 7/8 lg.	1
27	Socket Head Capscrew 5/16-18 x 5/8 lg.	6
28	Pipe Plug, Hex Sock, 1/8 NPT	2
29	Gas Ballast Valve	1
30	Drain Cock, Oil, 1/4 NPT	1
31	Discharge Separator Tank Assy.	1
31A**	Flange Gasket	1
31B	Oil Mist Eliminator Element	1
31C		
31D**	Check Disc, Viton	1
31E	Dispersion Screen	1
31F	Sightglass, 2" NPT	1
31G	Oil Drain Cock, 1/2 NPT	1
31H*	Seal Nut, 1-1/2 NPT	1
31I*	Reinforcing Plate	1
32*	Solenoid Valve 240/480V	1
33*	Pump Sheave	1
34*	V-Belt 3VX375 (w/ FR 56 motor)	1
34*	V-Belt 3VX470 (w/ FR145T motor)	1
<p>* Item Not Shown. Item 31, Bolting Hardware, not shown. ** Item included in repair/maintenance kit</p>		

WARRANTY – VACUUM PRODUCTS

Subject to the terms and conditions hereinafter set forth and set forth in General Terms of Sale, Tuthill Vacuum & Blower Systems (the seller) warrants products and parts of its manufacture, when shipped, and its work (including installation and start-up) when performed, will be of good quality and will be free from defects in material and workmanship. This warranty applies only to Seller's equipment, under use and service in accordance with seller's written instructions, recommendations and ratings for installation, operating, maintenance and service of products, for a period as stated in the table below. Because of varying conditions of installation and operation, all guarantees of performance are subject to plus or minus 5% variation. (Non-standard materials are subject to a plus or minus 10% variation).

Product Type	Warranty Duration
New	15 months after date of shipment or 12 months after initial startup date, whichever occurs first
Repair	6 months after date of shipment or remaining warranty period, whichever is greater
Remanufactured	9 months after date of shipment or 6 months after initial startup date, whichever occurs first

THIS WARRANTY EXTENDS ONLY TO BUYER AND/OR ORIGINAL END USER, AND IN NO EVENT SHALL THE SELLER BE LIABLE FOR PROPERTY DAMAGE SUSTAINED BY A PERSON DESIGNATED BY THE LAW OF ANY JURISDICTION AS A THIRD PARTY BENEFICIARY OF THIS WARRANTY OR ANY OTHER WARRANTY HELD TO SURVIVE SELLER'S DISCLAIMER.

All accessories furnished by Seller but manufactured by others bear only that manufacturer's standard warranty.

All claims for defective products, parts, or work under this warranty must be made in writing immediately upon discovery and, in any event within one (1) year from date of shipment of the applicable item and all claims for defective work must be made in writing immediately upon discovery and in any event within one (1) year from date of completion thereof by Seller. Unless done with prior written consent of Seller, any repairs, alterations or disassembly of Seller's equipment shall void warranty. Installation and transportation costs are not included and defective items must be held for Seller's inspection and returned to Seller's Ex-works point upon request.

THERE ARE NO WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS OF PURPOSE.

After Buyer's submission of a claim as provided above and its approval, Seller shall at its option either repair or replace its product, part, or work at the original Ex-works point of shipment, or refund an equitable portion of the purchase price.

The products and parts sold hereunder are not warranted for operation with erosive or corrosive material or those which may lead to build up of material within the product supplied, nor those which are incompatible with the materials of construction. The Buyer shall have no claim whatsoever and no product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action nor for problems resulting from build-up of material within the unit nor for problems due to incompatibility with the materials of construction.

Any improper use, operation beyond capacity, substitution of parts not approved by Seller, or any alteration or repair by others in such manner as in Seller's judgment affects the product materially and adversely shall void this warranty.

No employee or representative of Seller other than an Officer of the Company is authorized to change this warranty in any way or grant any other warranty. Any such change by an Officer of the Company must be in writing.

The foregoing is Seller's only obligation and Buyer's only remedy for breach of warranty, and except for gross negligence, willful misconduct and remedies permitted under the General Terms of Sale in the sections on CONTRACT PERFORMANCE, INSPECTION AND ACCEPTANCE and the PATENTS Clause hereof, the foregoing is BUYER'S ONLY REMEDY HEREUNDER BY WAY OF BREACH OF CONTRACT, TORT OR OTHERWISE, WITHOUT REGARD TO WHETHER ANY DEFECT WAS DISCOVERED OR LATENT AT THE TIME OF DELIVERY OF THE PRODUCT OR WORK. In no event shall Buyer be entitled to incidental or consequential damages. Any action for breach of this agreement must commence within one (1) year after the cause of action has occurred.

January, 2007

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

All KINNEY® vacuum pumps manufactured by Tuthill Vacuum & Blower Systems are date coded at time of shipment. In order to assure you of the full benefits of the product warranty, please complete, tear out and return the product registration card below, or you can visit our product registration web page at:

IMPORTANT

All KINNEY® vacuum pumps manufactured by Tuthill Vacuum & Blower Systems are date coded at time of shipment. In order to assure you of the full benefits of the product warranty, please complete, tear out and return this product registration card.

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Location _____

	City	State/Province	ZIP/Postal Code	Country
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E-mail: _____

Model: _____

Serial Number: _____

Date of Purchase: _____

Date of Startup: _____

PLEASE CHECK ONE

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Vacuum Coating	<input type="checkbox"/>
Pharmaceutical	<input type="checkbox"/>
Semiconductor/Electronics	<input type="checkbox"/>
Food/Meat Packing	<input type="checkbox"/>
Gas/Petrochemical	<input type="checkbox"/>
Other _____	



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