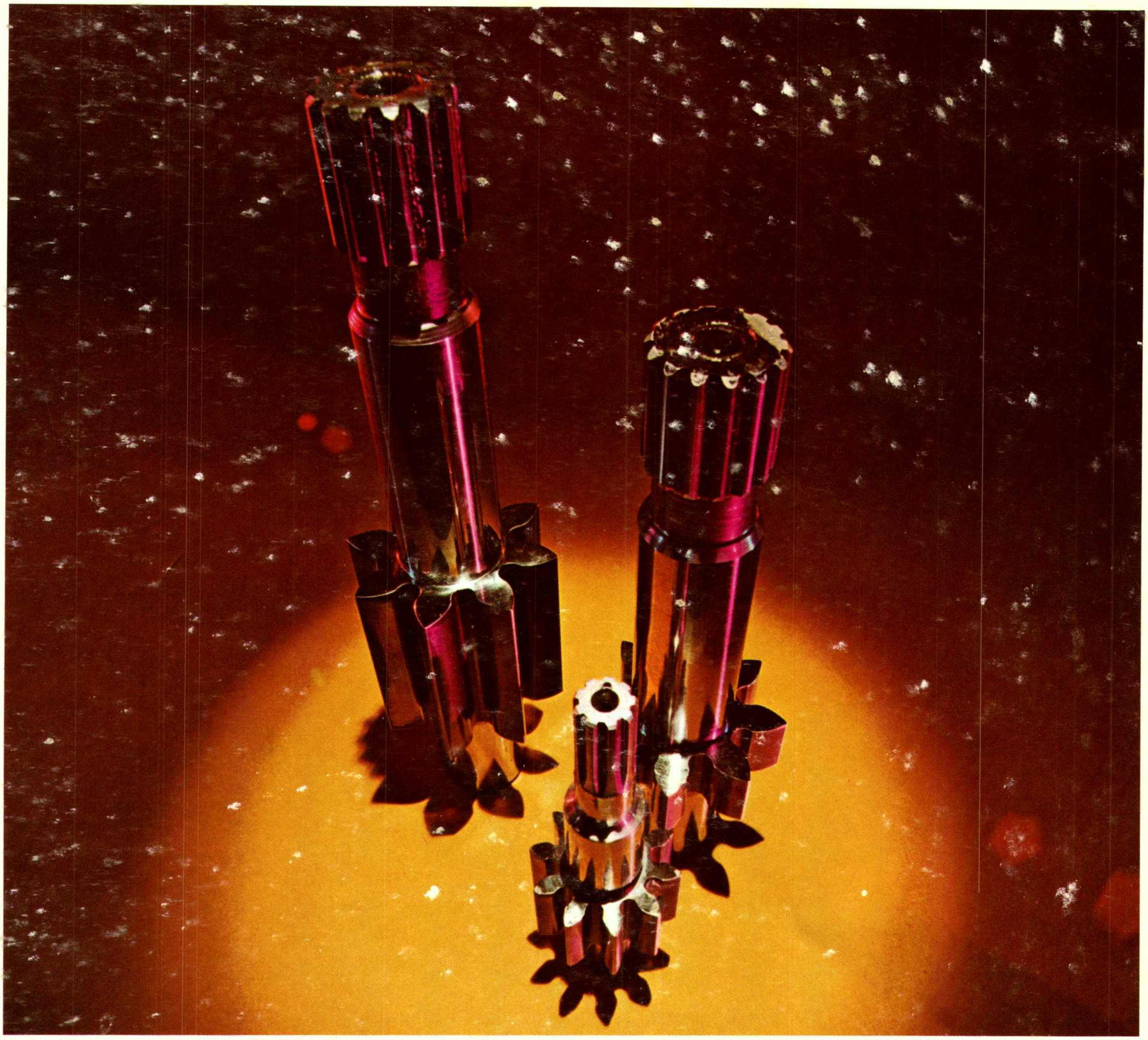
TYRONE®

DANA

DIAGNOSING
Tyrone Gear Pump Failures



GLOSSARY OF TERMS

ABRASIVE WEAR	Wear caused by abrasive action of dirt and fine contaminants in the oil.
AERATION	Presence of air bubbles in hydraulic oil. . .gives oil a foamy appearance.
CAVITATION	Formation and collapse of vapor bubbles in hydraulic oil.
DIRT OR FINE CONTAMINANTS	Very small particles of abrasive material suspended in hydraulic oil. Usually not visible to the naked eye.
EROSION	Removal of metal particles from the surface of a part, leaving a rough, pitted area.
FLUSHING	Thorough cleaning of entire system to remove all contaminants that can or have caused pump failures.
GEAR TRACK	Area in pump housing milled by gear teeth on initial pump break in (at factory) to provide proper tip clearance.
HIGH OIL TEMPERATURE	Temperature above 200° F, when the oil film weakens and its lubricating ability is reduced.
ISOLATION PLATE	Support for pressure balance seals used to separate low pressure and high pressure areas of pressure balance system.
LACK OF OIL	Low oil level in tank. This can allow suction to be uncovered due to sloshing of oil.
METAL CONTAMINANTS	Small particles of metal in the hydraulic oil. Probably have worn from components in the system and may or may not be visible to the eye.
OVERPRESSURE	Pressure in the system exceeds the specified relief valve pressure.
PRESSURE BALANCE	Hydraulic loading of pressure plates to keep them firmly against gear ends. This is essential for high pump efficiency.
PRESSURE PLATES	Plates on each side of gears. The pressure plates and housing form the pumping chamber.
TRAP	Recess in the pressure plates that allow the trapped fluid between the teeth of the pump gears to escape.

GEAR-TYPE HYDRAULIC PUMPS

Modern machines used in construction, logging, mining and material handling rely to an increasing extent on hydraulic systems. The increased productivity of these machines requires that hydraulic pumps have large capacities and high pressure ratings to handle the heavier loads, faster cycles, and higher travel speeds.

High pressures impose greater stress on all components in the hydraulic system. At the same time, increased reliability is required for operational safety. Careful maintenance is essential to reduce failure rate, extend service life, and insure safe machine operation.

Gear-type hydraulic pumps will normally give good performance over a long period of time when operating in a properly maintained system. Clean oil of the correct grade, regular filter changes, and frequent inspections of all hydraulic system components are essential to hydraulic pump performance.

Principle of Tyrone Gear Pump Operation and Identification of Parts

A thorough knowledge of design, principle of operation, and function of each part will help to:

1. Diagnose the cause of the failure.
2. Determine reuse or replacement of parts.
3. Install the pump correctly.

Tyrone Hydraulic Pump Type and Model Identification

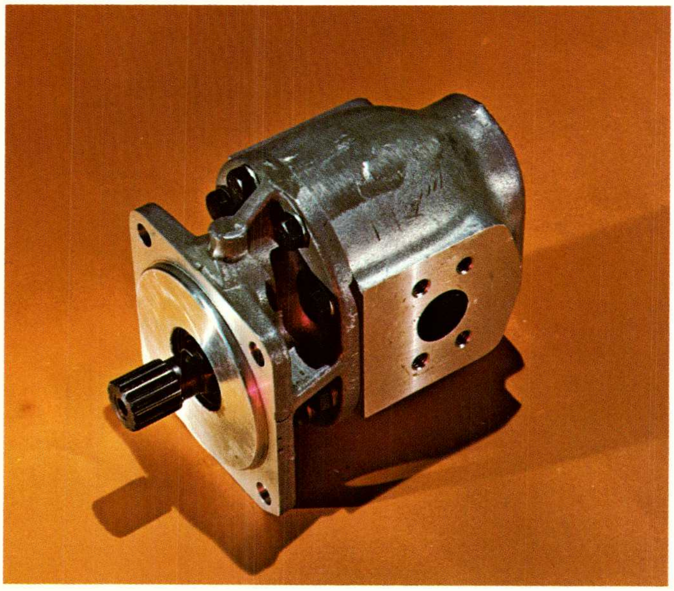


Figure 1. Single section Tyrone Mobil-Master Gear Pump.

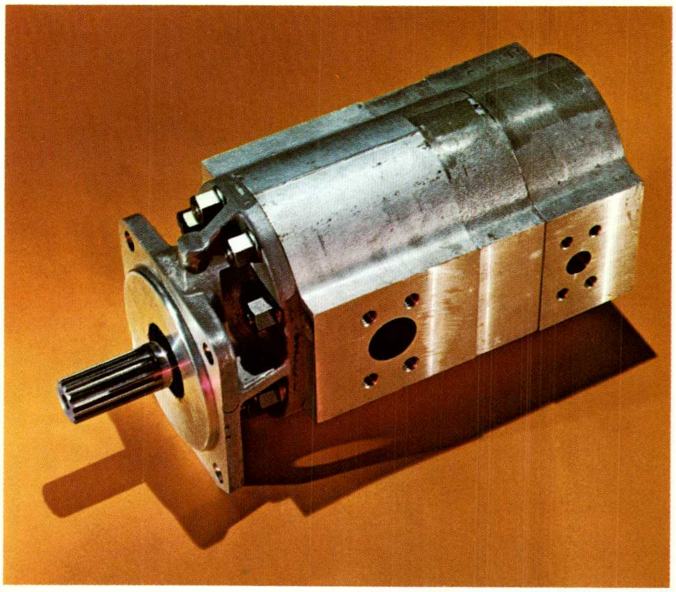


Figure 2. Double section Tyrone Mobil-Master Gear Pump.

Hydraulic pumps are illustrated and identified in Figures 1 and 2.

The correct identification of the type and model of pump is very important. The information that follows covers the Tyrone Mobil-Master Gear Pumps only.

These gear-type pumps are positive displacement pumps and come in two versions: Reversible and Uni-Directional.

A reversible pump can operate in either direction of rotation, without any internal changes. The inlet and outlet ports are determined by the direction of rotation.

A uni-directional pump operates in one direction only. It can be assembled for clockwise or counter-clockwise operation. However, once it is assembled for a specific rotation, it can be operated in that direction only. Correct identification of the type of pump on hand is most important before any service work is attempted on any hydraulic pump.

The following information identifies the individual pump parts, and describes their function.

Parts Identification

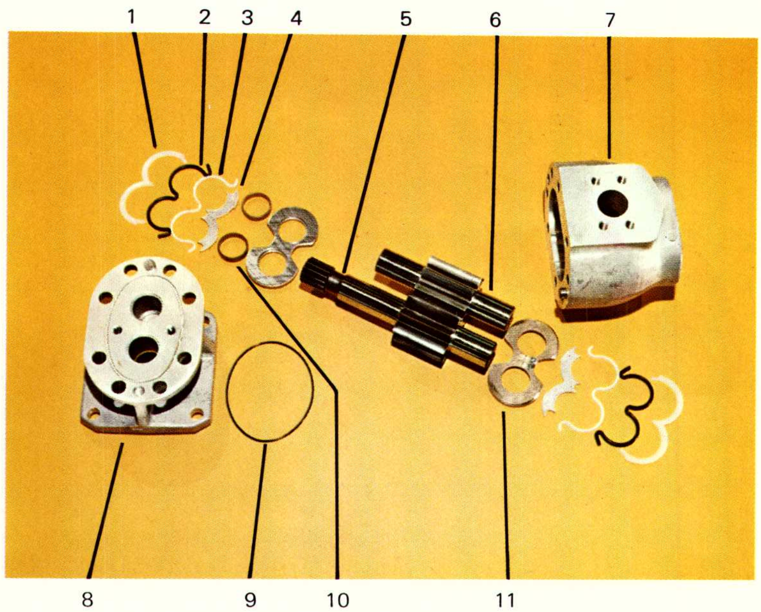


Figure 3. Parts of the single section gear pump of the Uni-directional design: 1-Retainer. 2-Sealing Strip. 3-Back-Up Ring. 4-Isolation Plate. 5-Drive Gear. 6-Idler Gear. 7-Housing. 8-Flange. 9-O-Ring. 10-Support Ring. 11-Pressure Plate.

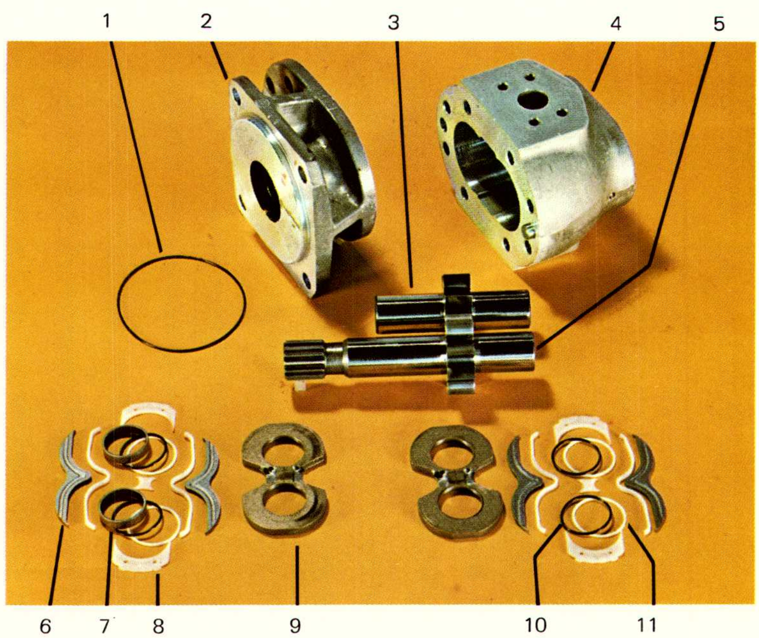


Figure 4. Parts of the single section gear pump of reversible design: 1-O-Ring. 2-Flange. 3-Idler Gear. 4-Housing. 5-Drive Gear. 6-Isolation Plate. 7-Support Ring. 8-Retainer. 9-Pressure Plate. 10-O-Ring. 11-Back-Up Ring.

Parts Identification-(Cont.)

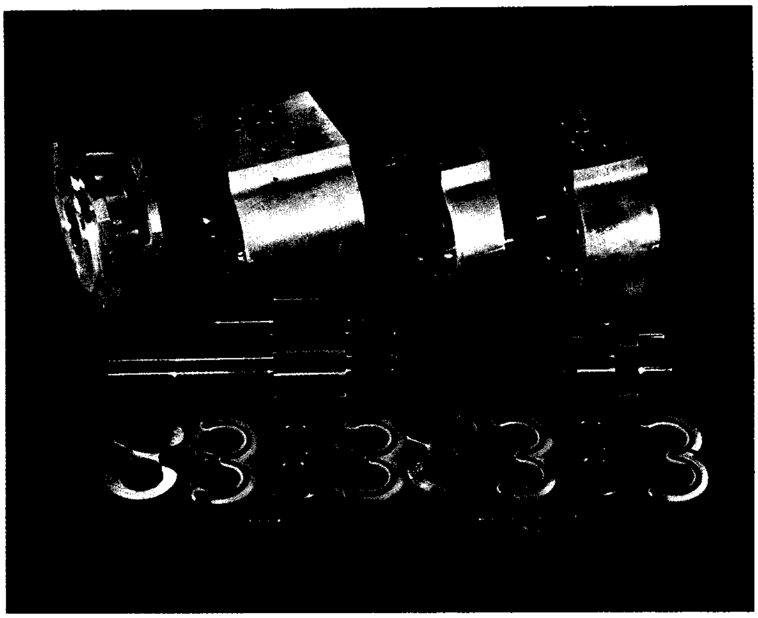
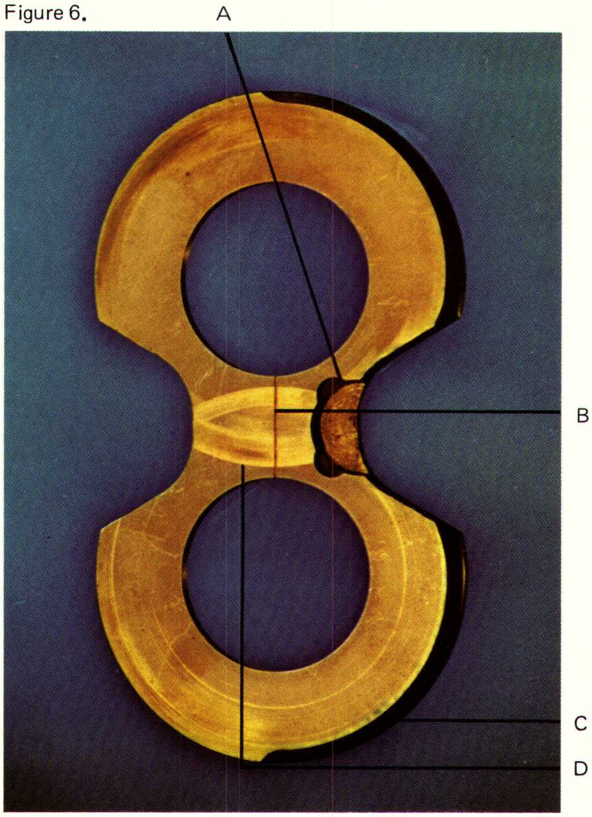


Figure 5. Parts of the double section gear pump. All parts shown, but not listed with a number, are identical to those of the single-section pump. 1-Flange. 2-Front Housing. 3-Center Bearing Plate. 4-Rear Housing. 5-Rear Idler. 6-Front Idler. 7-Rear Drive. 8-Front Drive Gear. 9-Coupling. 10-Stud (8 each). O-Rings (not shown) are located on the back of the flange, and on both sides of the center bearing plate.

Figure 6 shows a pressure plate from the uni-directional pump. This plate seals the ends of the gears to prevent leakage of the fluid from high pressure to inlet. The plate is hydraulically loaded against the end of the gears by discharge pressure. The recess in the plate marked "A" is the trap. This allows fluid trapped between the teeth to escape at the ends. This trap is very important in controlling the noise and performance of the pump. It is on the discharge side of the pump. The groove marked "B" is a lubrication

Figure 6.



groove. A small portion of the fluid is directed into each bore and then down to each bearing, lubricating the shafts. The chamfer marked "C" carries high pressure fluid to the proper point on the plate and provides proper balance. The small lines identified by the letter "D" are caused by the gear tips sweeping across the plates. Some discoloration and very slight grooves are quite common in this area.

The suction side of the pump housing is shown in Figure 7. During initial break-in at the factory, the gears cut into the housing. The nominal depth of this cut is .008" (0,203 mm) and should not exceed .015" (0,381 mm). This gear track provides low gear tip clearance and high volumetric efficiency. Note the smooth machined appearance of the gear track. Small bits of metal are sometimes pulled out of this surface during break-in. This is not detrimental.

Figure 7.

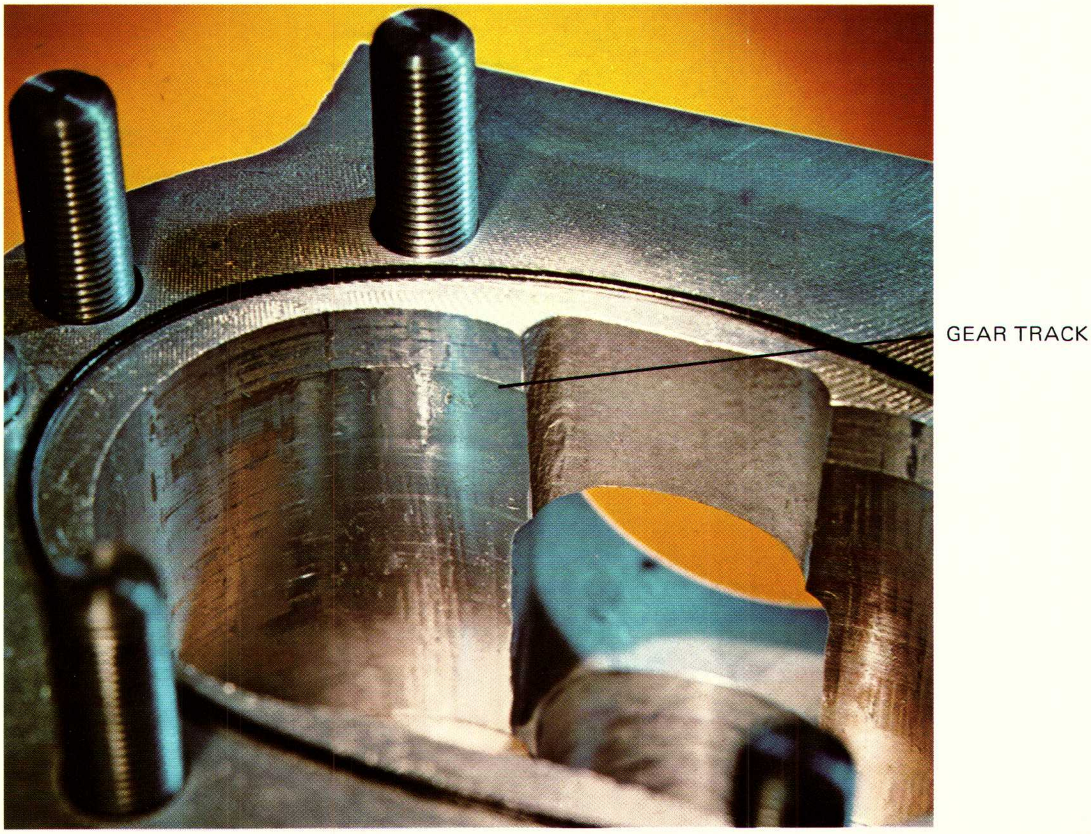


Figure 8.

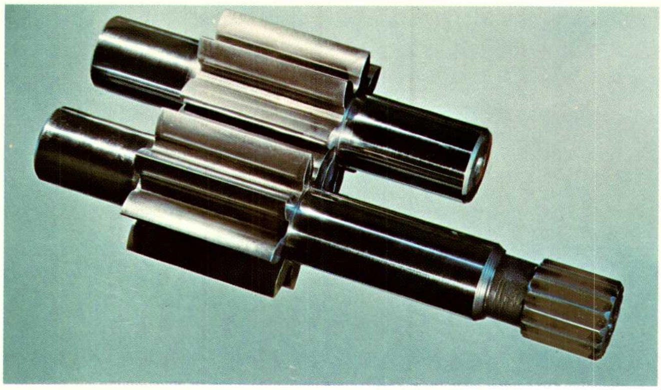
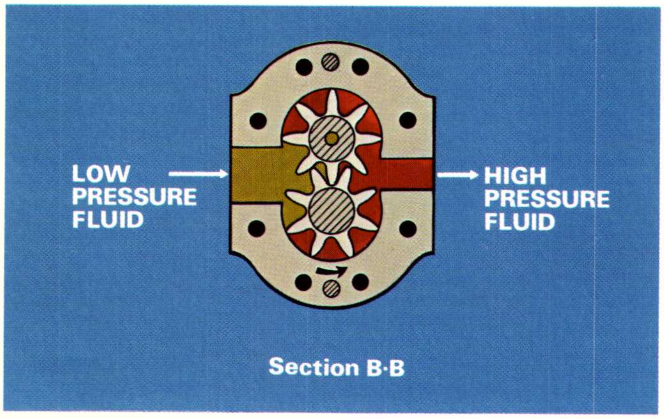


Figure 9.



The drive and idler gears from a properly operating pump are shown in Figure 8. Note the polishing of the loaded side of the gear teeth. Some pitting near the root of the tooth will occur after extended operation. The high gloss of the journals also indicates a properly operating pump.

Figure 9 shows the distribution of high pressure and low pressure fluid within the gear cavity.

In Figure 10, a section is taken through the center of the gears. High pressure fluid from the discharge is directed behind the plates to push them against the ends of the gears. The fluid indicated by yellow is low pressure fluid returning from the ends of the bearing back through drilled passageways to the inlet of the pump.

Figure 11 is a cross sectional drawing showing the fluid flow within the single section pump. A portion of the oil being pumped flows down the lubrication groove in the pressure plates and enters each bearing. This flow is collected at the ends of the bearings and returns through drilled passageways to the inlet of the pump.

Figure 12 shows a cross section of a two section

Figure 10.

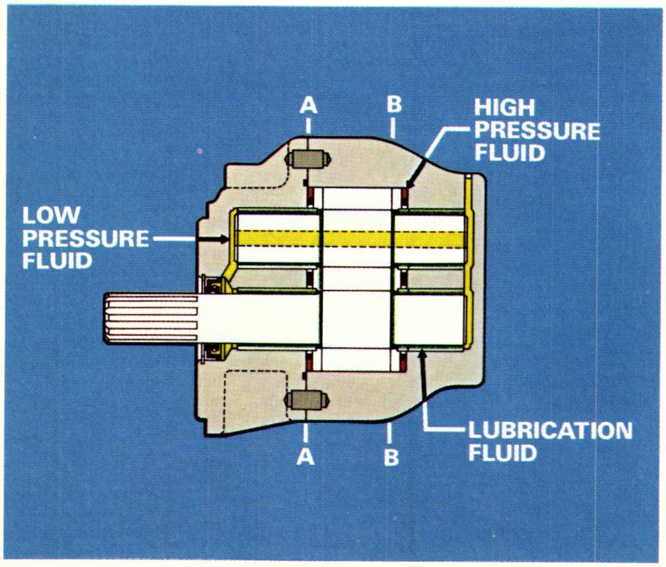
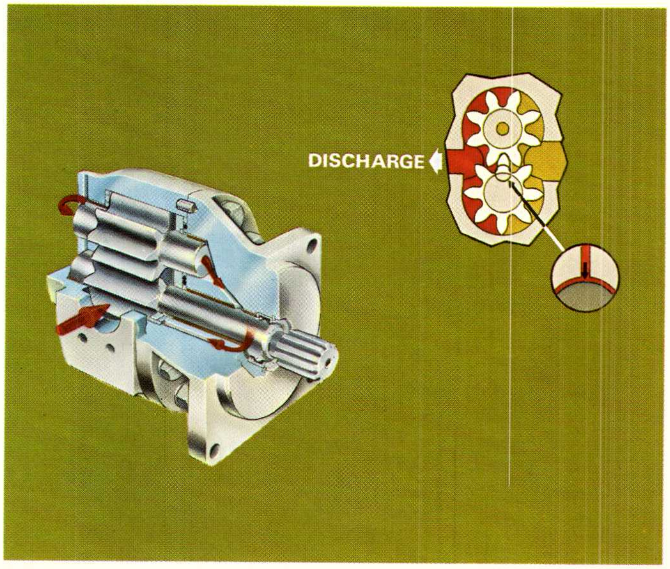


Figure 11. Single section pump.



pump along with the path of the fluid within the unit as indicated by arrows. As in the single section pump, part of the discharge flow enters the lubrication groove in the pressure plate on each end of the gears and is fed to each bearing. The oil is again collected at the ends of the bearing and returned back to the inlet end through a series of drilled passages.

The isolation plates used in reversible gear pumps are shown in Figure 13. Two of these plates are needed in the bottom of the housing, and two in the top. The isolation plates hold the seal components in place. The plates with a round edge along the outer radius on one edge go in the bottom of the housing. Plates with square edges on the radius go next to the top flange.

Pressure distribution on the back side of the pressure plate for a reversible unit when operating clockwise is illustrated in Figure 14.

Pressure distribution for counterclockwise rotation is illustrated in Figure 15.

Only two isolation plates are needed per unit in uni-directional gear pumps. The plate with the rounded edges along the outer radius goes in the bot-

Figure 13. Isolation Plates for Reversible Pumps.

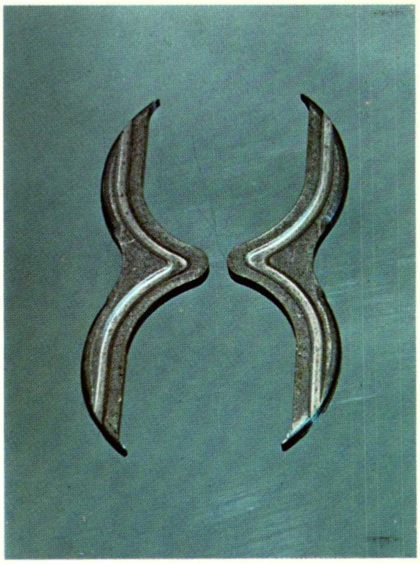


Figure 14.

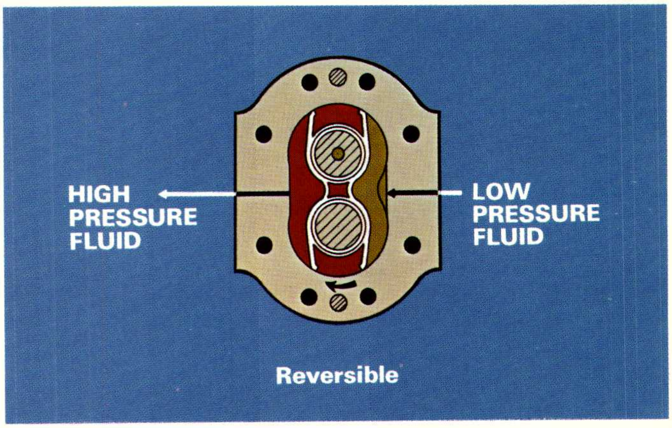


Figure 12. Two Section Pump.

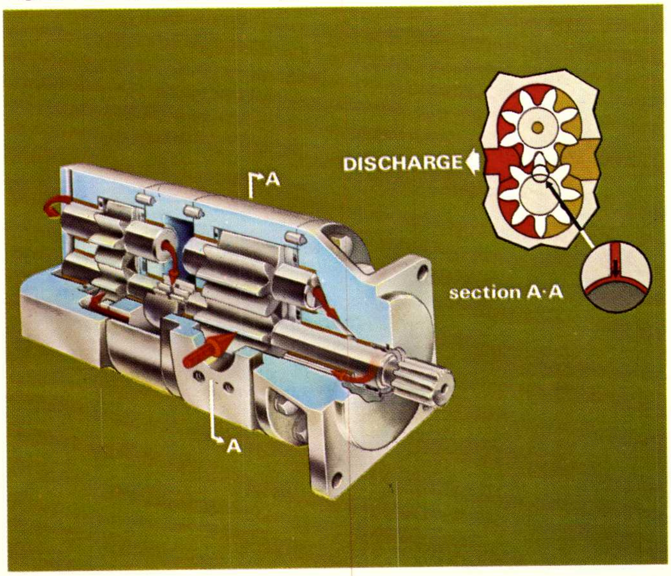


Figure 15.

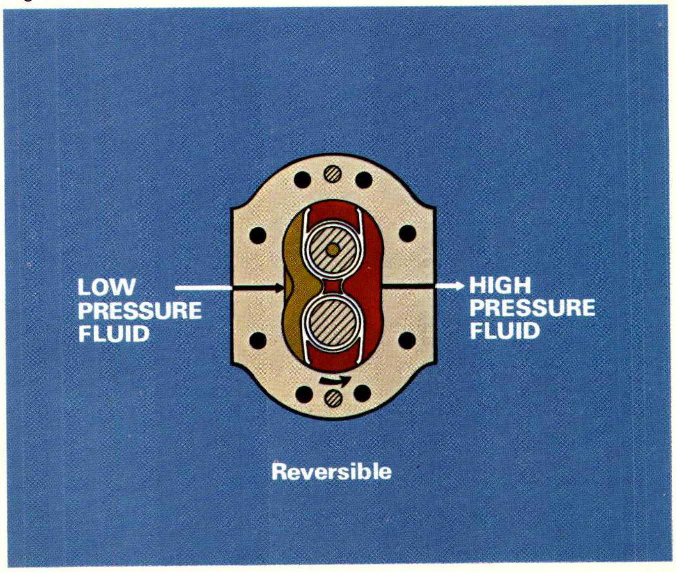


Figure 16. Isolation Plates for Uni- Directional Pumps

Figure 17.

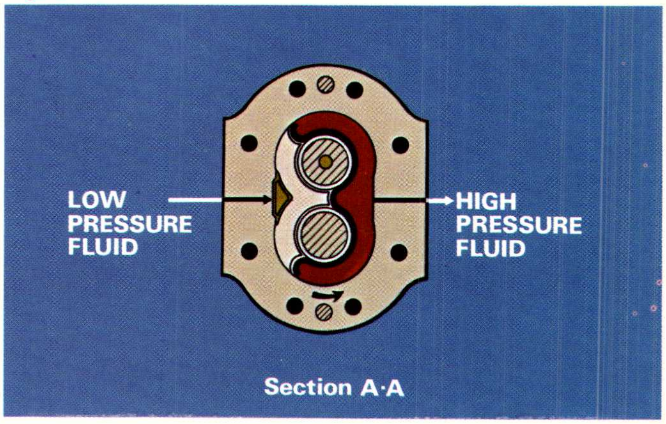


Figure 18. Reversible Uni-Directional Flanges.

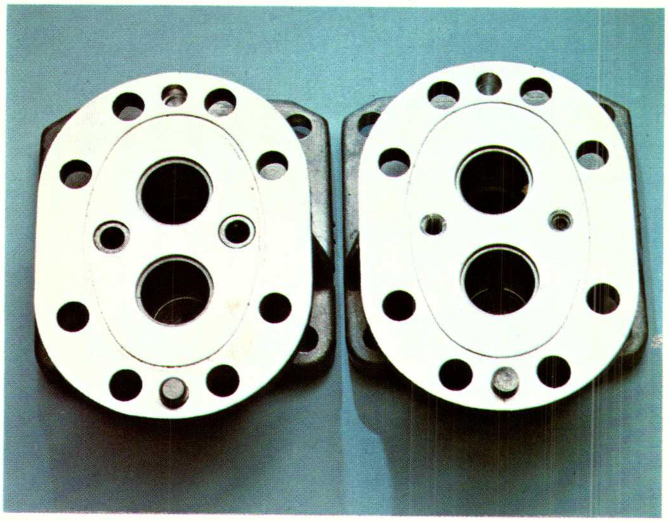
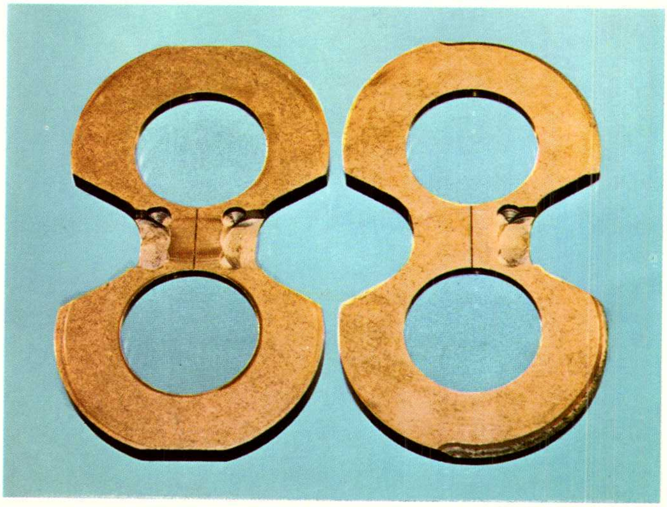


Figure 19. Reversible Uni-Drectional Pressure Plates.



tom of the housing, with the round edge down. The plate with square edges along the radius goes on top, next to the flange.

In Figure 17, the distribution of the high pressure on the back side of the pressure plates is shown. This area is of sufficient size to keep the pressure plate tight against the ends of the gears.

A pump can also be identified as a reversible or uni-directional unit by the following items: Flange, pressure plate, and isolation plates.

Figure 18 shows the flanges for uni-directional and reversible pumps. The uni-directional flange is on the right. Note the two threaded holes near the bearing bores. A pipe plug is installed in the hole which is on the high pressure side of the pump. The location of the plug is therefore determined by the direction of rotation for which the pump is assembled. The flange on the left side has a check valve on each side, and will operate automatically for either rotation of the pump.

The uni-directional pump pressure plate is on the right and has only one set of traps. (See Figure 19). The reversible pump pressure plate on the left side has two sets of traps and a flat on each end of the plate.

When changing operating directions of uni-directional pumps, see your Service Manual for details or Tyrone Pump Bulletin No. 101.

HYDRAULIC GEAR PUMP FAILURE ANALYSIS

Determine Cause of Failure

Some failures result from only one cause and the reason is often obvious. Other failures are a result of a combination of causes. You must be very careful to determine all of the causes and eliminate them to prevent repeat failure. Examine all of the components available, and consider all other factors which may have contributed to the cause. It is often very helpful to have some history of the machine. To completely analyze a hydraulic pump failure consider the following items:

1. Condition of each pump component.
2. Type and condition of hydraulic oil and filters.
3. Operating conditions and symptoms before failure.
4. Conditions of other hydraulic system components.
5. Severity of job application.
6. Amount of service received from pump before failure.
7. Previous failures and repairs in the hydraulic system.

Prevent Repeat Failures

A knowledge of the pump service life is an essential part of pump servicing. Even if the pump provided a satisfactory period of service before failure, several precautions must be taken to insure that the new pump will provide a similar period of service. See Installation Instructions for Replacement Hydraulic Pumps, Page 19. If the machine's records indicate that pump life shortens with each replacement pump, you can be sure that these instructions were not followed. The troubleshooting information and the illustrations should help in diagnosing hydraulic pump failures.

For details on operation, service, and repair of any part of the hydraulic system refer to the appropriate service manual for the machine.

WHAT CAUSES HYDRAULIC PUMP FAILURE?

There are several causes for gear pump failure. This booklet discusses these causes and the various indicators or symptoms of each cause. It further explains pump failure analysis and the preventive measures you can take to avoid repeat failure. Common causes of pump failure are:

1. Abrasive wear caused by fine particles.
2. Abrasive wear caused by metal particles.
3. Incorrect installation.
4. Aeration or cavitation.
5. Lack of oil
6. Damage caused by metal objects.
7. Excessive heat.
8. Overpressure.
9. Incorrect assembly.

ABRASIVE WEAR CAUSED BY FINE PARTICLES

Abrasive wear caused by fine particles is the most common cause of pump failure. Its symptom is usually a gradual decrease in power and speed of the hydraulic system. Fine particles (dirt, and other foreign matter) circulating through the system cause wear on all components, especially noticeable on pressure plates, housing bores, and in the shaft bearing area.

Dirt can enter the system through worn seals, or if the system is serviced in dusty conditions, or with dirty equipment. Always wipe tank caps, funnels, and all areas around the filler neck clean before opening the tank. Immediately cover all disconnected lines, fittings and openings. Check the rod wiper seals to be sure they are operating effectively.

The effectiveness of the cylinder rod wiper seals can be checked as follows, depending on the design of the seal:

A. V—Type Rod Packings:

1. Extend the cylinder rod (WARNING: When checking lift cylinder wipers, block the bucket securely in raised position.)
2. Remove the bolts securing the wiper seal retainer to the cylinder head.
3. Coat the rod with grease.
4. Slide the retainer and wiper seal up the rod.
5. Examine the rod. The wiper should wipe the rod clean. If the wiper does not remove all the grease 360° around the rod, it is too loose and should not be used.

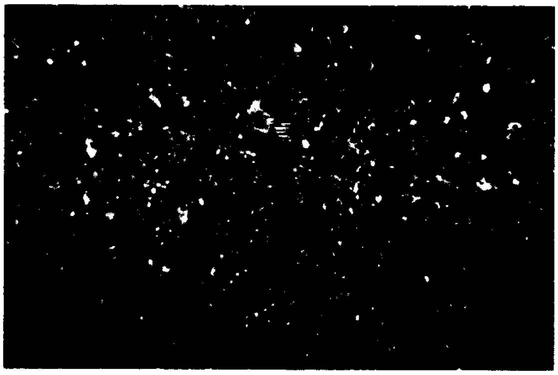
B. Lip-Type Wiper Seals with Buffer and U-Cup Rod Seals.

These rod seal arrangements do not have a retainer on the cylinder head that can be removed for checking the wiper seal. The wiper seal is mounted inside the counterbore of the head and can be inspected visually. A better check can be made by trying to insert a .001" or .002" (0,025 mm or 0,050 mm) feeler gauge between the wiper seal lip and the rod. If the wiper seal is effective, the feeler gauge cannot be inserted. The rod should not be in a scratched, scored or otherwise damaged condition.

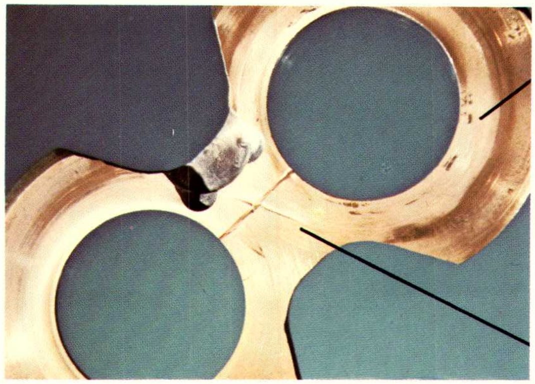
The fine particles that cause abrasive wear are usually not visible to the eye. The size of these particles is about 40 microns. Their relative size as compared to a human hair is shown in Figure 20. Oil containing particles of this size can actually look clean while having enough abrasive particles to cause pump failure.

NOTE: 1 micron = 1/1000 millimeter or .0000394 inches.

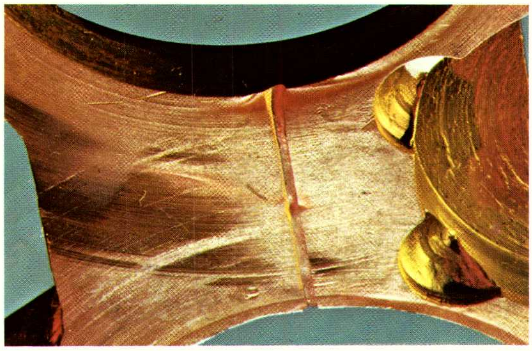
Figure 20. Relative size of 40 micron particles to human hair.



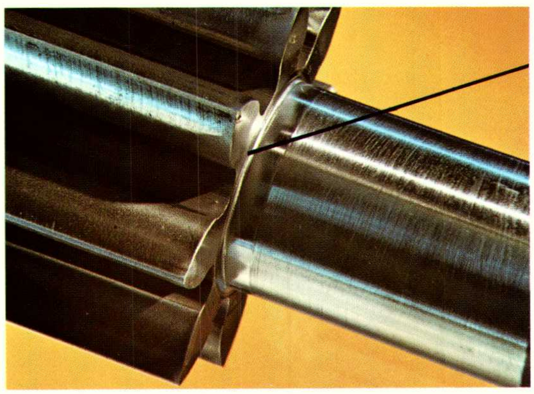
21
Identification: An approximate 1/4 inch wide sandblasted appearing band around the pressure plate bores is present. This is positive identification of fine particles. (Large quantity of 40 micron size.)
A small groove at an angle to the lube groove will often be present with fine particle abrasive wear.

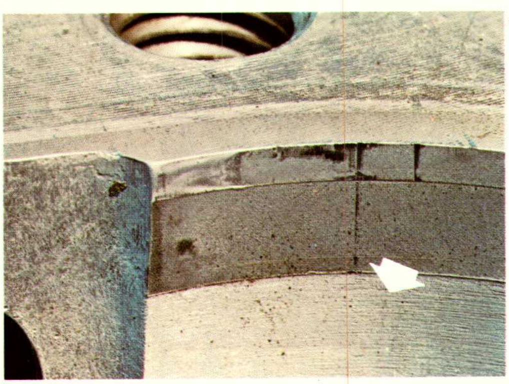


22
Identification: Contamination by fine particles will cause the edges of the lube groove to be rounded and the ends to be enlarged.



23
Identification: A dull sandblasted area may appear at the root of each tooth at the face of the gear. This is caused by contaminated oil flowing down the lubrication groove.
The shaft will have a dull finish the length of the bearing surface as if it had been sanded with fine sandpaper. This is caused by fine abrasive particles from the oil being embedded in the bearing. Either or both conditions may show up depending on concentration of contamination.



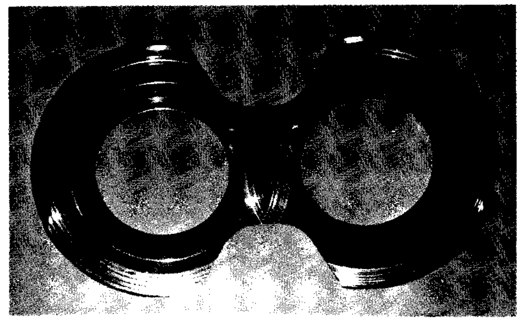


◄24
Identification: Contamination by fine particles will cause the gear track to be gray with a sandblasted appearance. This will occur at the inlet side only.

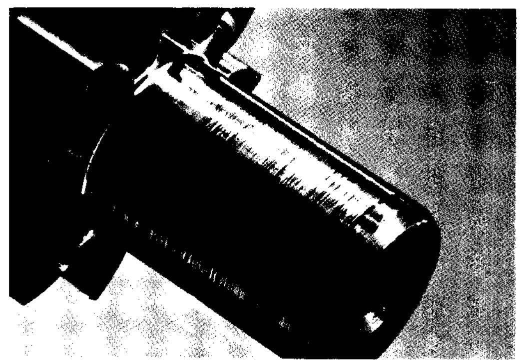
Identification: The seal lip will cut into the shaft. Fine abrasive particles will get under the seal lip and wear grooves in the shaft. 25►

ABRASIVE WEAR CAUSED BY METAL PARTICLES

Metal contaminants usually result from wearing components in the hydraulic system or insufficient flushing after a previous failure. Metal particle damage may be gradual or fairly sudden depending on quantity and size of particles. Metal particle damage is indicated by surface scratches on pressure plates.



26
Identification: The pressure plate will have many circular scratches caused by particles of more than 100 microns in size. If exposure to this size particle is continued long enough, the entire surface will be very rough and heavily grooved.

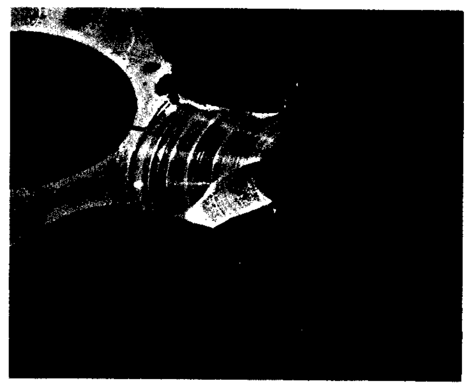


27
Identification: The bearing area of shaft will have many small grooves. The severity of damage will depend on the following conditions:
1. The amount of contamination in the system.
2. Operating pressure.
3. On double section pumps, one section may show greater damage than the other due to difference in bearing loads. (Loads depend on gear width and operating pressure.)

28
Identification: Worn housing will have small grooves in gear track caused by large particles being caught between tips of the gear teeth and body. This is usually caused by metal particles from failure of another component such as cylinder and valve or failure to clean system properly after previous failure.
These particles usually can be picked up from the bottom of the reservoir with a magnet.
Particles may also be detected in the pleats of the machine filter with a magnet.

INCORRECT INSTALLATION

Incorrect installation can impose external loads on the pump which cause various failures. Be sure drive shaft does not bottom in mating part. Piping should be attached to the pump without force. Pump should clear all machine components in all types of operation.



29
Identification: Wear will be visible on the pressure plate at rear of drive gear only. This is caused by the drive shaft bottoming out in the machine drive coupling. This puts heavy thrust load on drive shaft.

AERATION OR CAVITATION

Aeration and cavitation are discussed together because they act very much alike in the system. In both cases, oil vapor or air bubbles in the oil cause pump damage. This type of failure is rare and careful investigation is required to pinpoint it.

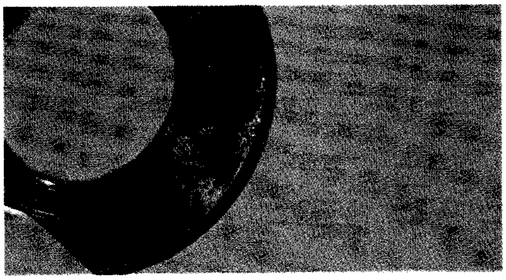
Aeration occurs when air mixes with the oil. Air may enter the system through a small suction leak or by agitation of the surface of the oil in the tank. Surface agitation occurs when return oil is dumped back above the surface of the oil. This can occur due to a high pressure leak inside the tank, or loose or failed lines inside the tank.

Cavitation is the formation and collapse of vapor bubbles in the oil. This is usually the result of the pump suction being restricted. Cavitation occurs more readily when the oil is hot.

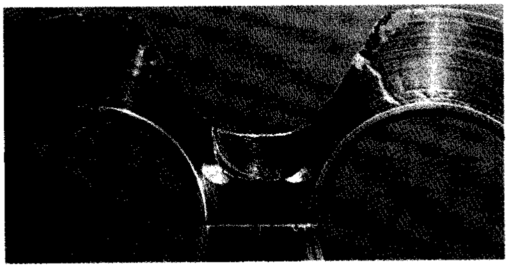
Aeration and cavitation erode and pit the pressure plates and pump housing. As the air or vapor bubbles in the oil are compressed to pump discharge pressure they collapse. This collapse is called an implosion. The force of the implosion removes metal from the pressure plates and housing.

A pump cavitating or operating on aerated fluid is usually noisy. It makes a sound like pumping marbles. The system operates in a spongy or jerky action.

30
Identification: Erosion will be evident on the suction side in the gear track. Small marks sometimes appear in the gear track during pump break in. Small particles of metal pull out, leaving holes about 1/16 inch across. These should not be confused with erosion caused by aeration or cavitation.
Cause: Air Bubbles in Oil or Starved Suction



31
Identification: Pressure plate will have an eroded area near end of chamfer. Erosion on plates progresses at a much slower rate than in the body of the pump.
Cause: Air Bubbles in Oil or Starved Suction



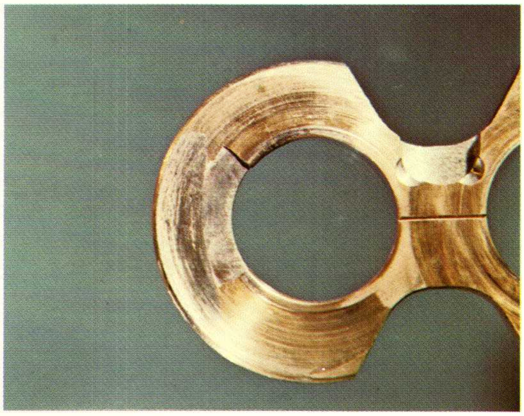
32
Identification: There will be an eroded area on the pressure plate on discharge side of pump. This type of erosion on pressure plate usually appears in conjunction with erosion on discharge side of body as shown in Figure 33. It results from the same causes.

33
Identification: The housing will have an eroded area on the discharge side of pump.
Erosion of this area is very unusual. It is caused by one or more of the following:
1. Leak in suction line.
2. Oil being returned above oil level in reservoir causing severe foaming.
3. Suction line restricted or too small.

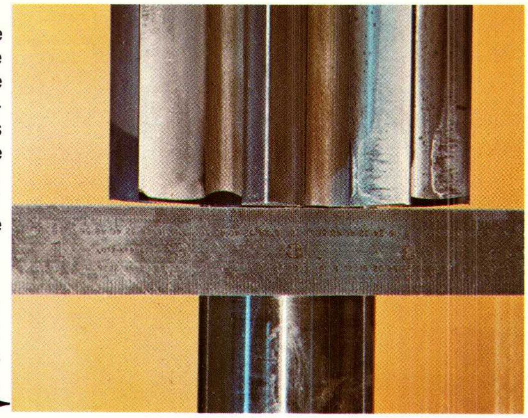
LACK OF OIL

When failure due to lack of oil occurs, the deterioration is usually very rapid. This type of failure can occur from either of two conditions; (1) Oil level low in reservoir allowing suction to be uncovered due to sloshing of the oil, (2) Large air leak in suction line.

This type of failure may occur with relatively little damage to the bearings. Bearings may also fail if the pump is allowed to run too long before removal.



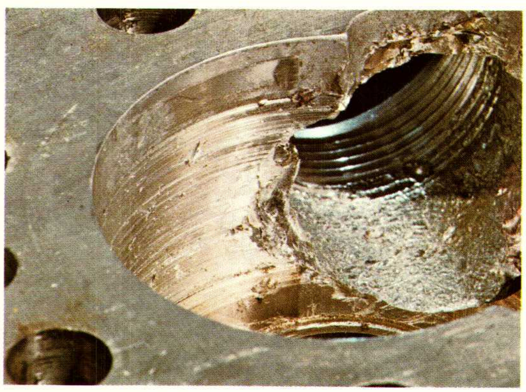
←34
Identification: There will be heavy wear on the end of pressure plate. Low oil level may allow the suction to be completely uncovered for short periods of time. This can occur during machine operation (due to sloshing action) even though suction may be well below oil level when the machine is not moving.



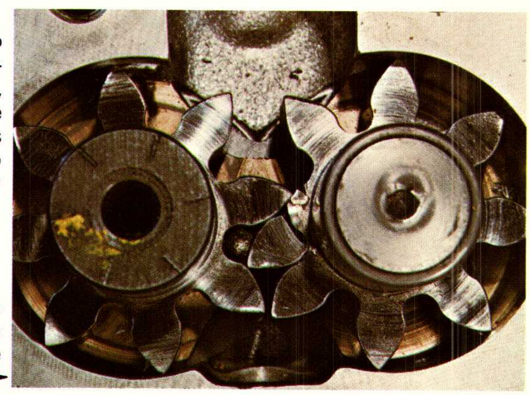
Identification: Heavy wear on end of gear usually occurs on both ends of gear. The wear is greater near the outside diameter.
35→

DAMAGE CAUSED BY METAL OBJECTS

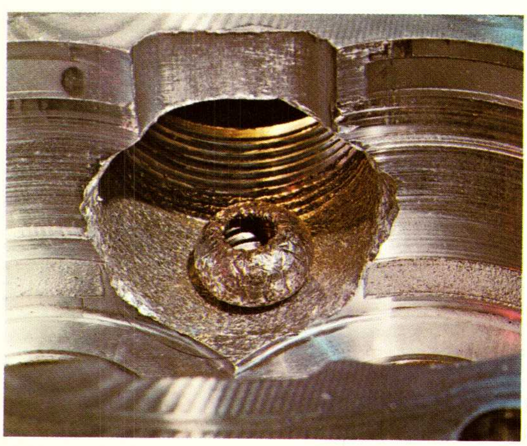
A pump failure due to large size metal object damage is usually very sudden. It is possible, however, for the pump to completely destroy the metal object and pump it downstream. In either case, the results are easily observed and identified.



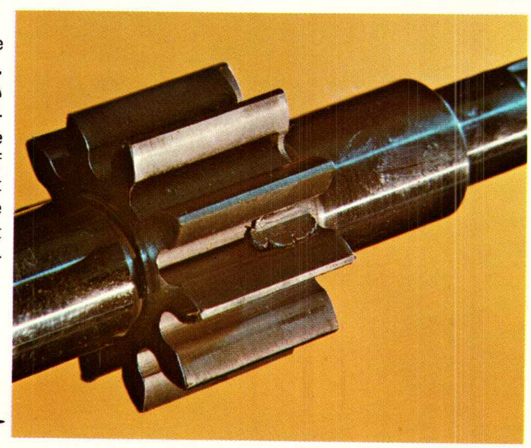
←36
Identification: There will be deep grooves cut into the housing. Created by any large metal object, such as a nut or bolt, entering the suction side of the pump. This causes deep grooves in the pump housing, and may cause heavy peening in the pump inlet port.



Identification: The broken tooth in Figure 37 was caused by a metal object caught between the gear teeth. 37→



←38
Identification: There will be severe peening of the pump inlet port. The object shown in the inlet is a hex nut. Foreign objects frequently will not be found since they are completely destroyed if pump continues to run. When it becomes small enough to be caught between the gear teeth, it may cause damage shown in Figure 37.

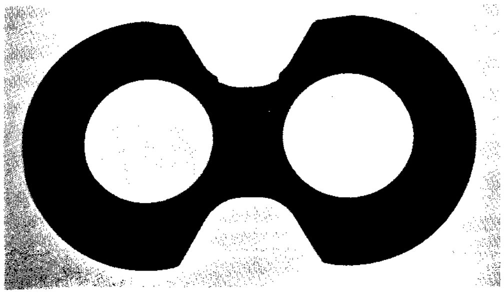


Identification: Soft metal object caught in gear teeth will cause the pump to lock up. 39→

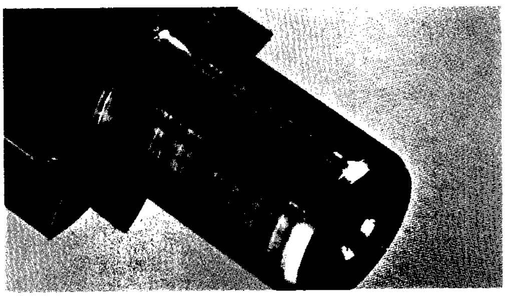
EXCESSIVE HEAT

Excessive heat will turn pressure plates and gears black and harden O-rings and seals. (If the excessive heat is of short duration, a temperature of more than 300° F is required to produce these results.)

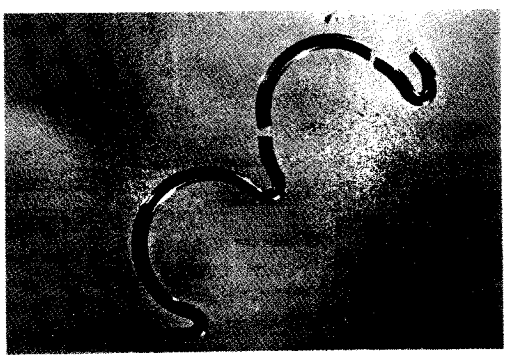
Excessive heat usually results from a sticking valve or a relief valve set too low. If a sticking valve does not return to the neutral position, the pump flow will be dumped continuously. This will over heat the system rapidly. If a relief valve is set too low, part of the oil will be dumped across the relief valve each cycle. In this case the machine will be very slow.



40
Identification: Entire plate will be coated with a black substance. Surfaces otherwise will show very little damage. Oil temperatures of well above 300° F are required to cause this type of damage. The plate cannot be reused.



41
Identification: Shaft and gear will be black all over. Shaft will show some bright streaks but no real grooves. Oil temperatures of well above 300° F are required to cause this type of damage.
Parts are not reusable. The bearing surfaces are damaged by such excessive temperatures.

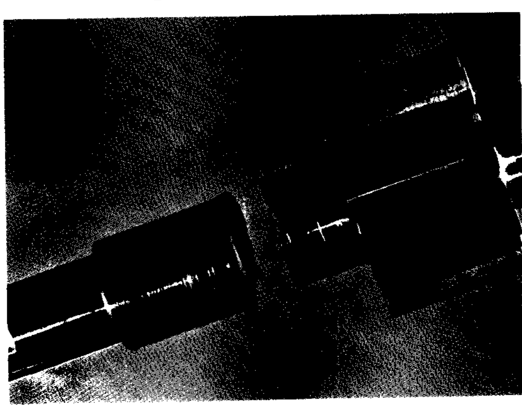


42
Identification: Seal strip will be extremely hard and brittle. It will snap like glass. Oil temperatures of well above 300° F will cause this condition in a few hours. Long exposure to temperature of 225° F will harden this part but it will still have some flexibility.
Excessive heat conditions may result from one or both of the following causes.

1. Control valve stuck, causing flow to be dumped at relief pressure continuously.
2. Relief valve setting too low, causing part of pump flow to dump over relief each time implement is used.

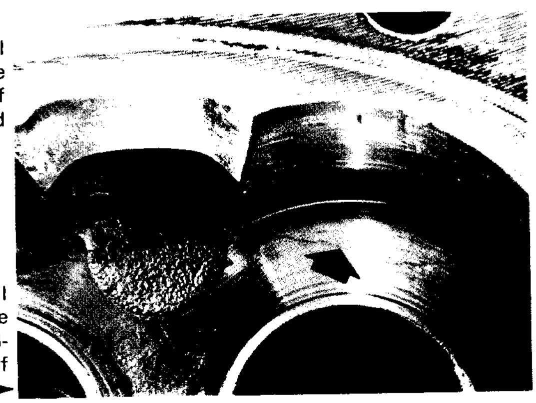
OVERPRESSURE

There can be two reasons for over pressure: (1) The relief valve fails to function. This produces one extreme surge and immediate failure. (2) The relief valve setting is too high, and results in repeated excessive pressure peaks. The damage to the pump looks very much the same for both types.



◄43
Identification: The shaft will break. This type of failure may be caused by failure of the relief valve to function or by repeated surges of excessive pressure.

Identification: The housing will crack. This type of failure may be caused by relief valve malfunction, or by repeated surges of excessive pressure. 44►

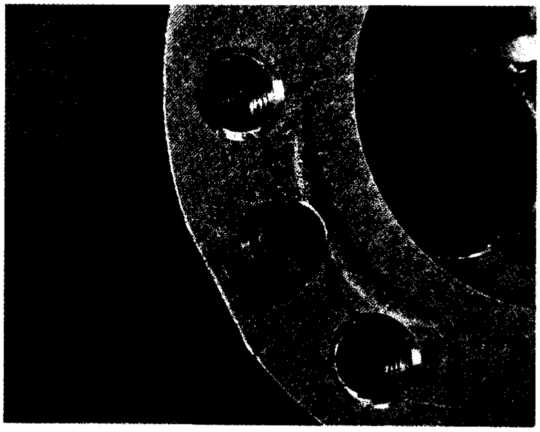


INCORRECT ASSEMBLY

This type of failure is self explanatory. Either the components were faulty or parts were not assembled correctly.

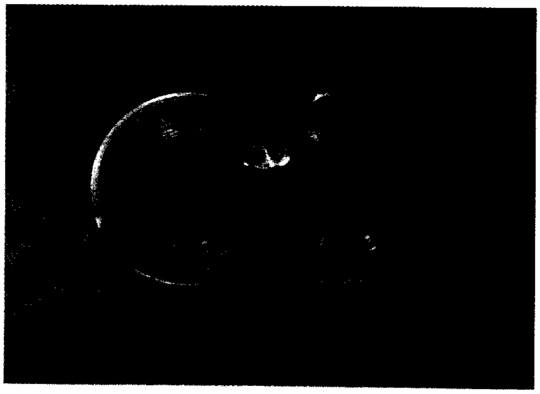
45

Identification: Pinching of the O-ring seal will occur if the O-ring is not properly placed in its groove. When the plates are bolted together, part of the O-ring will squeezed flat.



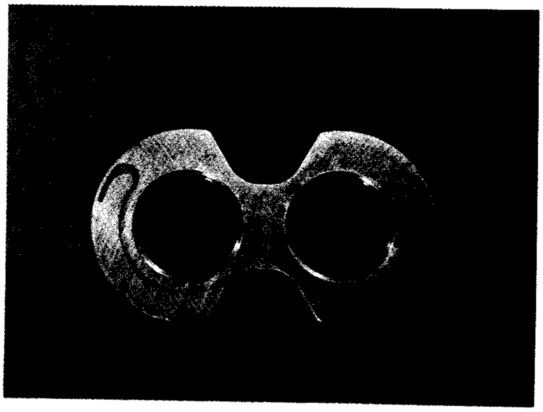
46

Identification: The surface of the housing will show a depressed area. This is caused by the O-ring being squeezed as shown in Figure 45.



47

Identification: There will be a smeared surface on the bronze side of pressure plate.
Possible Causes:
1. Isolation plate without radius installed in bottom of housing resulting in insufficient clearance.
2. Pressure plate installed in pump with chamfer and traps on suction side of pump rather than discharge side. This can be determined by checking Figure 48.



48

Identification: The sealing strip usually leaves a faint print on the steel side of the pressure plate. This print should be directly behind chamfer and traps. Observing this print makes it possible to determine if pump was properly assembled.

REPLACEMENT HYDRAULIC PUMP INSTALLATION INSTRUCTIONS

The preceding information should be a valuable tool in diagnosing hydraulic pump failures. A pump failure may not be as clear cut or as well defined as the examples given here. Failure may be due to a combination of causes. Understanding the different causes of pump failure will eliminate repeat failures.

When a Pump Fails

1. Determine cause of failure.
2. Eliminate cause of failure.
3. Retract all cylinder rods.
   (A) Drain tank.
4. Flush tank.
   (A) Using Diesel Fuel under pressure flush tank thoroughly and wipe with clean cloths.
5. Install new filter elements.
   (A) Check filter element to make sure it is 10 micron or better.
   (B) If machine does not have filtration, install 10 micron filter on return line. The filter must be able to filter a minimum of 20% of the total pump flow. It can be installed on one return leg of a multiple pump circuit and still be effective.
6. Install new pumps.
7. Fill the tank with new oil.
   (A) Be sure recommended oil is used.
   (B) NOTE: You are filling the system, not just the oil supply tank. Pump failure due to lack of oil can result if filling is not done correctly. The tank may contain only enough oil to take care of changes in volume when the cylinder rods are extended. Keep close check on oil level as following steps are completed.
8. Disconnect all lines to cylinders and/or motors at the cylinder or motor.
   (WARNING: Be sure all implements are securely blocked and all accumulators are bled before disconnecting lines.)
9. Activate each circuit by moving the control valve handle so lines are flushed with new oil. This flushes the lines and valves from pump to all cylinders and motors.
   (WARNING: Check oil level and add new oil if required.)
10. Connect lines to blind end of cylinders and all fluid motors. Leave rod end disconnected and with engine at one-fourth throttle, activate circuits slowly until cylinder bottoms out. New oil will be put in the blind end of the cylinder and old dirty oil flushed out rod end. Do this for all cylinders on the machine.
11. Connect lines to rod end of cylinders.
    (WARNING: Check oil level and add new oil as required.)
12. Operate all cylinders and motors alternately for 30 minutes at full throttle.
13. Change filter element. Check oil level and add new oil if required.

The above procedure, if followed, will allow you to install a new pump and know you will get satisfactory pump life. To short cut these steps will cause premature pump failure. A pump will not run on a contaminated system.

In nearly all cases a replacement pump will fail in a shorter time than the pump preceding it unless the system is thoroughly cleaned.

To insure good service from your equipment, the hydraulic system must be properly maintained. Recommended procedures include:

1. Check oil level frequently.
2. Inspect for leaks daily.
3. Change filter elements and the oil at the recommended intervals.
4. Use the correct filter elements and the recommended grade of oil.
5. Use good operating techniques.

TROUBLESHOOTING GUIDE FOR GEAR TYPE HYDRAULIC PUMPS

IDENTIFICATION	FIG. REF.	PAGE NO.	CAUSE	CORRECTIVE CHECKS
1. Sandblasted band around pressure plate bores 2. Angle groove on face of pressure plate 3. Lube groove enlarged and edges rounded 4. Dull area on shaft at root of tooth 5. Dull finish on shaft in bearing area 6. Sandblasted gear bore in housing	21 21 22 23 23 24	13 13 13 13 13 13	I. Abrasive wear caused by fine particles. 1. Dirt (fine contaminants, not visible to the eye)	1. Was clean oil used? 2. Was filter element change period correct? 3. Were correct filter elements used? 4. Cylinder rod wiper seals in good condition? 5. Cylinder rods dented or scored? 6. Was system flushed properly after previous failure?
1. Scored pressure plates 2. Scored shafts 3. Scored gear bore	26 27 28	14 14 14	II. Abrasive wear caused by metal particles 1. Metal (coarse) contaminants, visible to the eye	1. Was system flushed properly after previous failure? 2. Contaminants generated elsewhere in hydraulic system? 3. Contaminants generated by wearing pump components?
1. Any external damage to pump 2. Damage on rear of drive gear and rear pressure plate only	 29	14 14	III. Incorrect Installation	1. Did shaft bottom in mating part? 2. Any interference between pump and machine?
1. Eroded pump housing 2. Eroded pressure plates	30 33 31 32	15 15 15 15	IV. Aeration – Cavitation 1. Restricted oil flow to pump inlet 2. Aerated oil	1. Tank oil level correct? 2. Oil viscosity as recommended? 3. Restriction in pump inlet line? 4. Air leak in pump inlet line? 5. Loose hose or tube connection near or above oil level in tank? 6. Excessive operation of relief valve?
1. Heavy wear on pressure plate 2. Heavy wear on end of gear	34 35	16 16	V. Lack of Oil	1. Was oil level correct? 2. Any leaks in piping inside tank? 3. Any oil returning above oil level?
1. Housing scored heavily 2. Inlet peened and battered 3. Foreign object caught in gear teeth	36 38 37 39	16 16 16 16	VI. Damage caused by metal object	1. Metal object left in system during initial assembly or previous repair? 2. Metal object generated by another failure in system?
1. Pressure plate black 2. O-rings and seals brittle 3. Gear and journals black	40 42 41	17 17 17	VII. Excessive Heat	1. Was a valve stuck? 2. Was relief valve too low? 3. Was oil viscosity correct? 4. Was oil level correct?
1. Broken shaft 2. Broken housing or flange	43 44	17 17	VIII. Over Pressure	1. Relief valve setting correct? 2. Did relief valve function?

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