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Draft
Operation and Maintenance Manual for Land Treatment of Petroleum Contaminated Soils for MCB Camp Lejeune, North Carolina

Prepared for:

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1.0 SYSTEM OPERATIONS

The Biocell located at Lot 203 is designed to treat only petroleum contaminated soil as defined in N.C.G.S. 143-215.1. Petroleum contaminated soil is loaded into the cell via a dozer or tracked loader. Prior to loading the soil a sample is taken from the soil to confirm that the soil meets requirements to enter the cell and to get a baseline for nutrient addition. The material is spread over the cell in a 1-foot lift. Nutrients are applied in dry granular form using a conventional spread caster at a rate based upon initial baseline nutrient sampling. The nutrients are tilled into the material using a tractor with disc attachment. The Biocell is then tilled as needed based upon the moisture content of the soil. After one month, the material is sampled. If the material is below the cleanup criteria, then the material is loaded out and stored awaiting final disposition by the base. If the material is above the cleanup criteria, then the process continues until the cleanup criteria is attained. Appendix B contains the as-built drawing depicting the layout of the biocell.

1.1 INCOMING MATERIAL ACCEPTANCE TESTING

Petroleum soils identified for treatment at this facility from MCB Camp Lejeune include: (1) contaminated soils where the source of contamination was virgin petroleum products from regulated USTs and which are not hazardous wastes under the North Carolina Administrative Code; (2) contaminated soils where the source of the contamination is neither virgin petroleum products from a regulated UST, nor a listed hazardous waste, nor a characteristic hazardous waste in accordance with the TCLP test (40 CFR 261.24).

Soils which are characteristically hazardous for RCRA metals (Arsenic, Barium, Cadmium, Lead, Mercury, Selenium, Silver, or Chromium) or volatile and semi-volatile organics cannot be managed at this facility. Therefore, prior to acceptance and treatment of TPH contaminated soils from MCB Camp Lejeune, incoming loads to the Lot 203 facility are certified as nonhazardous based upon appropriate testing results in accordance with the requirements of 15A NCAC 2H.0200. These certifications are the responsibility of the generator of each incoming load.

1.2 NUTRIENT ADDITION

Soil fertility is managed through conventional fertilization techniques, using relatively soluble commercial fertilizers. The soil biotreatment facility is designed to accommodate both dry granular fertilizer or aqueous based nutrients. The primary nutrients used include diammonium phosphate and ammonium sulfate. The initial nutrient addition ratios should be consistent with North Carolina regulations for dedicated facilities based on organic carbon:nitrogen:phosphorus of 60:1:.075.

The application rate is determined from baseline carbon:nitrogen:phosphorus present in the untreated soil. Total organic carbon concentration in the untreated soil is used to establish the baseline nutrient addition rates.

Nutrient are applied in dry granular form using a conventional spread caster. The relatively small size of the treatment area favors the use of dry reagents which are manually applied by operation personnel.

Nutrient levels will be measured in the biocell prior to each separate 1,000-cubic yard batch treatment and monthly during operation and maintenance. Composite soil samples will be analyzed for the following parameters and frequency:

Table 1.1
Nutrient Monitoring Sampling and Analysis

Parameter	*Method*	*Frequency*
Total Organic Carbon	SW-846 Method 9060	Initial, Monthly
Ammonium-Nitrogen	ASA/SSSA Method 33-3, 33-4	Initial, Monthly
Phosphate-Phosphorous	ASA/SSSA Method 24-5.1, 24-5.3	Initial, Monthly
pH	ASA/SSSA Method 12-2.6	Initial, Monthly
Moisture Content	ASA/SSSA Method 21-22	Initial, Monthly
Bacterial Population Density	SM EWW 9215B	Initial, Monthly

The Biocell is divided into six equal quadrants for nutrient monitoring purposes. Grab samples should be collected by personnel approximately 6 inches from the surface from the middle of each of the six quadrant locations and composited into three samples. The samples should be numbered sequentially and sent with a chain-of-custody for off-site analysis. The results are compared with the target nutrient ratios and adjusted as necessary to maintain biological treatment efficiency and modify the operating plan as needed. Nutrient monitoring will continue monthly until the batch reaches the soil treatment standards listed below in Table 1.2.

Table 1.2

	Method Number	*Cleanup Criteria*
TPH/GRO	5030/8015	<10 mg/kg
TPH/DRO	3550/8015	<40 mg/kg
Oil and Grease	9071	<250 mg/kg

1.3 WATER MANAGEMENT

Because soil microorganisms inhabit and are only active within thin films of water, the soil water content is maintained at an optimal condition for their growth. Soil water moisture content is monitored on-site using an oven as needed. Initial and monthly moisture measurements will be performed in accordance with Table 1.1. The target soil moisture content is approximately 60 to 80 percent of the field holding capacity corresponding to between 10 and 15 percent moisture on a weight basis. The percent moisture can vary depending on the material being treated. Table 1.3 shows the data sheet used to calculate the percent moisture. Because the driest soil conditions will occur at or near the surface, soil samples should be obtained from 0 to 4 inches. Soil at this depth is subject to the greatest drying. Six sample locations are selected, one from each quadrant, and composited into three samples prior to analysis.

Stormwater and leachate which is collected in the biocell sump is pumped into the 20,000-gallon holding tank adjacent to the facility. Water is applied to the biocell for moisture control as necessary from this tank using a centrifugal pump and a sprinkler system. Moisture monitoring results from the biocell quadrants are used to determine recycle rates. In case of excess stormwater and leachate, the water is transferred to the water treatment plant located adjacent to the facility.

1.4 SOIL MIXING AND AERATION

Following the initial application of fertilizer, soil will be thoroughly mixed to distribute hot spots of contamination and reduce soil particle size. Once the soil fertility and moisture regimes are optimized, the factor limiting growth of soil microorganisms is usually oxygen. Oxygen is supplied by conventional tilling methods, which thoroughly mixes and loosens the soil. A conventional farm tractor with tiller attachment is used for this purpose. Several overlapping passes of the equipment will be performed longitudinally in rows in the north-south direction. The entire biocell will be tilled to the full depth of the contaminated soil immediately following initial moisture and nutrient additions and turned twice per month during the operation and maintenance period or as needed.

1.5 SAMPLING AND ANALYSIS

Collection and analysis of soil samples will be performed at three different times for each batch of petroleum contaminated soil. They are as follows:

- Initial characterization of incoming soils
- During the O&M period for performance monitoring
- At the completion of treatment for confirmation sampling

Table 1.3 – Percent Moisture Data
Lot 203 Biocell

Soil Area	*Date*	*Pan Weight*	*Pan and Sample Weight*	*Pan and Sample Dry Weight*	*Sample Weight*	*Sample Weight Dry*	*Moisture*	*Percent Moisture*

Initial Characterization

Baseline soil samples will be collected from the placed lift prior to initiating treatment for each batch, and periodically thereafter. The treatment cell (1000 cubic yards) will be divided into 6 equal quadrants for baseline sampling and analysis. Representative samples will be taken with a soil hand auger or other sampling device from each of the six quadrants and composited into three samples for off-site analysis. The samples will be analyzed for the following:

- Average total petroleum hydrocarbon concentration (mg/kg TPFH) using EPA Method 5030/8015;
- Average total petroleum hydrocarbon concentration (mg/kg TPFH) using EPA Method 3550/8015;
- Concentration of Oil and Grease (mg/kg) using EPA Method 9071; and
- Section 1.2, Table 1.1 parameters.

Baseline soil contaminant concentrations for both light and heavy fraction hydrocarbons will be identified. This information will be used to determine nutrient loadings and predict treatment time needed to achieve the specified standards. Following each sampling event, the equipment will be decontaminated by OHM personnel using a three-step process in accordance with standard operating procedures.

Performance Monitoring

Monitoring during the O&M period consists of measuring total organic carbon, available nutrients, moisture, microbial population and pH which are key for optimizing biological degradation. These parameters, methods, and frequencies were previously provided in Section 1.2, Table 1.1.

Confirmation Sampling

At the end of each month, confirmation soil samples are collected by personnel. The same six quadrants used for initial characterization and performance monitoring are used for confirmation sampling. One composite sample per two quadrants are obtained and analyzed by an off-site laboratory using the same methods as performed in the initial characterization as described above. The laboratory results are evaluated to compare the effectiveness of treatment in removing hydrocarbons to below the treatment criteria. An evaluation is made whether the cleanup objectives have been attained or to continue treatment.

If the soil analyses indicate continued presence of elevated petroleum hydrocarbons, additional nutrients are applied to the soils and the biodegradation process will continue. Treatment time will vary depending on the contaminant type, initial concentrations, and time of year the treatment is employed. Treatment times will be shorter in the summer due to the higher degree of biological activity during the warmer summer months.

Sampling Summary and QA/QC

Table 3 provides a summary of the sampling to be performed at the site for initial characterization, ongoing operation and maintenance, and final confirmation. The table includes sample type, frequency, methods, turnaround times, sample quality control levels, preservation and sampling techniques. Off-site analyses will be performed by an NFESC and North Carolina approved laboratory.

1.6 TREATED SOIL REMOVAL AND BIOCELL RECONDITIONING

Following confirmation testing, and completion of treatment to the specified standards, the soil is pushed with a light bulldozer into stockpiles within the contained biocell for placement outside the biocell at the designated location. The soil is directly loaded onto transport vehicles parked on the ramp using a front-end loader or excavator. Although the material is nonhazardous, each truck should be inspected by operations personnel to ensure that vehicles are properly loaded, tarped if required.

The sand drainage layer is inspected following removal of the treated soil and prior to arrival of the next batch. Replacement sand is provided and spread proportionally if necessary following a visual survey of the biocell.

1.7 RESIDUALS MANAGEMENT

During the course of installation and operations, small amounts of contaminated debris including personnel protective equipment and nonhazardous rinse water is generated. The nonhazardous debris is containerized and stored on-site until transportation and disposal can be arranged. Nonhazardous liquids are processed through the nearby groundwater treatment facility.

2.0 EQUIPMENT

Table 2.1 lists the major equipment components pertaining to the Biocell.

Table 2.1		
Component	*Manufacturer*	*Phone*
20-mil HDPE liner	In-Line Plastics	(800) 364-7688
Sump Pump	Aurora Pumps, Inc.	(419) 289-3042
Transfer Pump	Goulds Pumps, Inc.	(800) 446-8537
Sprinklers	Rain Bird	(602) 741-6100
20,000-gallon Tank	Baker Tanks	(800) 946-4646

Sump Pump

The function of the sump pump is to transfer water collected in the sump into the 20,000-gallon Baker tank. The pump is manually operated by a control box located outside the Biocell. The submersible pump is manufactured by Aurora Pump. See attached manual in Appendix A for specifications.

Baker Tank

The function of the 20,000-gallon Baker tank is to store rain water from the Biocell for moisture control or for subsequent treatment at the adjacent groundwater treatment plant. Water is pumped into me top of the tank from the sump pump and out via the transfer pump. To transfer water to the groundwater treatment plant, water is pumped by a 2-inch pump through flexible hose into the groundwater treatment plant wet well.

Transfer Pump

The function of the transfer pump is to disperse water onto the Biocell for moisture control. The seal water for the Goulds pump is fed by water diverted from the Baker tank. The flow rate for the seal water is 0.5 gpm at 20 psi. The pump is started by a control box located at the electrical panel. See attached manual in Appendix A for specifications.

Sprinkler System

A 2-inch PVC line delivers the water from the transfer pump to the Biocell. There are four mobile sprinkler stands located on the Biocell. These sprinkler stands have 1-inch flexible hose attached so that the stands can be relocated during loading, tilling and removal activities. The sprinklers are manufactured by Rain Bird. See the attached manual in Appendix A for specifications.

Table 2.2 shows the Operation and Maintenance Log completed daily. Technical data sheets or manuals for the items listed above are located in Appendix A. Only one of the items requires regular routine maintenance. That is the Goulds Pump. Refer to Section 5.0 of its manual in Appendix A for routine maintenance items.

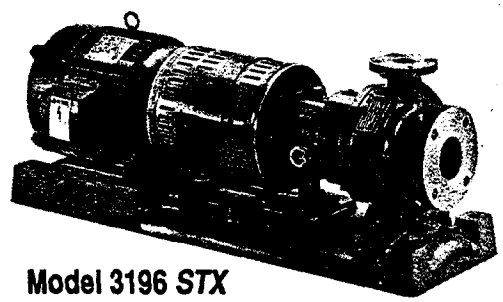
Table 2.2 – Operation and Maintenance Log	
Lot 203 Biocell	**MCB Camp Lejeune**
Date	
Operator	
Soil Loaded (YD)	
Soil Removed (YD)	
Manifest No.	
Nutrient Addition	
Moisture Content	
Check	
Sump Pump	
Goulds Pump	
Storage Tank Level	
Samples Taken	
Soil Tilled	
NOTES:	
Weather	
Rainfall	
Temperature	
Wind Speed	
Maintenance Issues/Comments	

Appendix A

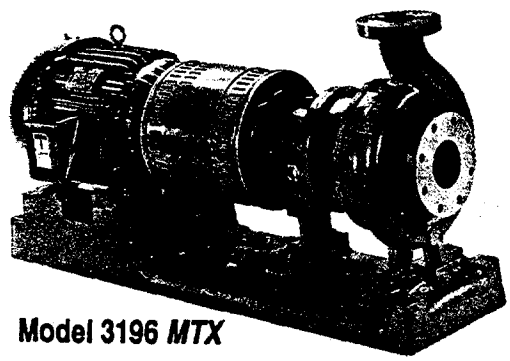
Technical Data Sheets

GOULDS PUMPS

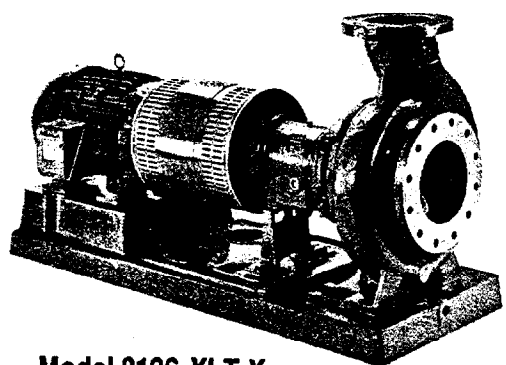
Installation, Operation and Maintenance Instructions



Model 3196 *STX*



Model 3196 *MTX*



Model 3196 *XLT-X*

Model 3196

FOREWORD

This manual provides instructions for the Installation, Operation, and Maintenance of the Goulds Model 3196 ANSI Standard Dimension Process Pump. This manual covers the standard product plus common options that are available. For special options, supplemental instructions are supplied. **This manual must be read and understood before installation and start-up.**

The design, materials, and workmanship incorporated in the construction of Goulds pumps makes them capable of giving, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection, condition monitoring and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and the correct methods of installing, operating, and maintaining these pumps.

Goulds shall not be liable for physical injury, damage or delays caused by a failure to observe the instructions for Installation, Operation, and Maintenance contained in this manual.

Warranty is valid only when genuine Goulds parts are used.

Use of the equipment on a service other than stated in the order will nullify the warranty, unless written approval is obtained in advance from Goulds Pumps, Inc.

Supervision by an authorized Goulds representative is recommended to assure proper installation.

Additional manuals can be obtained by contacting your local Goulds representative or by calling 1-800-446-8537.

THIS MANUAL EXPLAINS

- **Proper Installation**
- **Start-up Procedures**
- **Operation Procedures**
- **Routine Maintenance**
- **Pump Overhaul**
- **Trouble Shooting**
- **Ordering Spare or Repair Parts**

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SAFETY

1

DEFINITIONS

This pump has been designed for safe and reliable operation when properly used and maintained in accordance with instructions contained in this manual. A pump is a pressure containing device with rotating parts that can be hazardous. Operators and maintenance personnel must realize this and follow safety measures. Goulds Pumps Inc. shall not be liable for physical injury, damage or delays caused by a failure to observe the instructions in this manual.

Throughout this manual the words **Warning, Caution,** and **Note** are used to indicate procedures or situations which require special operator attention:

⚠ WARNING

Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ CAUTION

Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

NOTE: Operating procedure, condition, etc. which is essential to observe.

EXAMPLES

⚠ WARNING

Pump shall never be operated without coupling guard installed correctly.

⚠ CAUTION

Throttling flow from the suction side may cause cavitation and pump damage.

NOTE: Proper alignment is essential for long pump life.

GENERAL PRECAUTIONS

⚠ WARNING

Personal injuries will result if procedures outlined in this manual are not followed.

- Never apply heat to remove impeller. It may explode due to trapped liquid.
- Never use heat to diassemble pump due to risk of explosion from trapped liquid.
- Never operate pump without coupling guard correctly installed.
- Never operate pump beyond the rated conditions to which the pump was sold.
- Never start pump without proper prime (sufficient liquid in pump casing).
- Never run pump below recommended minimum flow or when dry.
- Always lock out power to the driver before performing pump maintenance.
- Never operate pump without safety devices installed.
- Never operate pump with discharge valve closed.
- Never operate pump with suction valve closed.
- Do not change conditions of service without approval of an authorized Goulds representative.

GENERAL INFORMATION

PUMP DESCRIPTION

The Model 3196 is a horizontal overhung, open impeller centrifugal pump that meets requirements of ANSI B73.1.

The model is based on 5 power ends and 28 hydraulic pump sizes. Groupings are as follows:

STX	5 pump sizes
MTX	15 pump sizes
LTX	11 pump sizes
XLT-X	5 pump sizes
X17	3 pump sizes

Casing - The casing is top centerline discharge and self-venting. The gasket is fully confined. An integral foot support is used for maximum resistance to misalignment and distortion from piping loads. ANSI flat face serrated flanges are standard. ANSI Class 150 raised face serrated, ANSI Class 300 flat face serrated and ANSI Class 300 raised face serrated are available.

Impeller - The impeller is fully open and threaded to the shaft. The threads are sealed from the pumpage by a Teflon O-ring.

Seal Chamber/Stuffing-Box Cover - The 3196 is available with a stuffing box cover designed for packing and BigBore™ seal chamber or TaperBore™ seal chamber for improved performance of mechanical seals.

Frame Adapter - The ductile iron frame adapter has machined rabbet fit to the seal chamber/stuffing box cover and precision dowel pin fit to the bearing frame.

Power End - Oil level is viewed through a sight glass. Optional oil cooling is provided by a finned tube. Flood oil lube is standard. The power end is sealed with Goulds designed labyrinth seals. No machining is required to convert from oil to grease or oil mist. Regreaseable bearings, greased for life bearings and oil mist lubrication are optional.

Shaft - The shaft is available with or without sleeve.

Bearings - The inboard bearing carries only radial load, it is free to float axially in the frame. The outboard bearing is shouldered and locked to the shaft and housing to enable it to carry radial and thrust loads. All fits are precision machined to industry standards. The inboard bearing is a single row deep groove ball bearing. The outboard bearing is a double row angular contact bearing, except for the LTX which uses a pair of single row angular contact ball bearings mounted back to back.

Dynamic Seal - A dynamic seal is available which uses a repeller to pump liquid out of the stuffing box while the pump operates, a static seal prevents leakage when the pump is shut down.

Direction of Rotation - Clockwise (right hand) as viewed from the driver, looking at the pump shaft.

NAMEPLATE INFORMATION

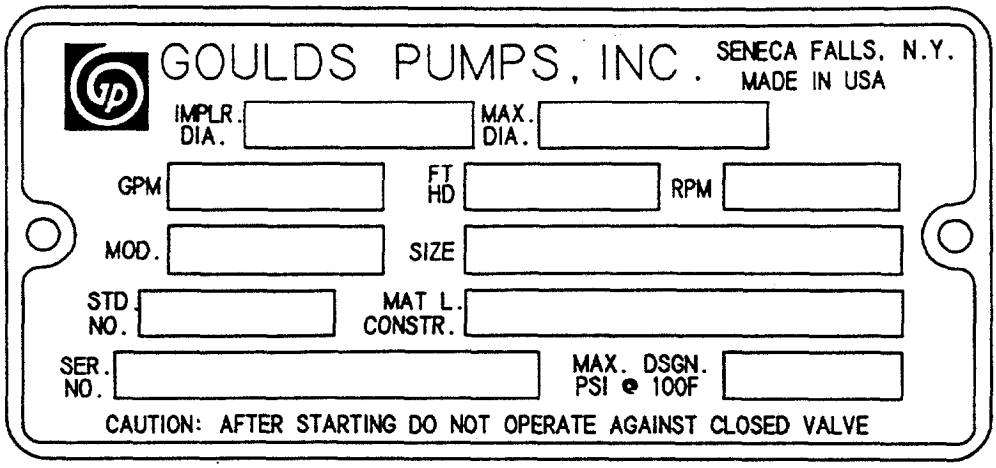


Fig. 1

Every pump has two Goulds nameplates that provide information about the pump. The tags are located on the casing and bearing frame.

Pump Casing Tag - provides information about the pump's hydraulic characteristics. Note the format of the pump size: Discharge x Suction - Nominal maximum Impeller Diameter in inches. (Example: 2x3-6)(Fig. 1).

Bearing Frame Tag - provides information on the lubrication system used (Fig. 2).

When ordering spare parts you will need to identify pump model, size, serial number, and the item number of required parts. Information can be taken from the pump casing tag. Item numbers can be found in this manual.

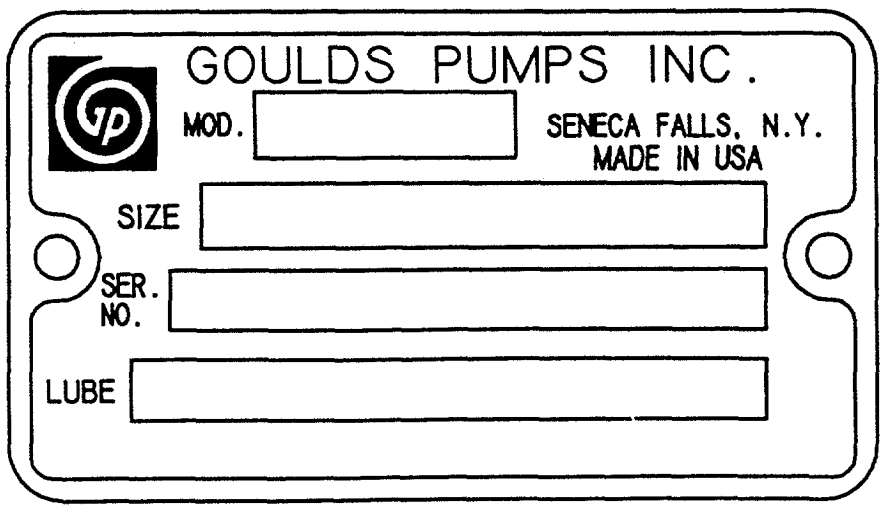


Fig. 2

RECEIVING THE PUMP

Inspect the pump as soon as it is received. Carefully check that everything is in good order. Make notes of damaged or missing items on the receipt and freight bill. File any claims with the transportation company as soon as possible.

STORAGE REQUIREMENTS

Short Term: (Less than 6 months) Goulds normal packaging procedure is designed to protect pump during shipping. Upon receipt store in a covered and dry location.

Long Term: (More than 6 months) Preservative treatment of bearings and machined surfaces will be required. Rotate shaft several times every 3 months. Refer to driver and coupling manufacturers for their long term storage procedures. Store in a covered dry location.

NOTE: Long term storage treatment can be purchased with initial pump order.

HANDLING

⚠ WARNING

Pump and components are heavy. Failure to properly lift and support equipment could result in serious physical injury, or damage to pumps. Steel toed shoes must be worn at all times.

Use care when moving pumps. Lifting equipment must be able to adequately support the entire assembly. Hoist bare pump using a suitable sling, under the suction flange and bearing frame. Baseplate mounted units are moved with slings under the pump casing and driver. Refer to figures 3A,B,C for examples of proper lifting techniques.

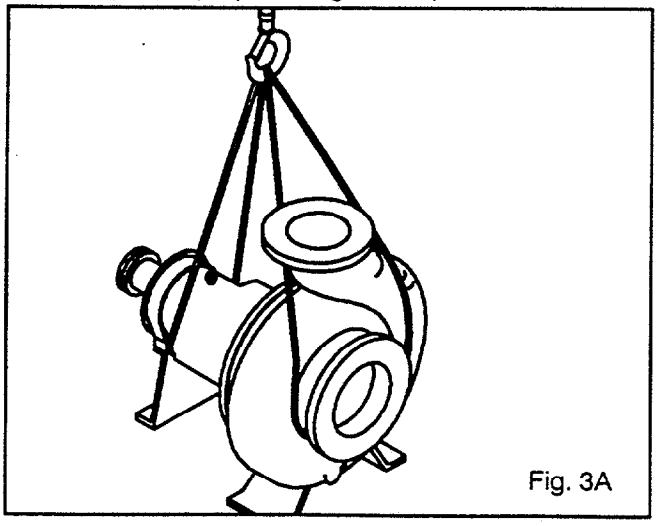


Fig. 3A

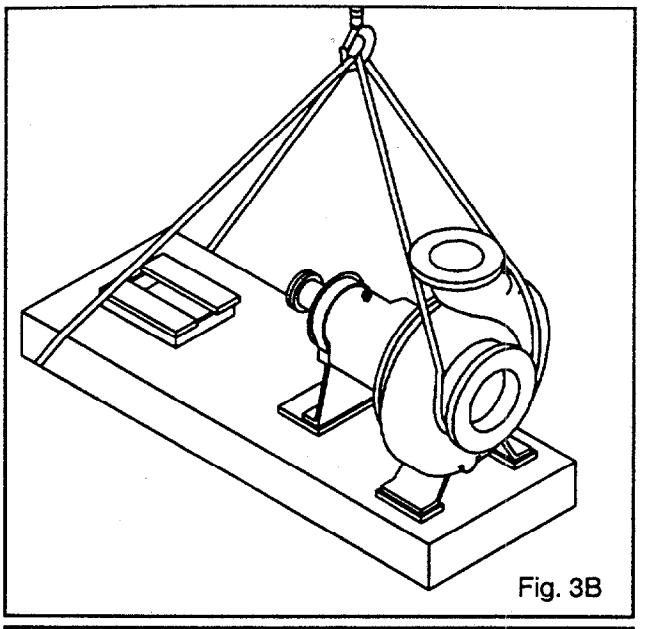


Fig. 3B

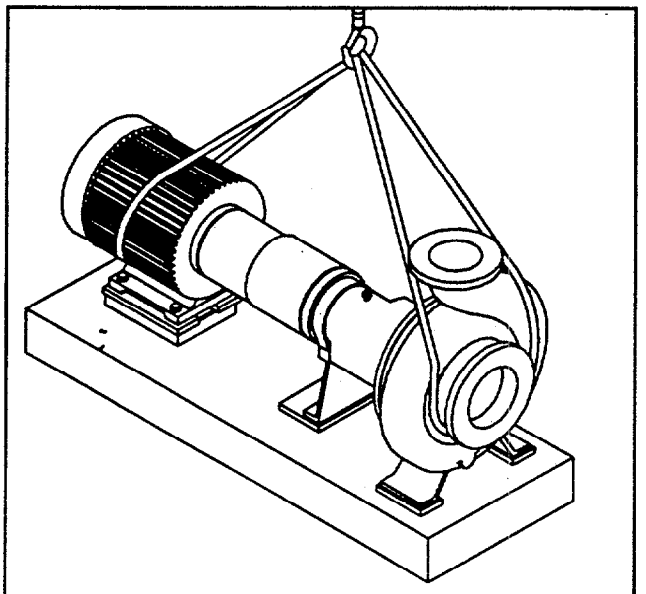


Fig. 3C

2

INSTALLATION

SITE/FOUNDATION

A pump should be located near the supply of liquid and have adequate space for operation, maintenance, and inspection.

Baseplate mounted pumps are normally grouted on a concrete foundation, which has been poured on a solid footing. The foundation must be able to absorb any vibration and to form a permanent, rigid support for the pumping unit.

The location and size of the foundation bolts are shown on outline assembly drawing, provided with the pump data package.

Foundation bolts commonly used are sleeve type (Fig. 4A) and J type (Fig. 4B). Both designs permit movement for final bolt adjustment.

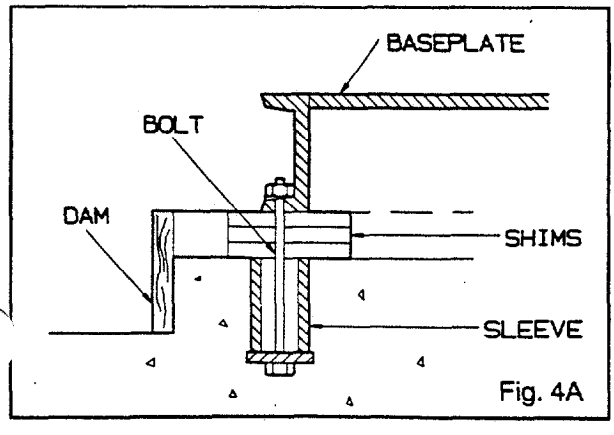


Fig. 4A

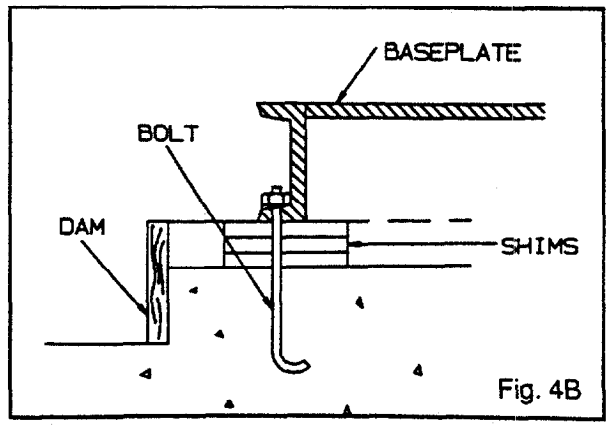


Fig. 4B

LEVEL BASEPLATE

1. Place 2 sets of wedges or shims on the foundation, one set on each side of every foundation bolt. The wedges should extend .75 in. (20mm) to 1.5 in. (40mm) above foundation, to allow for adequate grouting. This will provide even support for the baseplate once it is grouted.
2. Remove water and/or debris from anchor bolt holes/sleeves prior to grouting. If the sleeve type bolts are being used, fill the sleeves with rags to prevent grout from entering.
3. Carefully lower baseplate onto foundation bolts.
4. Level baseplate to within 1/8" (3.2mm) over length of the baseplate and to within .088 in. (1.5mm) over the width of the base by adjusting wedges.
5. Hand tighten bolts.

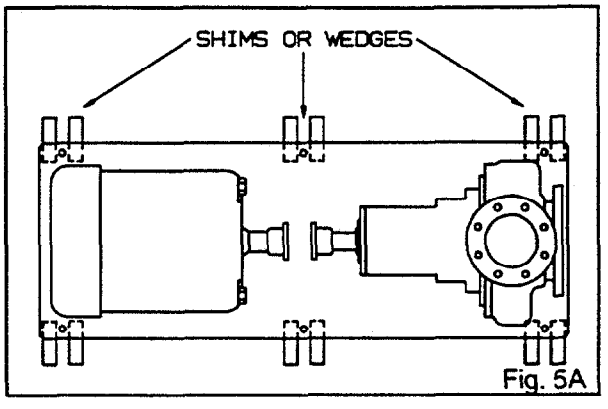


Fig. 5A

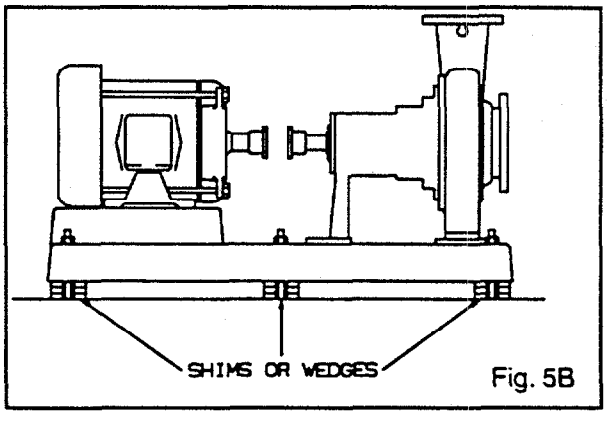


Fig. 5B

ALIGNMENT AND ALIGNMENT PROCEDURE

⚠ WARNING

Before beginning any alignment procedure make sure driver power is locked out. Failure to lock out driver power will result in serious physical injury.

To remove guard refer to coupling guard assembly/disassembly instructions.

The points at which alignment is checked and adjusted are:

- **Initial Alignment** is done prior to operation when the pump and the driver are at ambient temperature.
- **Final Alignment** is done after operation when the pump and driver are at operating temperature.

Alignment is achieved by adding or removing shims from under the feet of the driver and shifting equipment horizontally as needed.

NOTE: Proper alignment is the responsibility of the installer and user of the unit.

Accurate alignment of the equipment must be attained. Trouble free operation can be accomplished by following these procedures.

ALIGNMENT CHECKS

Initial Alignment (Cold Alignment)

- Before Grouting Baseplate - To ensure alignment can be obtained.
- After Grouting Baseplate - To ensure no changes have occurred during grouting process.
- After Connecting Piping - To ensure pipe strains haven't altered alignment. If changes have occurred, alter piping to remove pipe strains on pump flanges.

Final Alignment (Hot Alignment)

- After First Run - To obtain correct alignment when both pump and driver are at operating temperature. Thereafter, alignment should be checked periodically in accordance with plant operating procedures.

NOTE: ***Alignment check must be made if process temperature changes, piping changes and or pump service is performed.***

ALIGNMENT CRITERIA

Good alignment is achieved when the dial indicator readings as specified in the alignment procedure are .002 in. (.05 mm) Total Indicated Reading (T.I.R.) or less when the pump and driver are at operating temperature (Final Alignment).

During the installation phase, however, it is necessary to set the parallel alignment in the vertical direction to a different criteria due to differences in expansion rates of the pump and driver. Table 1 shows recommended preliminary (cold) settings for electric motor driven pumps based on different pumpage temperatures. Driver manufacturers should be consulted for recommended cold settings for other types of drivers (steam turbines, engines, etc.)

Table 1
Cold Setting of Parallel Vertical Alignment

PUMPAGE TEMPERATURE	SET DRIVER SHAFT
50°F (10°C)	.002in. (.05mm) LOW
150°F (65°C)	.001in. (.03mm) HIGH
250°F (120°C)	.005in. (.12mm) HIGH
350°F (175°C)	.009in. (.23mm) HIGH
450°F (218°C)	.013in. (.33mm) HIGH
550°F (228°C)	.017in. (.43mm) HIGH
650°F (343°C)	.021in. (.53mm) HIGH
700°F (371°C)	.023in (.58mm) HIGH

SET UP

1. Mount two dial indicators on one of the coupling halves (X) so they contact the other coupling half (Y) (Fig. 6).
2. Check setting of indicators by rotating coupling half X to ensure indicators stay in contact with coupling half Y but do not bottom out. Adjust indicators accordingly.

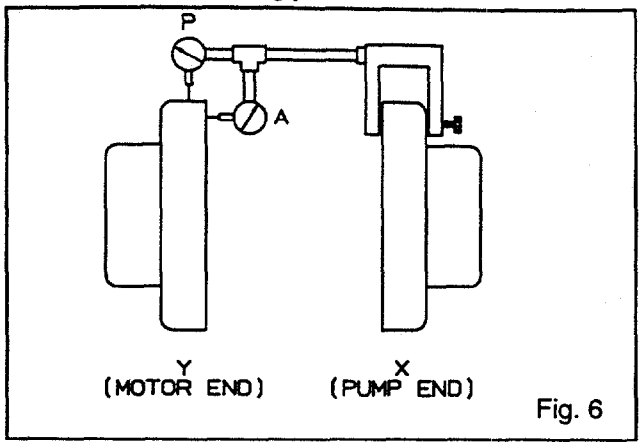


Fig. 6

MEASUREMENT

1. To ensure accuracy of indicator readings, always rotate both coupling halves together so indicators contact the same point on coupling half Y. This will eliminate any measurement problems due to runout on coupling half Y.
2. Take indicator measurements with driver feet hold-down bolts tightened. Loosen hold down bolts prior to making alignment corrections.
3. Take care not to damage indicators when moving driver during alignment corrections.

ANGULAR ALIGNMENT

A unit is in angular alignment when indicator A (Angular indicator) does not vary by more that .002 in. (.05 mm) as measured at four points 90° apart.

Vertical Correction (Top-to-Bottom)

1. Zero indicator A at top dead center (12 o'clock) of coupling half Y.
2. Rotate indicators to bottom dead center (6 o'clock). Observe needle and record reading.
3. **Negative Reading** - The coupling halves are further apart at the bottom than at the top. Correct by either raising the driver feet at the shaft end (add shims) or lowering the driver feet at the other end (remove shims), (Fig. 7A).

   Positive Reading - The coupling halves are closer at the bottom than at the top. Correct by either lowering the driver feet at the shaft end (remove shims) or raising the driver feet at the other end (add shims).

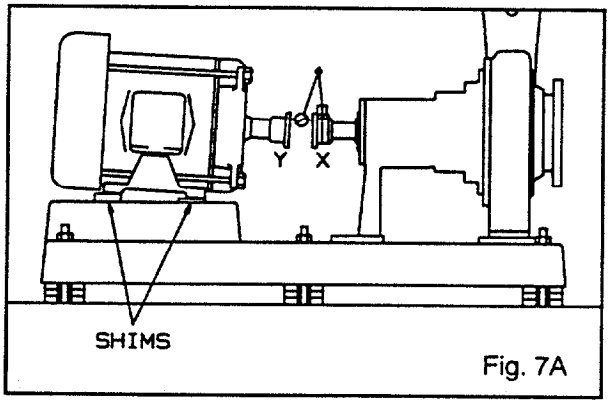


Fig. 7A

4. Repeat steps 1-3 until indicator A reads .002 in (.05 mm) or less.

Horizontal Correction (Side-to-Side)

1. Zero indicator A on left side of coupling half Y, 90° from top dead center (9 o'clock).
2. Rotate indicators through top dead enter to the right side, 180° from the start (3 o'clock). Observe needle and record reading.
3. **Negative Reading** - The coupling halves are further apart on the right side than the left. Correct by either sliding the shaft end of the driver to the left or the other end to the right.

   Positive Reading - The coupling halves are closer together on the right side than the left. Correct by either sliding the shaft end of the driver to the right or the other end to the left (Fig. 7B).

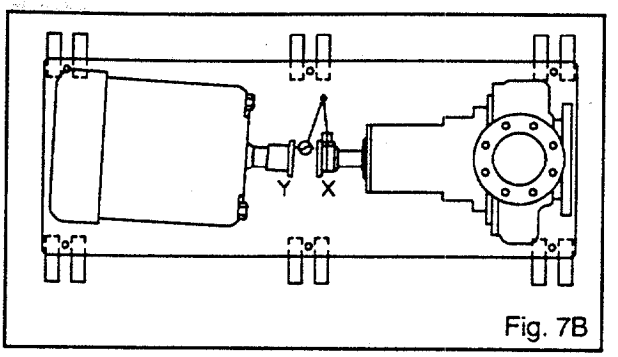


Fig. 7B

4. Repeat steps 1 through 3 until indicator A reads .002 in. (.05 mm) or less.
5. Re-check both horizontal and vertical readings to ensure adjustment of one did not disturb the other. Correct as necessary.

PARALLEL ALIGNMENT

A unit is in parallel alignment when indicator P (parallel indicator) does not vary by more than .002 in. (.05 mm) as measured at four points 90° apart at operating temperature. Note the preliminary vertical cold setting criteria, Table 1.

Vertical Correction (Top-to-Bottom)

1. Zero indicator P at top dead center of coupling (12 o'clock) half Y (Fig. 6).
2. Rotate indicator to bottom dead center (6 o'clock). Observe needle and record reading.
3. **Negative Reading** - Coupling half X is lower than coupling half Y. Correct by removing shims of thickness equal to half of the indicator reading under each driver foot.

   Positive Reading - Coupling half X is higher than coupling half Y. Correct by adding shims of thickness equal to half of the indicator reading from each driver foot (Fig. 8A).

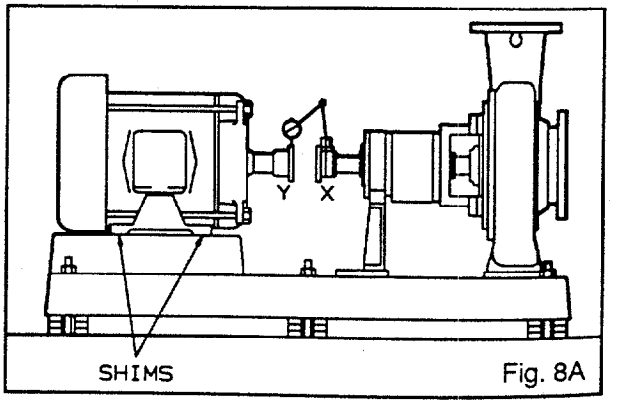


Fig. 8A

NOTE: ***Equal amounts of shims must be added to or removed from each driver foot. Otherwise the vertical angular alignment will be affected.***

4. Repeat steps 1 through 3 until indicator P reads within .002 in. (.05 mm) or less when hot, or per Table 1 when cold.

Horizontal Correction (Side-to-Side)

1. Zero indicator P on the left side of coupling half Y, 90° from top dead center (9 o'clock).
2. Rotate indicators through top dead center to the right side, 180° from the start (3 o'clock). Observe needle and record reading.
3. **Negative Reading** - Coupling half Y is to the left of coupling half X. Correct by sliding driver evenly in the appropriate direction (Fig. 8B).

   Positive Reading - Coupling half Y is to the right of coupling half X. Correct by sliding driver evenly in the appropriate direction.

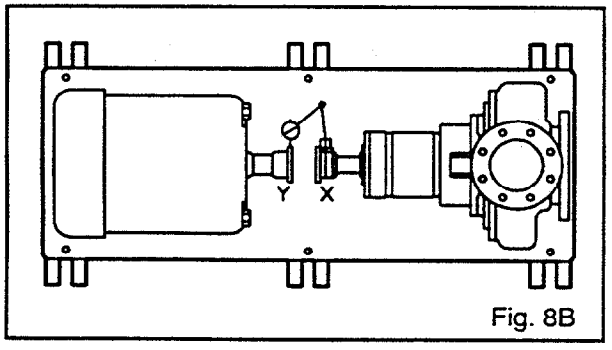


Fig. 8B

NOTE: Failure to slide motor evenly will affect horizontal angular correction.

4. Repeat steps 1 through 3 until indicator P reads .002 in. (.05 mm) or less.
5. Re-check both horizontal and vertical readings to ensure adjustment of one did not disturb the other. Correct as necessary.

COMPLETE ALIGNMENT

A unit is in complete alignment when both indicators A (angular) and P (parallel) do not vary by more than .002 in. (.05 mm) as measured at four points 90° apart.

Vertical Correction (Top-to-Bottom)

1. Zero indicators A and P at top dead center (12 o'clock) of coupling half Y.
2. Rotate indicator to bottom dead center (6 o'clock). Observe the needles and record the readings.
3. Make corrections as outlined previously.

Horizontal Correction (Side-to-Side)

1. Zero indicators A and P on the left side of coupling half Y, 90° from top dead center (9 o'clock).
2. Rotate indicators through top dead center to the right side, 180° from the start (3 o'clock). Observe the needle, measure and record the reading.
3. Make corrections as outlined previously.
4. Recheck both vertical and horizontal readings to ensure adjustment of one did not disturb the other. Correct as necessary.

NOTE: ***With experience, the installer will understand the interaction between angular and parallel and will make corrections appropriately.***

3

Table 2
Alignment Trouble Shooting

PROBLEM	PROBABLE CAUSE	REMEDY
Cannot obtain horizontal (Side-to-Side) alignment, angular or parallel	Driver feet bolt bound.	Loosen pump hold down bolts and slide pump and driver until horizontal alignment is acheived.
	Baseplate not leveled properly, probably twisted.	Determine which corner(s) of the baseplate are high or low and remove or add shims at the appropriate corner(s) and realign.
Cannot obtain vertical (Top-to-Bottom) alignment, angular or parallel	Baseplate not leveled properly, probably bowed.	Determine if center of baseplate should be raised or lowered and correct by evenly adding or removing shims at the center of the baseplate.

GROUT BASEPLATE

1. Clean areas of baseplate that will contact grout. Do not use oil-based cleaners because grout will not bond to it. Refer to grout manufacturer's instructions.
2. Build dam around foundation. Thoroughly wet foundation (Fig. 9A).
3. Pour grout through grout hole in baseplate, up to level of dam. Remove air bubbles from grout as it is poured by puddling, using a vibrator, or pumping the grout into place. Non-shrink grout is recommended.

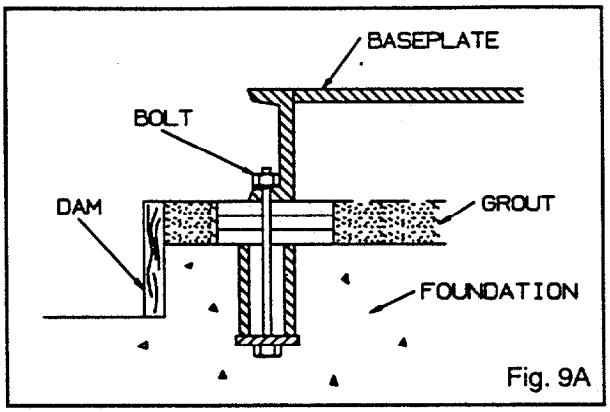


Fig. 9A

4. Allow grout to set.
5. Fill remainder of baseplate with grout. Remove air as before (Fig. 9B).

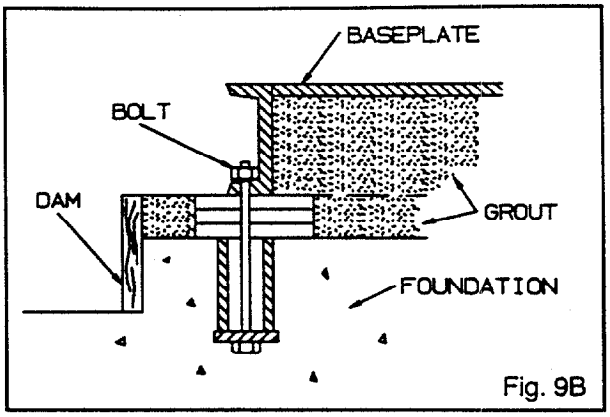


Fig. 9B

6. Allow grout to set at least 48 hours.
7. Tighten foundation bolts.

ALIGNMENT CHECK

Re-check alignment before continuing, using methods previously described.

PIPING

GENERAL

Guidelines for piping are given in the "Hydraulic Institute Standards" available from: Hydraulic Institute, 30200 Detroit Road, Cleveland, OH 44145-1967 and must be reviewed prior to pump installation.

⚠ WARNING

Never draw piping into place by forcing at the flanged connections of the pump. This may impose dangerous strains on the unit and cause misalignment between pump and driver. Pipe strain will adversely effect the operation of the pump resulting in physical injury and damage to the equipment.

1. All piping must be supported independently of, and line up naturally with, the pump flanges.
2. Piping runs should be as short as possible to minimize friction losses.
3. DO NOT connect piping to pump until grout has hardened and pump and driver hold-down bolts have been tightened.
4. It is suggested that expansion loops or joints be properly installed in suction and/or discharge lines when handling liquids at elevated temperatures, so linear expansion of piping will not draw pump out of alignment.
5. The piping should be arranged to allow pump flushing prior to removal of the unit on services handling corrosive liquids.
6. Carefully clean all pipe parts, valves and fittings, and pump branches prior to assembly.

SUCTION PIPING

⚠ WARNING

$NPSH_A$ must always exceed $NPSH_R$ as shown on Goulds performance curves received with order. (Reference Hydraulic Institute for NPSH and pipe friction values needed to evaluate suction piping.

Properly installed suction piping is a necessity for trouble-free pump operation. Suction piping should be flushed BEFORE connection to the pump.

1. Use of elbows close to the pump suction flange should be avoided. There should be a minimum of 2 pipe diameters of straight pipe between the elbow and suction inlet. Where used, elbows should be long radius.
2. Use suction pipe one or two sizes larger than the pump suction, with a reducer at the suction flange. Suction piping should never be of smaller diameter than the pump suction.
3. Reducers, if used, should be eccentric, at the pump suction flange, with sloping side down.
4. Pump must never be throttled on suction side.
5. Suction strainers, when used, must have a net "free area" of at least three times the suction pipe area.
6. Separate suction lines are recommended when more than one pump is operating from the same source of supply.

Suction lift conditions

1. Suction pipe must be free from air pockets.
2. Suction piping must slope upwards to pump.
3. All joints must be air tight.
4. A means of priming the pump must be provided, such as a foot valve.

Suction head/Flooded suction conditions

1. An isolation valve should be installed in the suction line at least two pipe diameters from the suction to permit closing of the line for pump inspection and maintenance.
2. Keep suction pipe free from air pockets.
3. Piping should be level or slope gradually downward from the source of supply.
4. No portion of the piping should extend below pump suction flange.
5. The size of entrance from supply should be one or two sizes larger than the suction pipe.
6. The suction pipe must be adequately submerged below the liquid surface to prevent votices and air entrainment at the supply.

DISCHARGE PIPING

1. Isolation and check valves should be installed in discharge line. Locate the check valve between isolation valve and pump, this will permit inspection of the check valve. The isolation valve is required for priming, regulation of flow, and for inspection and maintenance of pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.
2. Increasers, if used, should be placed between pump and check valves.
3. Cushioning devices should be used to protect the pump from surges and water hammer if quick-closing valves are installed in system.

FINAL PIPING CHECK

After connecting the piping to pump:

1. Rotate shaft several times by hand to be sure that there is no binding and all parts are free.
2. Check alignment, per the alignment procedure outlined previously to determine absence of pipe strain. If pipe strain exists, correct piping.

OPERATION

4

PREPARATION FOR START-UP

CHECKING ROTATING

⚠ CAUTION

Serious damage may result if pump is run in the wrong rotation.

1. Lock out power to driver.

⚠ WARNING

Lock out driver power to prevent accidental start-up and physical injury.

2. Make sure coupling hubs are securely fastened to shafts.
   NOTE: Pump is shipped with coupling spacer removed.
3. Unlock driver power.
4. Make sure everyone is clear. Jog driver just long enough to determine direction of rotation. Rotation must correspond to arrow on bearing housing.
5. Lock out power to driver.

CHECK IMPELLER CLEARANCE

Prior to starting the pump the impeller clearance must be checked. The pump efficiency is maintained when the proper impeller clearance is set. The optimum hydraulic performance is attained by setting the impeller front clearance at the factory to predetermined limits which are consistent with service conditions.

Frame Designation	Impeller Front Clearance Inch (mm)
STX	.005 (.13)
MTX, LTX	.008 (.20)
XLTX, X17	.015 (.38)

The maximum impeller setting should not be set more than .005 inch (0.13mm) above values in table or significant performance degradation will result.

Also, for pumpage temperatures above 200 degrees F (93 degrees C) the cold (ambient) setting must be increased per Table 3. This is necessary to prevent the impeller from contacting the casing due to differential expansion from the higher operating temperatures. See Preventative Maintenance section for impeller adjustment procedure.

Table 3
Impeller Clearances

COLD TEMPERATURE CLEARANCES FOR VARIOUS SERVICE TEMPERATURES

Service Temperature	STX	MTX/LTX	XLTX/X17
Up to 200°F (93°C)	.005" (.13mm)	.008" (.20mm)	.015" (.38mm)
200 to 250° F (121°C)	.007" (.18mm)	.010" (.26mm)	.017" (.43mm)
250°F to 300°F (149°C)	.009" (.23mm)	.012" (.30mm)	.019" (.48mm)
300°F to 350°F (177°C)	.011" (.28mm)	.014" (.36mm)	.021" (.53mm)
350°F to 400°F(204°C)	.013" (.33mm)	.016" (.41mm)	.023" (.58mm)
Over 400°F (204°C)	.015" (.38mm)	.018" (.46mm)	.025" (.64mm)

COUPLE PUMP AND DRIVER

⚠ WARNING

Lock out driver power to prevent accidental rotation and physical injury.

1. Install and lubricate coupling per manufacturer's instructions.
2. Install coupling guard (Fig. 12). Refer to Coupling Guard Installation and Disassembly Section (Appendix II).

⚠ WARNING

Never operate a pump without coupling guard properly installed. Refer to Appendix II for coupling guard installation instructions. Personal injury will occur if pump is run without coupling guard.

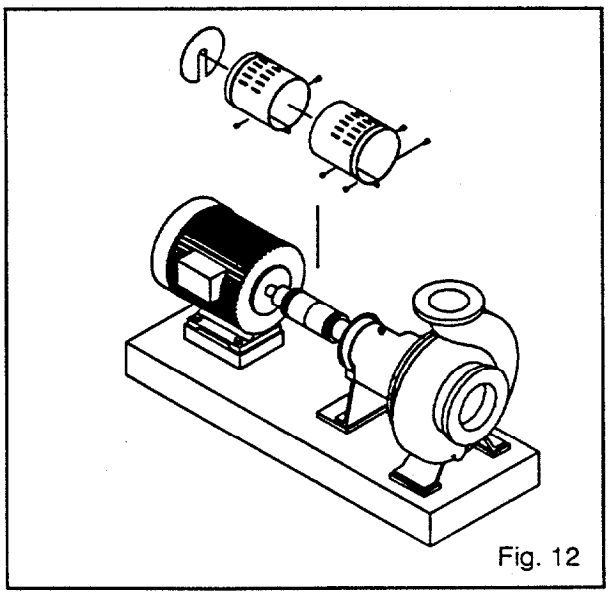


Fig. 12

LUBRICATING BEARINGS

⚠ CAUTION

Pumps are shipped without oil.

Oil Lubrication: Fill bearing frame with oil, through filler connection (located on top of bearing frame refer to Fig. 18B), until oil level reaches the middle of the sight-glass . A high quality turbine type oil, with rust and oxidation inhibitors should be used.

Pure Oil Mist Lubrication: Oil mist is an optional feature for the 3196. Follow oil mist generator manufacturer's instructions. The inlet connections are located on the top of the bearing frame, connection points are covered under lubrication. (Refer to Apprendix I on converting lubrication).

Grease Lubrication: Pumps are shipped **with** grease. See Table 6.

Greased For Life Bearings: These bearings are filled with grease and sealed by the bearing manufacturer.

If pump is put into operation after prolonged shut-down, flush out bearings and bearing frame with a light oil to remove contaminants. During flushing rotate shaft slowly by hand. Finally, flush bearing housing with proper lubricating oil to insure oil quality after cleaning.

See Preventive Maintenance section for lubrication recommendations.

⚠ WARNING

Operation of the unit without proper lubrication will cause bearing failure, and pump seizure.

SHAFT SEALING

Mechanical Seal Option: Pumps may be shipped with or without mechanical seals installed. A common seal with this model is the cartridge type. Cartridge seals are preset at the seal manufacturer's facility and require no field settings. Cartridge Seals installed by the user require removal of the holding clips prior to operation, allowing the seal to slide into place. If the seal has been installed in the pump at the Goulds factory, these clips have already been removed. For other types of mechanical seals, refer to the seal manufacturer's instructions for installation and setting.

Connection of Sealing Liquid: For satisfactory operation, there must be a liquid film between seal faces to lubricate them. Refer to seal manufacturer's drawing for location of taps. Some methods which may be used to flush/cool the seal are:

a. Product Flushing - In this arrangement, the pumpage is piped from the casing (and cooled in an external heat exchanger when required) then injected into seal gland.

b. External Flush - A clean, cool compatible liquid is injected from an outside source directly into seal gland. Flushing liquid must be at a pressure 5-15 PSI (0.35-1.01 kg/cm^2) greater than the stuffing box/seal chamber pressure. Injection rate should be ½-2 GPM (2-8 LPM).

c. Other methods may be used which make use of multiple gland connections and/or stuffing box connections. Refer to documentation supplied with the pump, mechanical seal reference drawing, and piping diagrams.

Packed Stuffing Box Option: Pumps are shipped without packing, lantern ring or spilt gland installed. These are included with the box of fittings shipped with the pump and must be installed before start-up.

Installation of packing:

1. Carefully clean stuffing box bore.
2. Twist the packing just enough to get it around the shaft (Fig. 13A,B).
3. Insert packing, staggering the joints in each ring by 90°.
4. The stuffing box arrangement in order of installation is: 2 packing rings, lantern ring (one piece), then 3 packing rings.

⚠ CAUTION

Follow instructions to insure the lantern ring is located at the flushing connection Fig. 14. Otherwise no flush will be obtained.

5. Install the gland halves and evenly hand tighten the nuts.

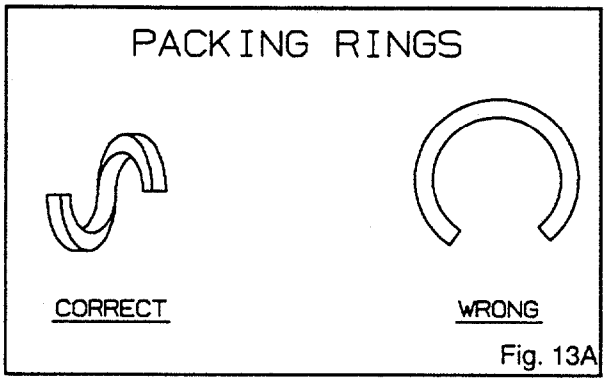


Fig. 13A

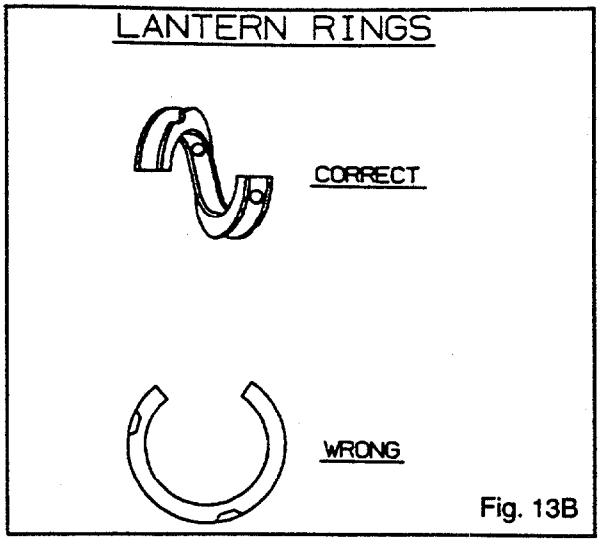


Fig. 13B

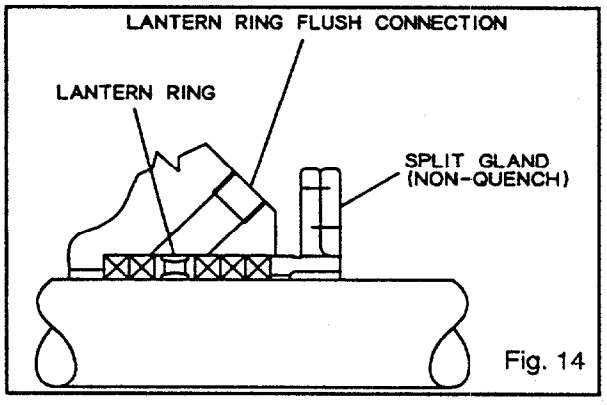


Fig. 14

Connection of Sealing Liquid: If stuffing box pressure is above atmospheric pressure and pumpage is clean, normal gland leakage of 40-60 drops per minute is usually sufficient to lubricate and cool packing and sealing liquid is not required.

NOTE: Otherwise a product flush can be used if a clean pumpage exists.

An external sealing liquid is required when:

1. Abrasive particles in pumpage could score shaft sleeve.
2. Stuffing box pressure is below atmospheric pressure due to pump running with suction lift, or when suction source is under vacuum. Under these conditions, packing will not be cooled and lubricated and air will be drawn into pump.

If an outside source of clean compatible liquid is required, the pressure should be 15 PSI (1.0 kg/cm^2) above suction pressure. The piping should be connected to the lantern ring connection.

NOTE: Most packing requires lubrication. Failure to lubricate packing may shorten the life of the packing and pump.

Dynamic Seal Option: The dynamic seal consists of two seals: a repeller that prevents leakage during pump operation and a secondary seal that prevents leakage when the unit is off. The repeller acts as a pump to prevent liquid from entering the stuffing box during pump operation. The repeller does not require a flush except for services which allow a build-up of solids on the repeller. A flush hole can be provided for this purpose. A drain hole can also be supplied to drain repeller chamber if danger of freezing exists.

Secondary Seals: The secondary seal prevents leakage during pump shut down. This seal is either graphite packing or an elastomeric face or lip seal.

1. **Graphite packing** - This packing will provide adequate life running dry but will provide longer performance if it is lubricated with either clean water or grease. When clean water is used, remember that the repeller reduces both the quantity and pressure of seal water required. If the suction head is less than the repeller capability, the stuffing box pressure is the same as atmospheric. Seal water pressure must be high enough to overcome static head when the pump is not operating to keep pumpage out of the packing. Flow must be sufficient to cool the packing. If grease is used as the lubricant, spring-loaded grease lubricators should be used to maintain a constant supply.
2. **Elastomeric Face or Lip seal** - The elastomeric face seal consists of an elastomer rotary fitted to the shaft, and a ceramic stationary seat fitted in the gland. To set the seal, remove the gland nuts and slide the gland back on the sleeve. Pull the rotary back on the sleeve until it is about 1 inch beyond the stuffing box face. Push the gland back onto the studs, pushing the rotary back along the sleeve. Tighten the gland nuts. This ensures contact, no other adjustments are needed. The lip seal is pressed into the gland and no adjustment is required. Both seals are designed to run dry, so no flush is required.

PRIMING PUMP

Never start the pump until it has been properly primed. Several different methods of priming can be used, depending upon type of installation and service involved.

Suction Supply Above Pump:

1. Slowly open the suction valve (Fig. 15).
2. Open air vents on the suction and discharge piping until water flows out.
3. Close the vent valves.

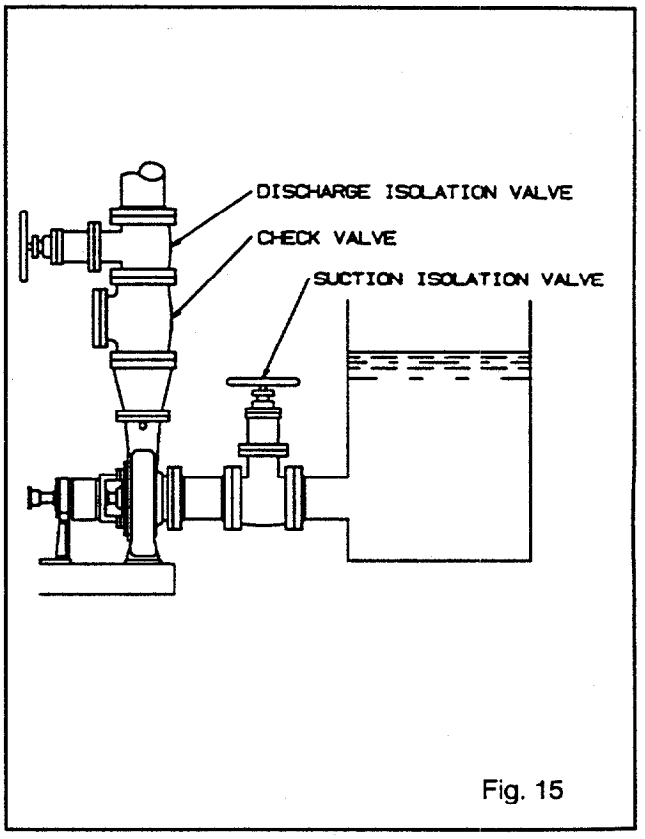


Fig. 15

Suction supply below pump: A foot valve and outside source of liquid may be used to prime the pump. Outside source of liquid can come from a priming pump, pressurized discharge line, or other outside supply (Fig. 16 and 17).

1. Close discharge valve and open air vents in casing.
2. Open valve in outside supply line until only water escapes from vent valves.
3. Close the vent valves and then the outside supply line.

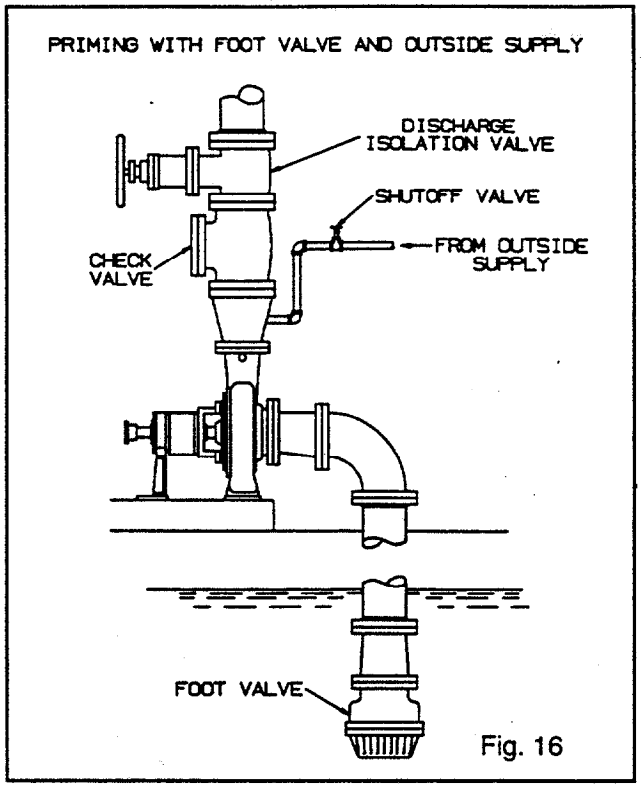


Fig. 16

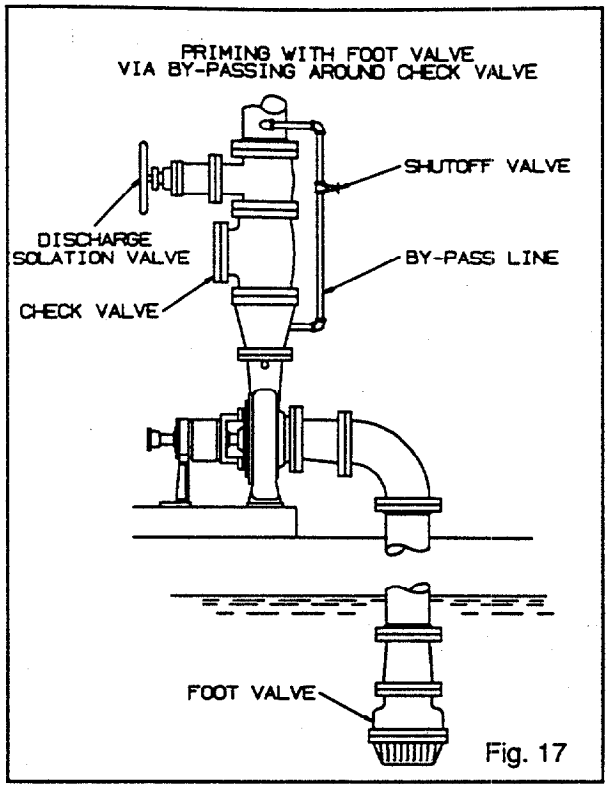


Fig. 17

4

Other Methods of Priming:

1. Priming by Ejector.
2. Priming by Automatic Priming Pump.

STARTING PUMP

1. Make sure suction valve and any recirculation or cooling lines are open.
2. Fully close or partially open discharge valve as dictated by system conditions.
3. Start Driver.

⚠ CAUTION

Immediately observe pressure gauges. If discharge pressure is not quickly attained - stop driver, reprime and attempt to restart.

4. Slowly open discharge valve until the desired flow is obtained.

⚠ CAUTION

Observe pump for vibration levels, bearing temperature and excessive noise. If normal levels are exceeded, shut down and resolve.

OPERATION

GENERAL CONSIDERATIONS

Always vary capacity with regulating valve in the discharge line. **NEVER** throttle flow from the suction side.

Driver may overload if the pumpage specific gravity (density) is greater than originally assumed, or the rated flow rate is exceeded.

Always operate the pump at or near the rated conditions to prevent damage resulting from cavitation or recirculation.

OPERATING AT REDUCED CAPACITY

⚠ WARNING

DO NOT operate pump below minimum rated flows or with suction and/or discharge valve closed. These conditions may create an explosive hazard due to vaporization of pumpage and can quickly lead to pump failure and physical injury. Reference Appendix III.

Damage occurs from:

1. Increased vibration levels - Affects bearings, stuffing box (or seal chamber), and mechanical seal.
2. Increased radial thrusts - Stresses on shaft and bearings.
3. Heat build up - Vaporization causing rotating parts to score or seize.
4. Cavitation - Damage to internal surfaces of pump.

OPERATING UNDER FREEZING CONDITIONS

Exposure to freezing conditions, while pump is idle, could cause liquid to freeze and damage the pump. Liquid inside pump should be drained. Liquid inside cooling coils, if supplied, should also be drained.

SHUTDOWN

1. Slowly close discharge valve.
2. Shut down and lock driver to prevent accidental rotation.

⚠ WARNING

When handling hazardous and/or toxic fluids, proper personal protective equipment should be worn. If pump is being drained, precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable environmental regulation.

FINAL ALIGNMENT

1. Run the unit under actual operating conditions for a sufficient length of time to bring the pump and driver up to operating temperature.
2. Check alignment while unit is still hot per alignment procedure in Section 3.
3. Reinstall coupling guard. Refer to coupling guard instruction in Appendix II.

PREVENTIVE MAINTENANCE

GENERAL COMMENTS

5

A routine maintenance program can extend the life of your pump. Well maintained equipment will last longer and require fewer repairs. You should keep maintenance records, this will help pinpoint potential causes of problems.

MAINTENANCE SCHEDULE

Routine Maintenance

- Bearing lubrication
- Seal Monitoring
- Vibration analysis
- Discharge pressure
- Temperature monitoring

Routine Inspections

- Check level and condition of oil through sight glass on bearing frame.
- Check for unusual noise, vibration and bearing temperatures.
- Inspect pump and piping for leaks.
- Check seal chamber/stuffing box leakage.
  - Mechanical Seal: Should be no leakage.
  - Packing: Excessive leakage requires adjustment or possible packing replacement. Refer to Section 4: Operation for packing gland adjustment.

3 Month Inspections

- Check foundation and hold-down bolts for tightness.
- If pump has been left idle, check packing. Replace if required.
- Oil should be changed at least every 3 months (2000 hours) or more often if there are any adverse atmospheric conditions or other conditions which might contaminate or break down the oil, or if it is cloudy or contaminated as seen by inspection through the sight glass.
- Check shaft alignment and realign if required.

Annual Inspections

- Check pump capacity, pressure and power. If pump performance does not satisfy your process requirements, and process requirements have not changed, pump should be disassembled, inspected, and worn parts should be replaced, otherwise, a system inspection should be done.

MAINTENANCE OF BEARINGS

OIL LUBRICATED BEARINGS

⚠ WARNING

Pumps are shipped without oil. Oil lubricated bearings must be lubricated at the job site.

Remove fill plug (408H) and add oil until level is at the center of the sight glass (319). Replace fill plug (Fig. 18A). See Table 4.

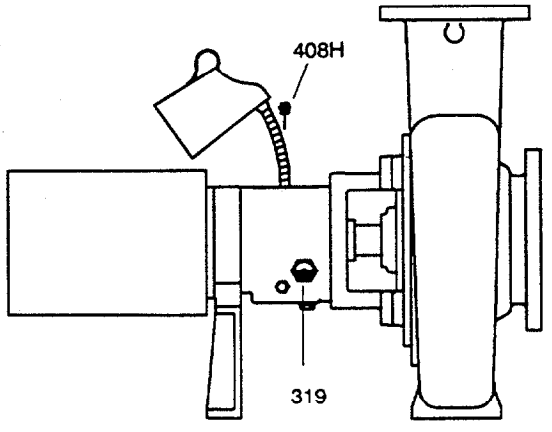


Fig. 18A

Change the oil after 200 hours for new bearings, thereafter every 2000 operating hours or 3 months (whichever comes first).

Table 4
Oil Volumes

Frame	Pints	ml
STX	1.0	400
MTX	2.6	1250
LTX	3.0	1400
XLT-X and X17	6.0	3000

A high quality turbine oil with rust and oxidation inhibitors should be used. For the majority of operational conditions, bearing temperatures will run between 120°F (50°C) and 180°F (82°C). In this range, an oil of ISO viscosity grade 68 at 100°F (40°C) is recommended. If bearing temperatures exceed 180°F (82°C) use ISO viscosity grade 100 with Bearing Frame cooling. See Table 5. For higher operating temperatures, pumpage above 350°F (177°C), synthetic lubrication is recommended.

Table 5
Lubricating Oil Requirements

	Pumpage temperature below 350°F (177°C)	Pumpage temperature above 350°F (177°C)
ISO Grade	VG 68	VG 100
Approx. SSU at 100°F (38°C)	300	470
DIN 51517	C68	C100
Kinem. viscosity at 100°F (40°C) mm^2/sec	68	100

Some acceptable lubricants are:

Exxon	Teresstic EP 68
Mobil	Mobil DTE 26 300 SSU @ 100°F (38°C)
Sunoco	Sunvis 968
Royal Purple	SYNFILM ISO VG 68 Synthetic Lube

GREASE LUBRICATED BEARINGS

Grease lubricated bearings are pre-lubricated at the factory. Regrease bearings every 2000 operating hours or 3 months.

Regrease Procedure:

NOTE: ***When regreasing there is danger of impurities entering the bearing housing. The grease container, the greasing device, and fittings, must be clean.***

1. Wipe dirt from grease fittings.
2. Remove 2 grease relief plugs (408H) from bottom of frame.
3. Fill both grease cavities through fittings with recommended grease until fresh grease comes out of the relief holes. Reinstall grease relief plugs (408H).
4. Ensure frame seals are seated in bearing housing and if not press in place with drains located at the bottom .

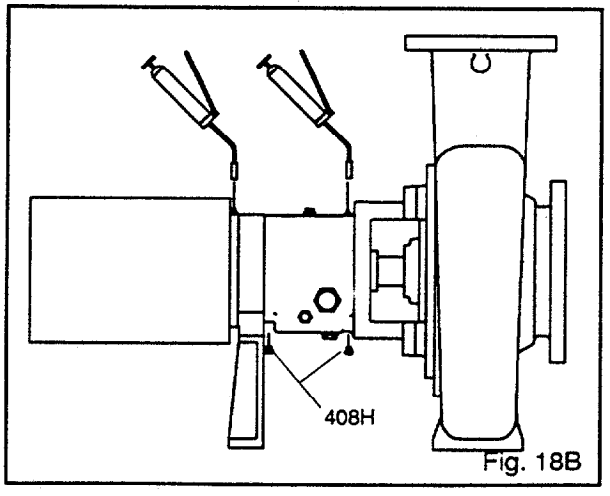


Fig. 18B

NOTE: ***The bearing temperature usually rises after regreasing due to an excess supply of grease. Temperatures will return to normal after pump has run and purged the excess from the bearings, usually two to four hours.***

For most operating conditions a lithium based mineral oil grease of NLGI consistency No. 2 is recommended. This grease is acceptable for bearing temperatures of 5°F to 230°F (-15°C to 110°C). Bearing temperatures are generally about 20°F (18°C) higher than bearing housing outer surface temperature.

Table 6
Lubricating Grease Requirements

	Pumpage temperature below 350°F (177°C)	Pumpage temperature above 350°F (177°C)
NLGI consistency	2	3
Mobil	Mobilux EP2	
Exxon	Unirex N2	Unirex N3
Sunoco	Mutipurpose EP,	
SKF	LGMT 2	LGMT 3

⚠ CAUTION

Never mix greases of different consistency (NLGI 1 or 3 with NLGI 2) or different thickener. For example never mix a lithium base grease with a polyurea base grease.

Pumpage temperatures above 350°F (177°C) should be lubricated by a high temperature grease. Mineral oil greases should have oxidation stabilizers and a consistency of NLGI 3.

NOTE: ***If it is necessary to change grease type or consistency, the bearings must be removed and the old grease removed.***

5

MAINTENANCE OF SHAFT SEALS

MECHANICAL SEALS

When mechanical seals are furnished, a manufacturer's reference drawing is supplied with the data package. This drawing should be kept for future use when performing maintenance and adjusting the seal. The seal drawing will also specify required flush liquid and attachment points. The seal and all flush piping must be checked and installed as needed prior to starting the pump.

The life of a mechanical seal depends on various factors such as cleanliness of the liquid handled and its lubricating properties. Due to the diversity of operating conditions it is, however, not possible to give definite indications as to its life.

⚠ WARNING

Never operate the pump without liquid supplied to mechanical seal. Running a mechanical seal dry, even for a few seconds, can cause seal damage and must be avoided. Physical injury can occur if mechanical seal fails.

PACKED STUFFING BOX

⚠ WARNING

Lock out driver power to prevent accidental start-up and physical injury.

The stuffing box is not packed at the factory and must be packed properly before operation of the pump. The packing is furnished in a box of fittings which accompany the pump. The packing used must be suitable for the pumpage. Make sure the stuffing box is clean. Examine shaft-sleeve for wear or scoring, replace if necessary.

Starting from the innermost ring, the packing is usually arranged as two packing rings, lantern ring, three packing rings, followed by the split gland (Fig. 14). Insert single packing rings by twisting as shown in Fig. 6. Press each ring to ensure proper compression in the stuffing box. Stagger joints 90°. Refer to Fig. 13A, 13B.

Lightly and evenly tighten the gland. Excessive tightening will result in premature failure of the packing and shaft sleeve. After packing it must be possible to rotate shaft by hand. Final adjustment of packing gland is made after pump is started.

DYNAMIC SEAL

Dynamic Seal Components

Repeller - The dynamic repeller effectively prevents leakage of pumpage through the stuffing box when the pump is operating under published acceptable conditions. Dynamic seal parts do not wear substantially to affect operation unless the service is particularly abrasive or corrosive. Refer to Section 6 for maintenance disassembly and repair.

A static seal is used to prevent leakage when the pump is shut down. This is either a lip seal, elastomeric face seal, or graphite packing. The lip and elastomeric face seal require no maintenance other than replacement when leakage becomes excessive. The packing should be installed as for stuffing box packing, and is a special type designed to run dry, so does not require an external flush.

IMPELLER CLEARANCE SETTING

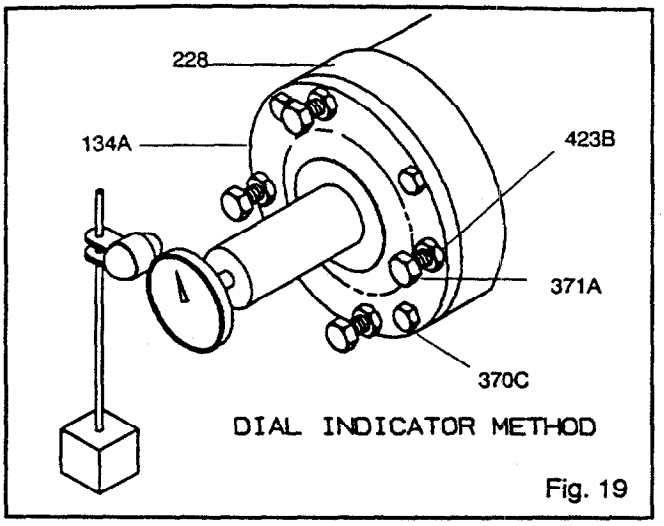
⚠ WARNING

Lock out driver power to prevent accidental startup and physical injury.

A change in pump performance may be noted over time by a drop in head or flow or an increase in power required. Performance can usually be renewed by adjusting the impeller clearance. Two techniques are given to set the impeller clearance, the dial indicator method and the feeler gauge method.

DIAL INDICATOR METHOD

1. Remove coupling guard. Refer to coupling guard instructions Appendix II.
2. Remove coupling.
3. Set indicator so that button contacts either the shaft end or against face of coupling (Fig. 19).
4. Loosen jam nuts (423B) on jack bolts (371A) and back bolts out about two turns.
5. Tighten each locking bolt (370C) evenly, drawing the bearing housing (134A) towards the bearing frame (228) until impeller contacts the casing. Turn the shaft to ensure contact is made.
6. Set indicator to zero and back locking bolt (370C) out about one turn.
7. Thread jack bolts (371A) in until they evenly contact the bearing frame. Tighten the jack bolts evenly (about one flat at a time) backing the bearing housing (134A) away from the bearing frame until the indicator shows the proper clearance per Table 3.
8. Evenly tighten locking bolts (370C), then jack bolts (371A) keeping indicator reading at proper setting.
9. Check shaft for free turning.
10. Replace coupling guard.



DIAL INDICATOR METHOD

Fig. 19

5

FEELER GAUGE METHOD

1. Remove coupling guard. Refer to coupling guard instructions in Appendix II.
2. Loosen jam nuts (423B) on jack bolts (371A) and back bolts out about two turns (Fig. 20).
3. Tighten locking bolts (370C) evenly, drawing bearing housing (134A) towards frame (228) until impeller contacts the casing. Turn shaft to ensure contact is made.
4. With a feeler gauge set the gap between the three locking bolts (370C) and bearing housing (134A) per impeller clearances in Table 3.
5. Evenly back out bearing housing (134A) using the three jack bolts (371A) until it contacts the locking bolts (370C). Evenly tighten jam nuts (423B).
6. Check shaft for free turning.
7. Replace coupling guard.

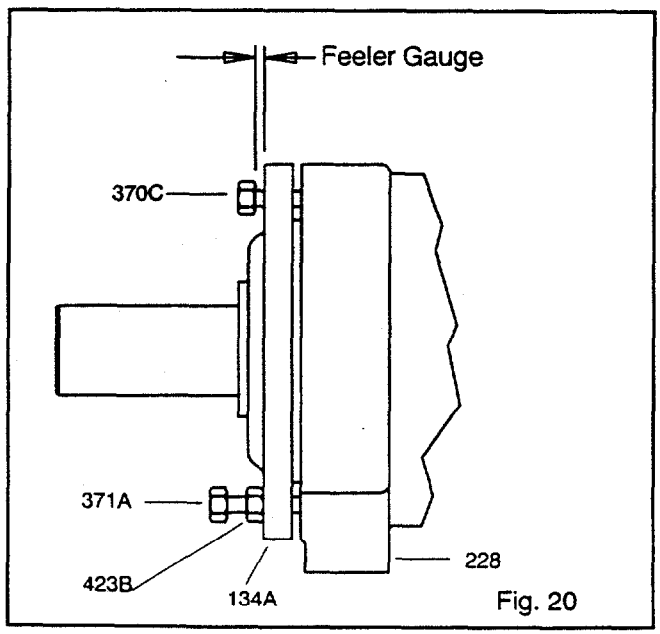


Fig. 20

Table 3
Impeller Clearances

COLD TEMPERATURE CLEARANCES FOR VARIOUS SERVICE TEMPERATURES	
200°F (93°C)	0.015 in. (0.38 mm)
250°F (121°C)	0.017 in. (0.43 mm)
300°F (149°C)	0.019 in. (0.48 mm)
350°F (177°C)	0.021 in. (0.53 mm)
400°F (204°C)	0.023 in. (0.58 mm)
Over 400°F (204°C)	0.025 in. (0.64 mm)

TROUBLE SHOOTING

Table 7
Troubleshooting Pump

PROBLEM	PROBABLE CAUSE	REMEDY
No liquid delivered.	Pump not primed.	Reprime pump, check that pump and suction line are full of liquid.
	Suction line clogged.	Remove obstructions.
	Impeller clogged with foreign material.	Back flush pump to clean impeller.
	Wrong direction of rotation.	Change rotation to concur with direction indicated by arrow on bearing housing or pump casing.
	Foot valve or suction pipe opening not submerged enough.	Consult factory for proper depth. Use baffle to eliminate vortices.
	Suction lift too high.	Shorten suction pipe.
Pump not producing rated flow or head.	Air leak thru gasket.	Replace gasket.
	Air leak thru stuffing box	Replace or readjust packing/mechanical seal.
	Impeller partly clogged.	Back flush pump to clean impeller.
	Worn suction sideplate or wear rings.	Replace defective part as required.
	Insufficient suction head.	Ensure that suction line shutoff valve is fully open and line is unobstructed.
	Worn or broken impeller.	Inspect and replace if necessary.
Pump starts then stops pumping.	Improperly primed pump.	Reprime pump.
	Air or vapor pockets in suction line.	Rearrange piping to elilminate air pockets.
	Air leak in suction line.	Repair (plug) leak.
Bearings run hot.	Improper alignment.	Re-align pump and driver.
	Improper lubrication.	Check lubricant for suitability and level.
	Lube cooling.	Check cooling system.
Pump is noisy or vibrates.	Improper pump/driver alignment.	Align shafts.
	Partly clogged impeller causing imbalance.	Back-flush pump to clean impeller.
	Broken or bent impeller or shaft.	Replace as required.
	Foundation not rigid.	Tighten hold down bolts of pump and motor or adjust stilts.
	Worn bearings.	Replace.
	Suction or discharge piping not anchored or properly supported.	Anchor per Hydraulic Institute Standards Manual recommendations
	Pump is cavitating.	System problem.
Excessive leakage from stuffing box.	Packing gland improperly adjusted.	Tighten gland nuts.
	Stuffing box improperly packed.	Check packing and repack box.
	Worn mechanical seal parts.	Replace worn parts.
	Overheating mechanical seal.	Check lubrication and cooling lines.
	Shaft sleeve scored.	Remachine or replace as required.
Motor requires excessive power.	Head lower than rating. Pumps too much liquid.	Consult factory. Install throttle valve, trim impeller diameter.
	Liquid heavier than expected.	Check specific gravity and viscosity.
	Stuffing packing too tight.	Readjust packing. Replace if worn.
	Rotating parts bind.	Check internal wearing parts for proper clearances.

5

DISASSEMBLY & REASSEMBLY

REQUIRED TOOLS

- 9/16", 3/4", 7/8", 15/16" Open end wrenches
- Lifting sling
- Impeller wrench
  STX, MTX - Goulds part # A01676A

  STX, MTX, LTX, XLT-X, X17 -
  Goulds part # A05107A
- 7/16" open end wrench (LTX)
- Induction bearing heater
- Brass drift punch
- Spanner wrench
- Snap-ring pliers
- Allen wrenches
- Torque wrench with sockets
- Dial indicator
- Micrometer
- Cleaning Agents
- Feeler gauges

6

DISASSEMBLY

⚠ WARNING

Pump components can be heavy. Proper methods of lifting must be employed to avoid physical injury and/or equipment damage. Steel toed shoes must be worn at all times.

⚠ WARNING

The 3196 may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable Environmental Regulations.

NOTE: Before disassembling the pump for overhaul, ensure all replacement parts are available.

⚠ WARNING

Lock out power supply to driver motor to prevent accidental startup and physical injury.

1. Shut off all valves controlling flow to and from pump.

⚠ WARNING

Operator must be aware of pumpage and safety precautions to prevent physical injury.

2. Drain liquid from piping, flush pump if necessary.
3. Disconnect all auxiliary piping and tubing.
4. Remove coupling guard. Refer to Coupling Guard Installation and Disassembly Section in Appendix 2.

5. Disconnect Coupling.
6. Remove coupling guard pump endplate.
7. If oil lubricated, drain oil from bearing frame by removing bearing frame drain plug (408A). Replace plug after oil is drained. Remove oil reservoir, if equipped (Fig. 21).

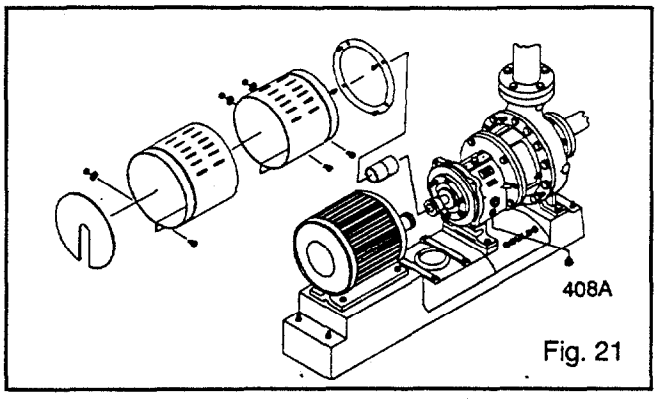


Fig. 21

NOTE: Oil analysis should be part of a preventive maintenance program, and is helpful to determine cause of a failure. Save oil in a clean container for inspection.

8. Place sling from hoist through frame adapter (108) or frame (228A) for STX (Fig. 22).
9. Remove bearing frame foot hold down bolts (370F).
10. Remove casing bolts (370).

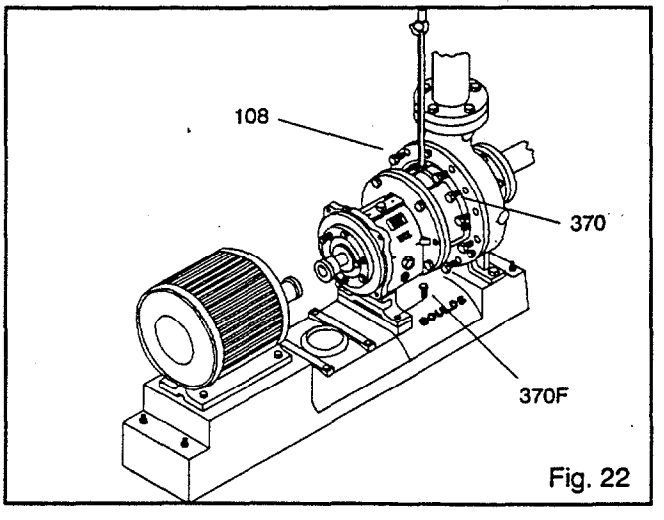


Fig. 22

⚠ WARNING

Never apply heat to remove parts. Use of heat may cause an explosion due to trapped fluid, resulting in severe physical injury and property damage.

11. Remove back pull-out assembly from casing (100). Tighten jack screws (418) evenly to remove back pull-out assembly (Fig. 23).

NOTE: Penetrating oil can be used if adapter to casing joint is excessively corroded.

NOTE: Remove and then mark shims from under frame foot. Save for reassembly.

⚠ WARNING

Never remove the back pull-out assembly unassisted, physical injury can occur.

12. Remove casing gasket (351) and discard. (Replace with new gasket during reassembly.)
13. Remove jack screws (418).

NOTE: Casing gasket (351) may partially adhere to casing due to binders and adhesives in the gasket material. Clean all gasket surfaces.

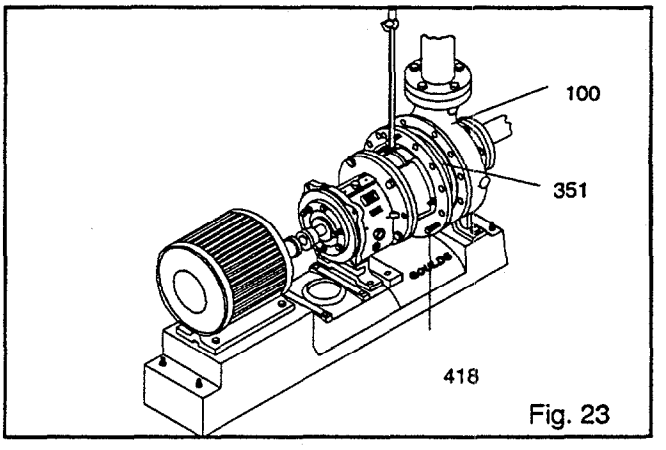


Fig. 23

14. Move back pull-out assembly to clean work bench.
15. Support frame adapter (108) securely to workbench.

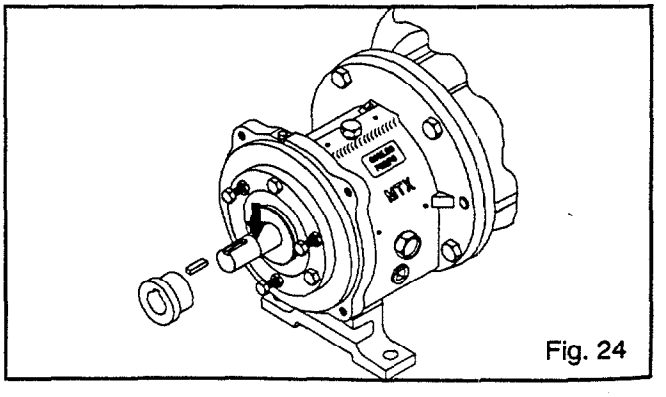


Fig. 24

NOTE: Blue and scribe shaft for relocating coupling hub during reassembly.

16. Remove coupling hub (Fig. 24).

Removal of Impeller

⚠ WARNING

Never apply heat to remove impeller. Use of heat may cause an explosion due to trapped fluid, resulting in severe physical injury and property damage.

⚠ WARNING

Wear heavy work gloves when handling impeller (101) as sharp edges may cause physical injury.

Two special features have been incorporated into the XLT design to ease maintenance problems and preclude the temptation to apply heat to stubborn parts.

1. A plug has been added to the nose of the XLT impellers. It is sealed with a teflon gasket. Removing the plug relieves any pressure between the impeller and the shaft and provides means to introduce penetrating oil to the threads to ease impeller removal.
2. A hexagonal nut is cast on the impeller hub so a socket wrench can be used to assist removal.

17. Recommended removal procedure is as follows:

STX, MTX, LTX: Remove impeller (101) from shaft (122). Slide Goulds shaft wrench (A05107A) over shaft (122) and key. Rotate impeller clockwise (viewed from impeller end of shaft) raising wrench off work surface. Quickly turn impeller (101) counterclockwise (viewed from impeller end of shaft) impacting wrench handle on workbench or solid block until impeller (101) loosens (Fig. 25).

XLT-X & X17: Remove plug (458Y) from front of impeller (101) and discard teflon gasket (428D) (Fig. 25A). Spray penetrating oil through plug hole into cavity at end of shaft. Wait 15 minutes. Rotate shaft several times while waiting to distribute oil. Proceed to remove impeller from shaft as described above for STX, MTX, and LTX. If impeller cannot be loosened after several tries, place socket wrench over cast nut on impeller hub and turn impeller counterclockwise (viewed from impeller end of shaft). Be sure impeller wrench is resting on workbench or solid block and the powerend is secure on workbench. It is further recommended that the frame foot (241) be clamped to the workbench when using this method to remove the impeller.

NOTE: FOR ALL MODELS

If the impeller cannot be removed by the previous methods, cut the shaft between the gland and the frame, remove the impeller, stuffing box cover, gland, sleeve and shaft end as a unit. Do not use heat.

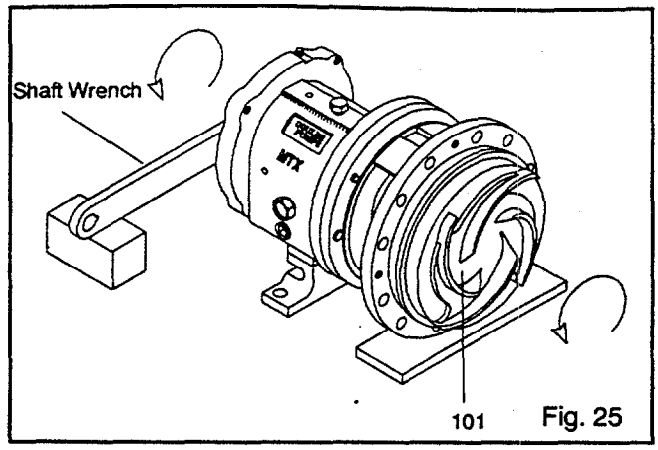


Fig. 25

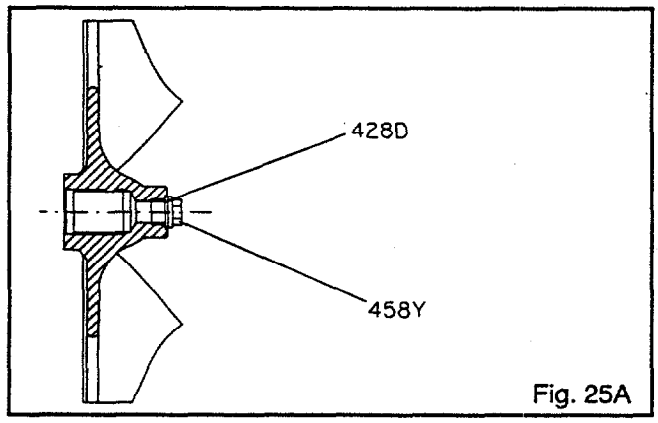


Fig. 25A

18. Remove impeller O-ring (412A) and discard (Fig. 26).

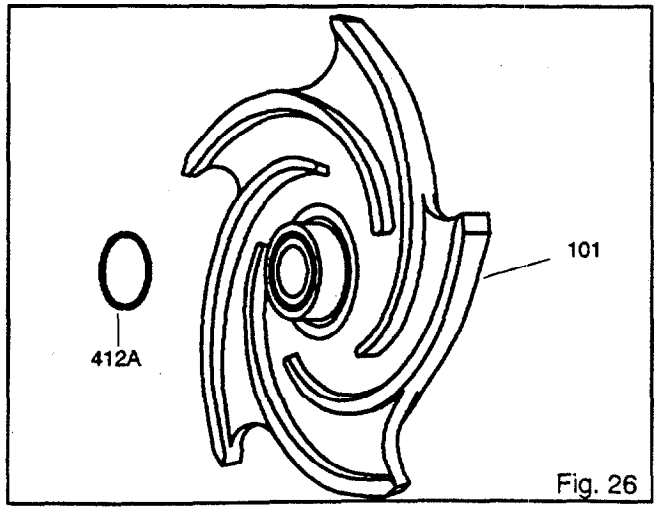


Fig. 26

6

19. REMOVAL OF SEAL CHAMBER COVER

(Mechanical Seal)

1. Remove gland stud nuts (355).
2. Remove seal chamber stud nuts (370H).
3. Remove seal chamber (184).

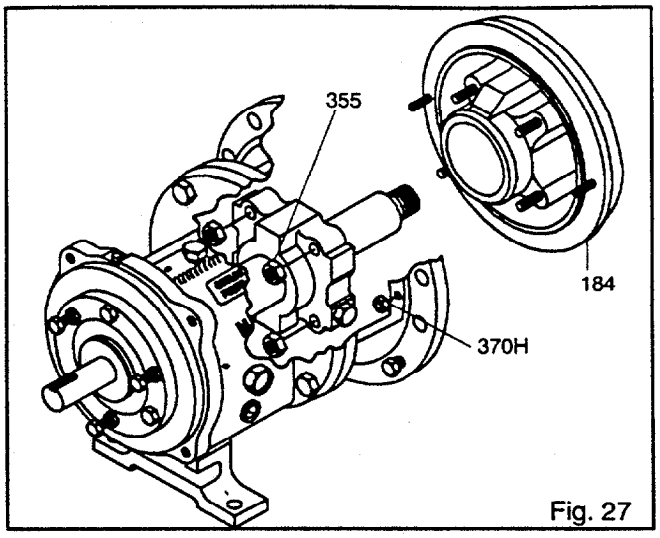


Fig. 27

4. Remove shaft sleeve (126), if used.

NOTE Mechanical seal is attached to sleeve (126). Rotary portion of seal needs to be removed from sleeve by loosening set screws and sliding it off the sleeve. Refer to mechanical seal instructions.

5. Remove gland (107) with stationary seat and O-ring (360Q) (Fig. 28).

NOTE: Be careful not to damage the stationary portion of the mechanical seal. It is seated in the gland bore.

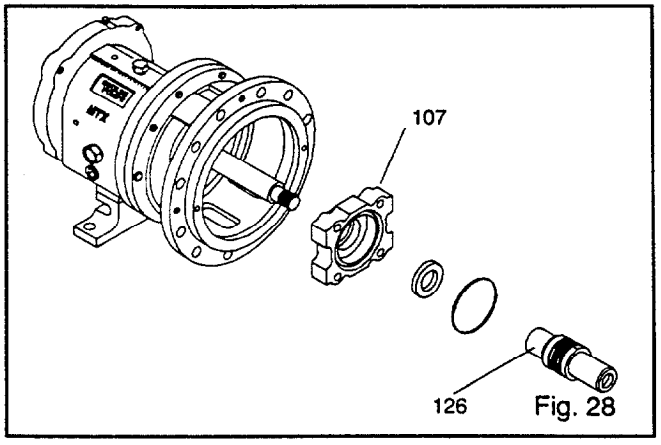


Fig. 28

19A. REMOVAL OF STUFFING BOX COVER

(Packed Box) (Fig. 29)

1. Remove gland stud nuts (355), and gland(107).
2. Remove stuffing box cover stud nuts (370H).
3. Remove stuffing box cover (184).

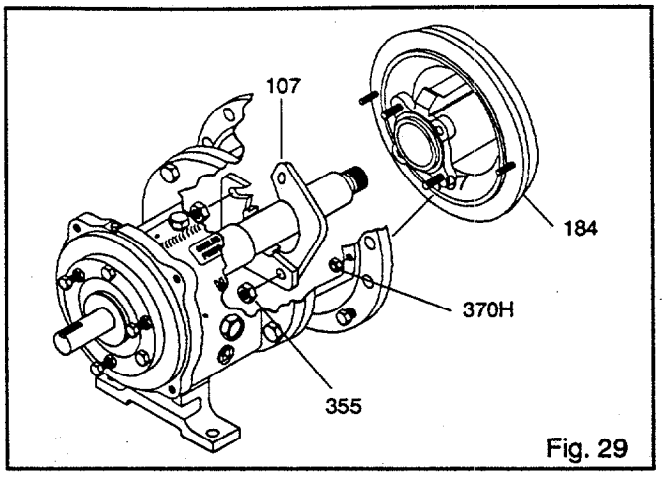


Fig. 29

4. Remove shaft sleeve (126) (Fig. 30).

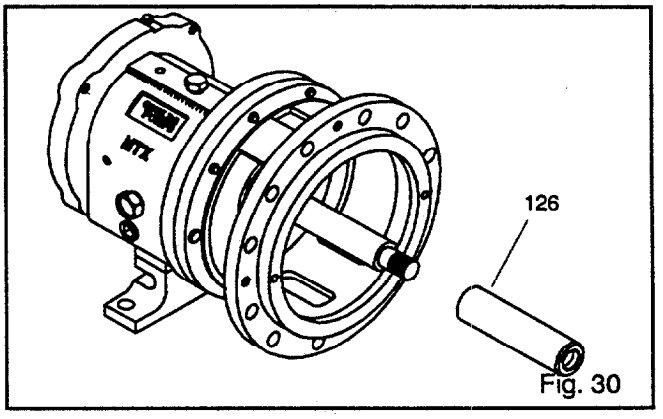


Fig. 30

5. Remove packing (106) and lantern ring (105) from stuffing box cover (184) (Fig. 31).

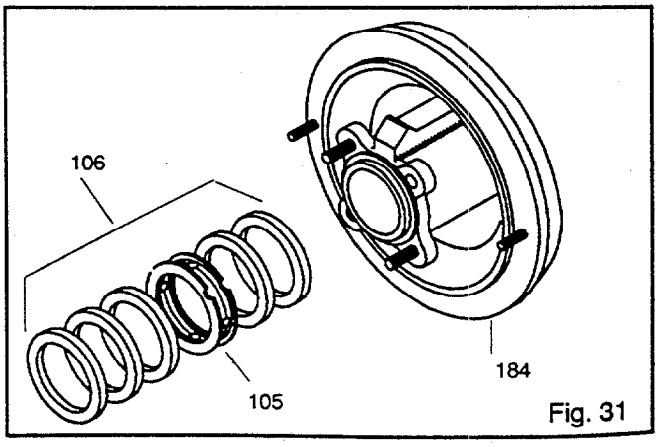


Fig. 31

19B. REMOVAL OF DYNAMIC SEAL

1. Remove stud nuts (370H).
2. Remove dynamic seal assembly (Fig. 32).

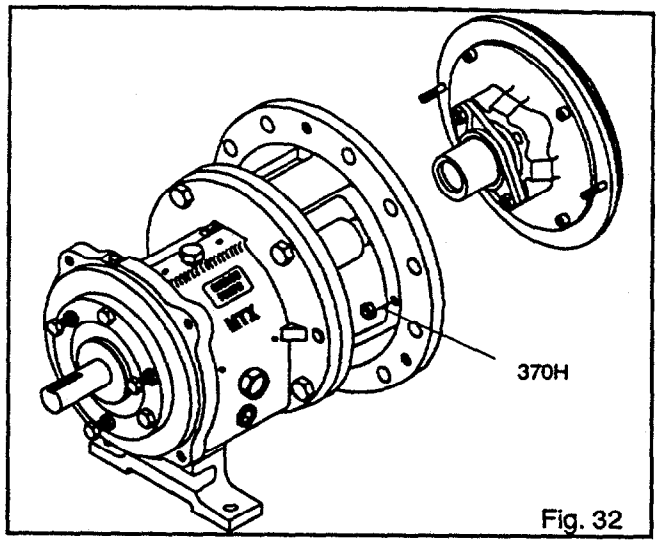


Fig. 32

3. Remove socket head cap screws (265) (Fig. 33).
4. Remove stuffing box cover (184) and gasket (264).
5. Remove repeller (262) from backplate (444).

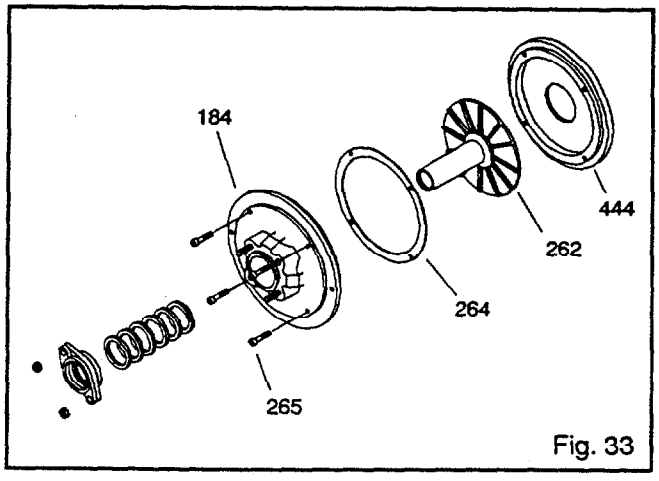


Fig. 33

20. REMOVE FRAME ADAPTER - MTX, LTX, XLT-X, X17

1. Remove dowel pins (469B), and bolts (370B).
2. Remove frame adapter (108) (Fig. 34).
3. Remove and discard gasket (360D). Replace with new gasket during reassembly.

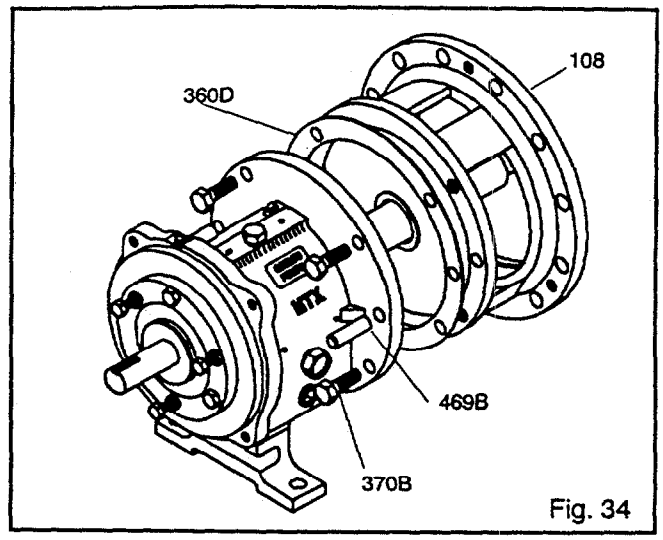


Fig. 34

21. Remove inboard labyrinth oil seal (333A), it is an O-Ring fit into the bearing frame (228A) for STX, frame adapter (108) for MTX, LTX, XLT-X and X17. Remove O-rings (497H), (497J) if necessary (Fig. 35).

NOTE: Labyrinth oil seal O-rings (497H, J) are part of 3196 maintenance kits or can be obtained separately

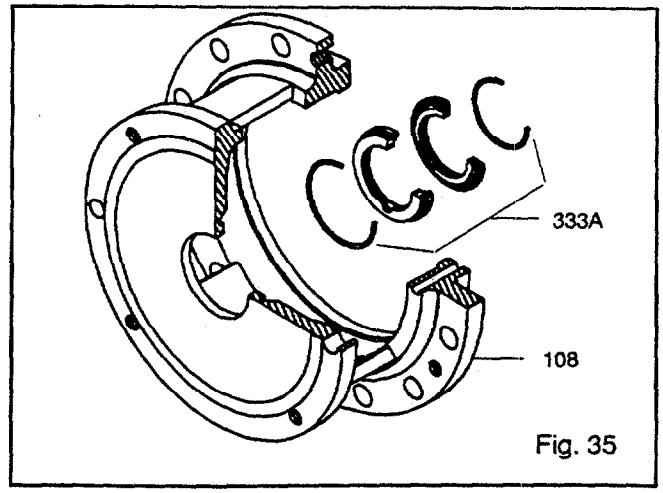


Fig. 35

6

22A. DISASSEMBLY OF POWER END - STX, MTX

1. Remove clamp screws (370C). Back off jam nuts (423). Tighten jack screws (370D) evenly, this will start bearing housing (134) out of bearing frame (228A) (Fig. 36).
2. Remove the shaft assembly from the bearing frame (228A).

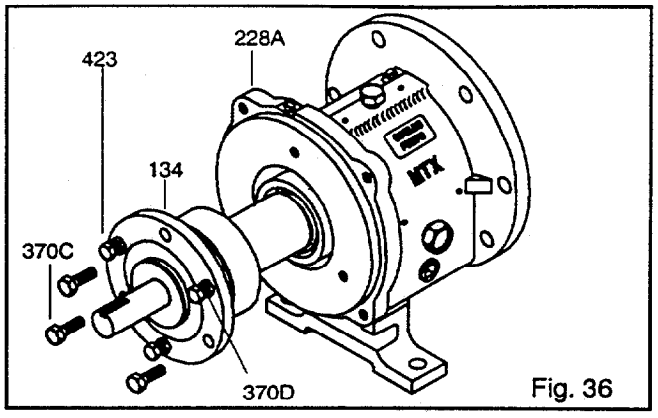


Fig. 36

3. Remove jack screws (370D) with nuts (423) (Fig. 37).
4. Remove bearing housing O-ring (469).
5. Remove outboard bearing retaining snap ring (316A).

NOTE: Snap ring cannot be removed from the shaft until bearings are removed.

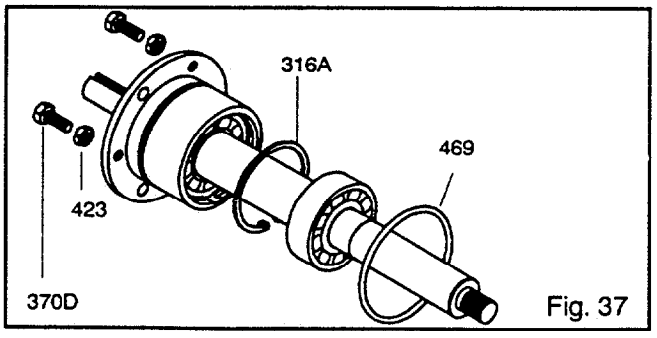


Fig. 37

6. Remove bearing housing (134) from shaft (122) with bearings (112A, 168A) (Fig. 38).

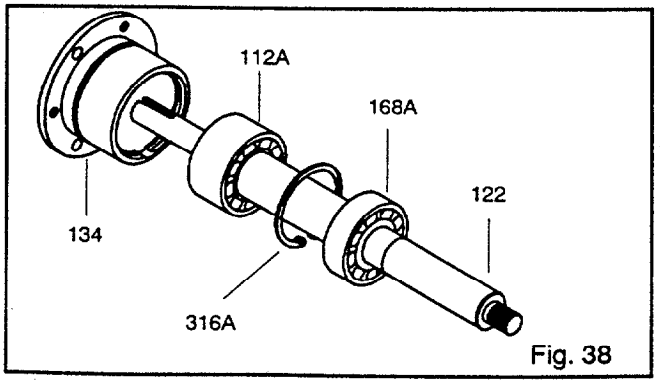


Fig. 38

7. Remove outboard labyrinth seal (332A) from bearing housing (134). Remove O-rings (497F), (497G) if necessary (Fig. 39).

NOTE: Labyrinth oil seal O-rings (497F, G) are part of 3196 maintenance kits or can be obtained separately

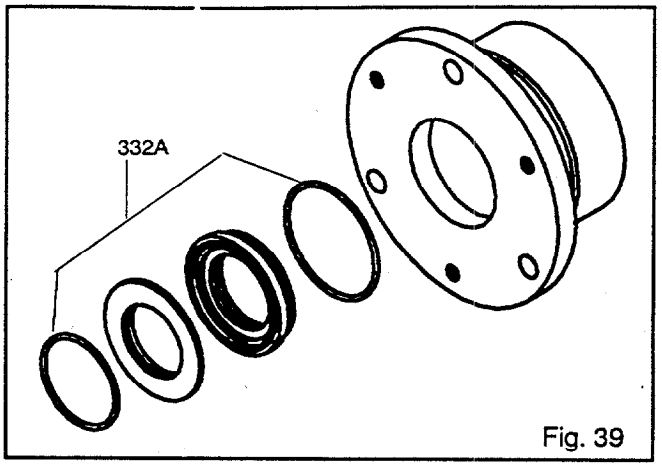


Fig. 39

8. Remove bearing locknut (136) and bearing lock washer (382) (Fig. 40).
9. Remove inboard bearing (168A).
10. Remove outboard bearing (112A).

NOTE: When pressing bearings off shaft, use force on inner race only.

NOTE: Save bearings for inspection.

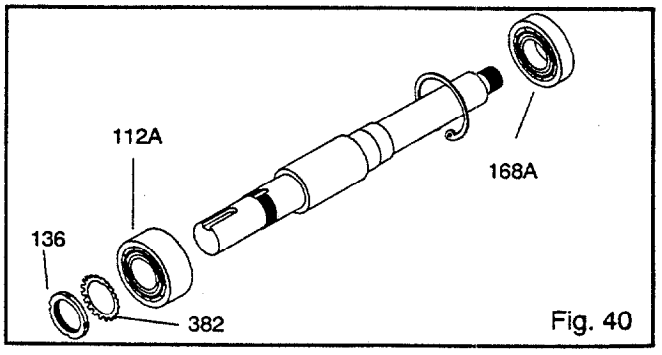


Fig. 40

22B. DISASSEMBLY OF POWER END - LTX

1. Remove clamp screws (370C). Back off jam nuts (423). Tighten jack screws (370D) evenly, this will start bearing housing (134) out of bearing frame (228A) (Fig. 41).
2. Remove shaft assembly from bearing frame (228A).

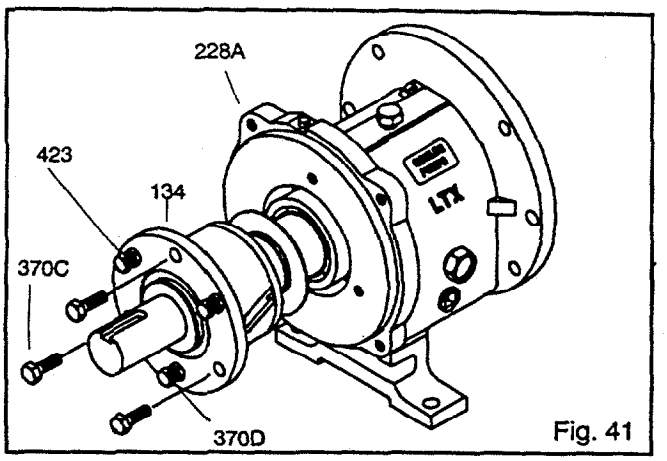


Fig. 41

3. Remove jack screws (370D) with nuts (423) (Fig. 42).
4. Remove clamp ring screws (236A). Separate clamp ring (253B) from bearing housing (134).

NOTE: Clamp ring cannot be removed from the shaft until bearings are removed.

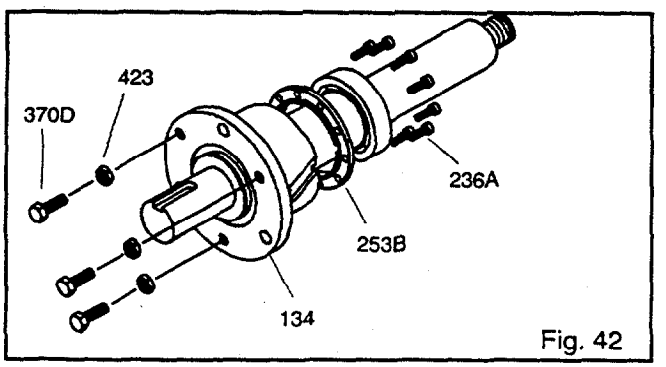


Fig. 42

5. Remove bearing housing (134) from shaft (122) with bearings (112A, 168A) (Fig. 43A).
6. Remove bearing housing O-ring (469).

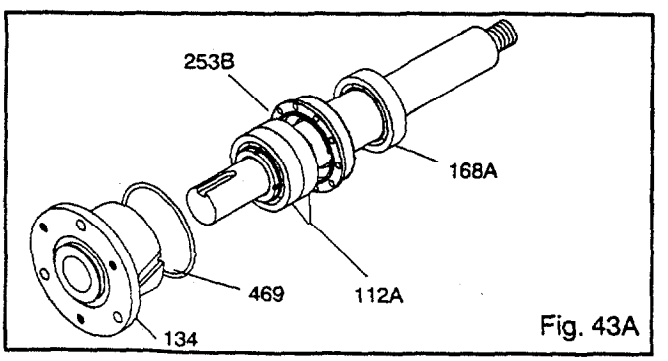


Fig. 43A

7. Remove inboard bearing (168A) (Fig. 43B).
8. Remove bearing locknut (136) and bearing lockwasher (382).
9. Remove outboard bearings (112A). Remove clamp ring (253B)

NOTE: When pressing bearings off shaft, use force on inner race only.

NOTE: Save bearings for inspection. Do not reuse bearings.

NOTE: Do not remove oil flinger (248A) unless it is damaged.

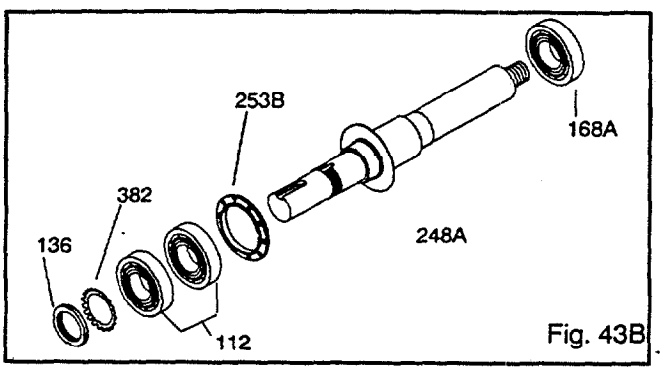


Fig. 43B

10. Remove outboard labyrinth seal (332A) from bearing housing (134). Remove O-rings (497F), (497G) if necessary (Fig. 44).

NOTE: Labyrinth oil seal O-rings (497F, G) are part of 3196 maintenance kits or can be obtained separately

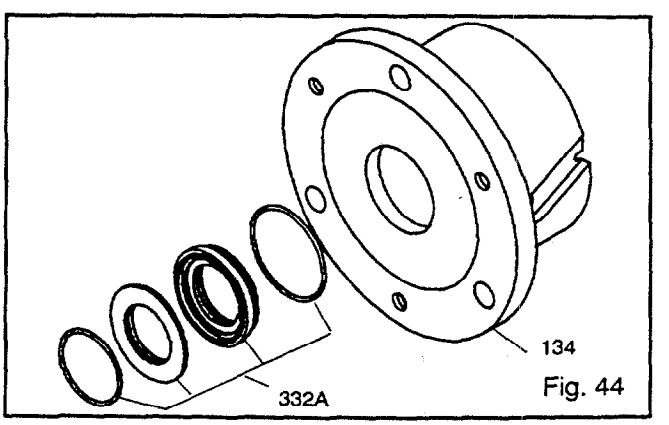


Fig. 44

6

22C. DISASSEMBLY OF THE POWER END - XLT-X, X17

1. Remove bearing frame to frame foot bolts (370F) and frame foot (241) (Fig. 45).
2. Remove clamp screws (370C). Back off jam nuts (423). Tighten jack screws (370D) evenly, this will start bearing housing (134) out of bearing frame (228A),
3. Remove shaft assembly from bearing frame (228A).

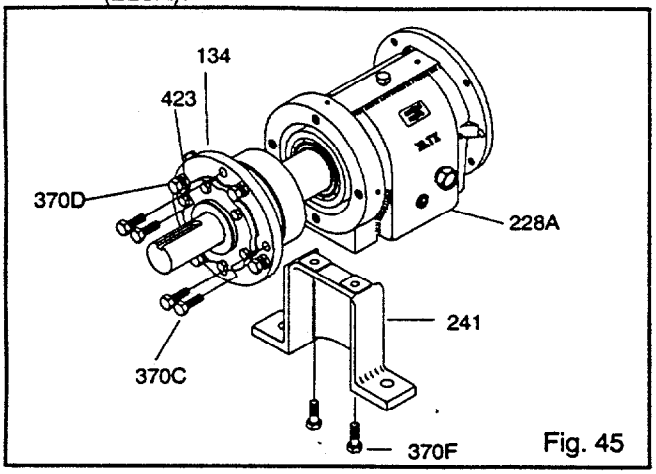


Fig. 45

4. Remove jack screws (370D) with nuts (423) (Fig. 46).
5. Remove bearing housing O-ring (469).
6. Remove inboard bearing (168A).

NOTE: When pressing bearings off shaft, use force on inner race only.

NOTE: Save bearings for inspection.

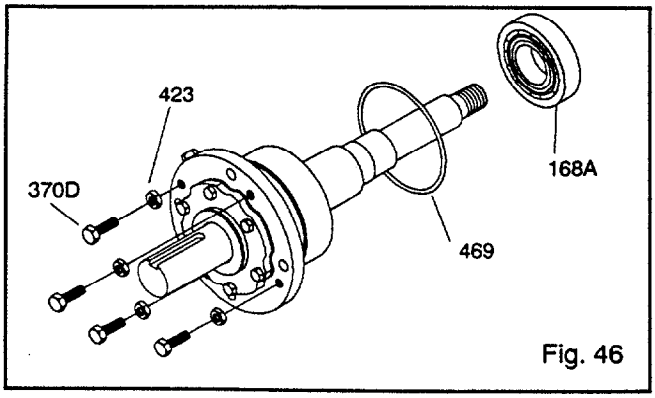


Fig. 46

7. Remove bolts (371C), bearing end cover (109A) and gasket (360C) (Fig. 47).
8. Remove outboard labyrinth seal (332A) from end cover (109A). Remove O-rings (497F), (497G) if necessary.

NOTE: Labyrinth oil seal O-rings (497F, G) are part of 3196 maintenance kits or can be obtained separately

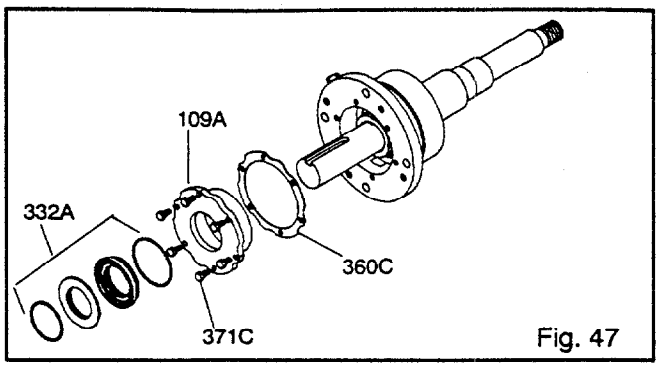


Fig. 47

9. Remove bearing housing (134) from shaft (122) with bearing (112A) (Fig. 48).

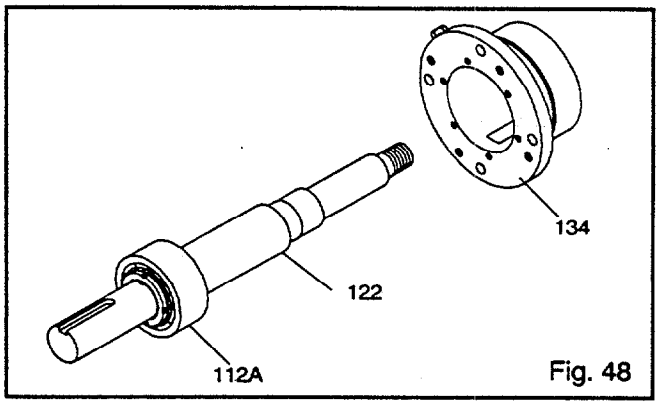


Fig. 48

10. Remove bearing locknut (136) and bearing lockwasher (382) (Fig. 49).
11. Remove outboard bearing (112A).

NOTE: When pressing bearings off shaft, use force on inner race only.

NOTE: Save bearings for inspection.

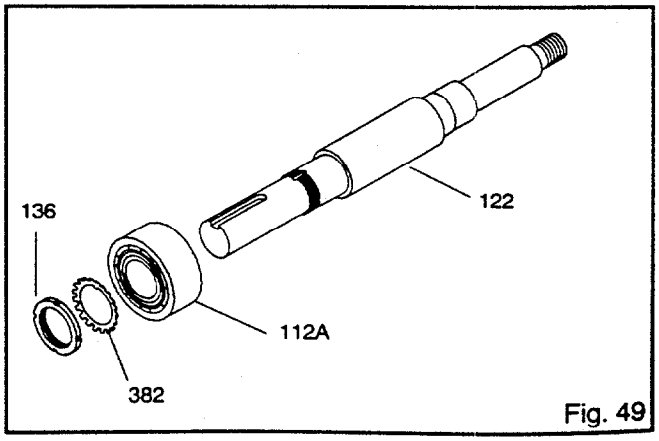


Fig. 49

22D. DISASSEMBLY OF POWER END - STX, MTX with Duplex Bearings

1. Remove clamp screws (370C). Back off jam nuts (423). Tighten jack screws (370D) evenly, this will start bearing housing (134) out of bearing frame (228A) (Fig. 50).

2. Remove shaft assembly from bearing frame (228A).

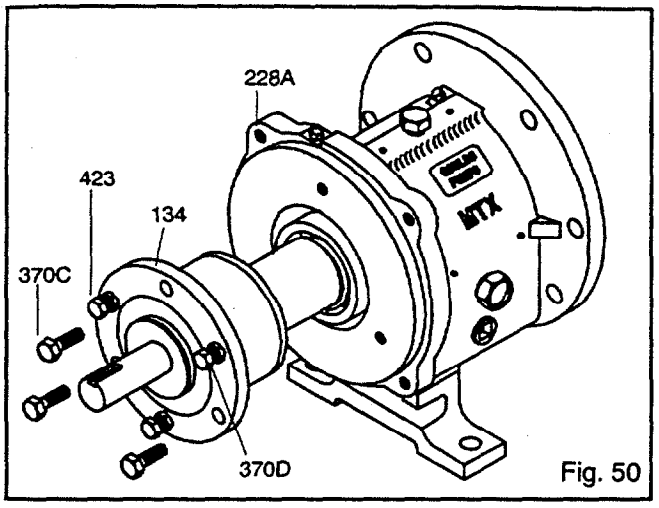


Fig. 50

3. Remove jack screws (370D) with nuts (423) (Fig. 51).
4. Remove bearing housing O-ring (469).
5. Remove clamp ring screws (236A). Separate clamp ring (253B) from bearing housing (134).

NOTE: Clamp ring cannot be removed from the shaft until bearings are removed.

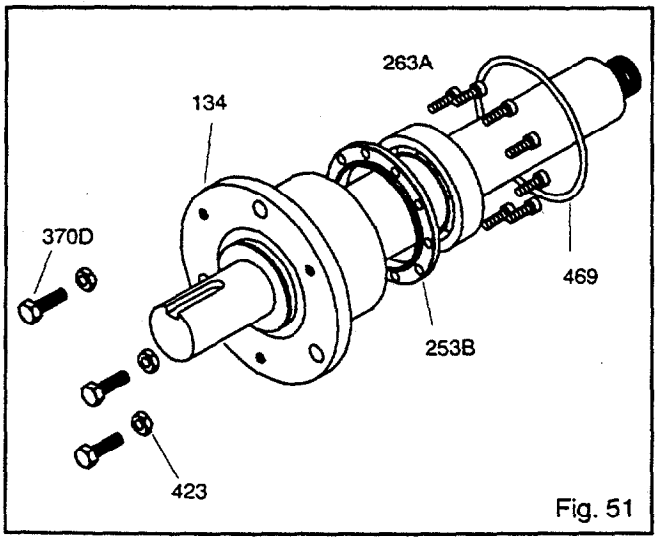


Fig. 51

6. Remove bearing housing (134) from shaft (122) with bearings (112A, 168A) (Fig. 52).

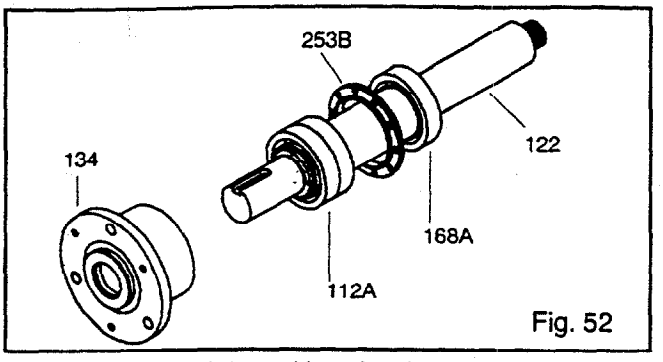


Fig. 52

7. Remove inboard bearing (168A) (Fig. 53).
8. Remove bearing locknut (136) and bearing lockwasher (382).
9. Remove outboard bearings (112A).

NOTE: When pressing bearings off shaft, use force on inner race only.

NOTE: Save bearings for inspection.

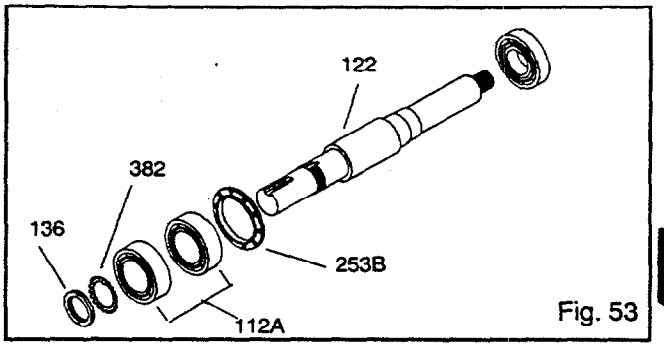


Fig. 53

10. Remove outboard labyrinth seal (332A) from bearing housing (134). Remove O-rings (497F), (497G) if necessary (Fig. 54).

NOTE: Labyrinth oil seal O-rings (497F, G) are part of 3196 maintenance kits or can be obtained separately

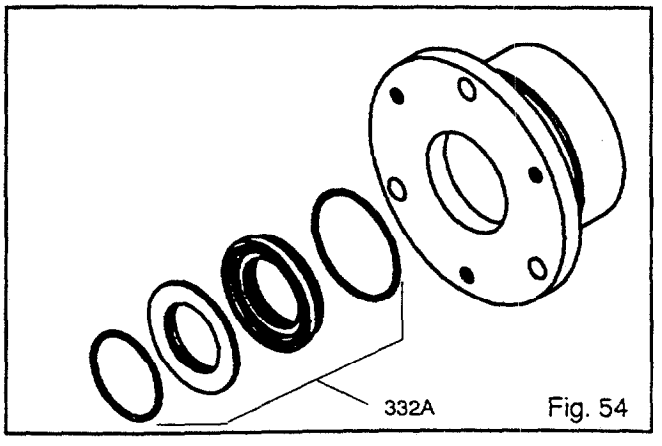


Fig. 54

6

22E. DISASSEMBLY OF POWER END - XLT-X, X17 with Duplex Bearings

1. Remove bearing frame to frame foot bolts (370F) and frame foot (241) (Fig. 55).
2. Remove clamp screws (370C). Back off jam nuts (423). Tighten jack screws (370D) evenly, this will start bearing housing (134) out of bearing frame (228A).
3. Remove shaft assembly from bearing frame (228A).

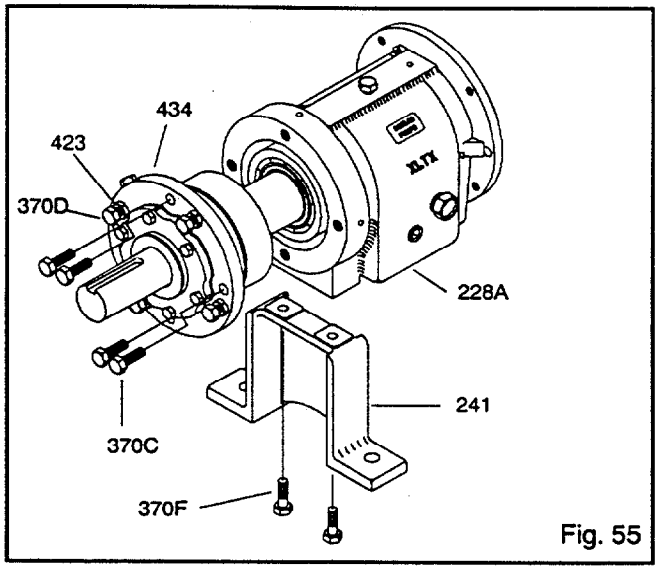


Fig. 55

4. Remove jack screws (370D) with nuts (423) (Fig. 56).
5. Remove bearing housing O-ring (469).
6. Remove inboard bearing (168A).

NOTE: When pressing bearings off shaft, use force on inner race only.

NOTE: Save bearings for inspection.

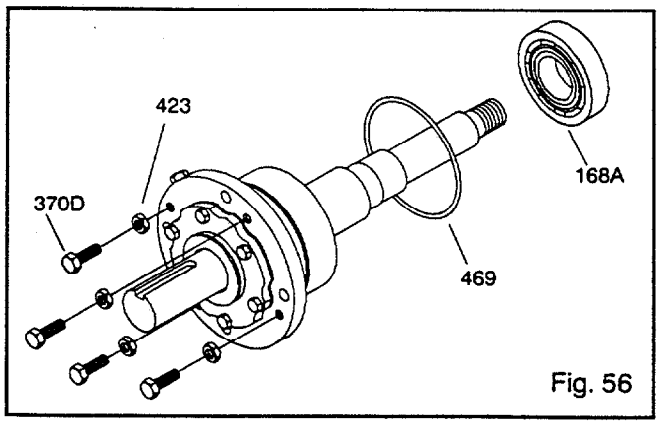


Fig. 56

7. Remove bolts (371C), end cover (109A) and gasket (360C) (Fig. 57).
8. Remove outboard labyrinth seal (332A) from end cover (109A). Remove O-rings (497F), (497G) if necessary.

NOTE: Labyrinth oil seal O-rings (497F, G) are part of 3196 maintenance kits or can be obtained separately

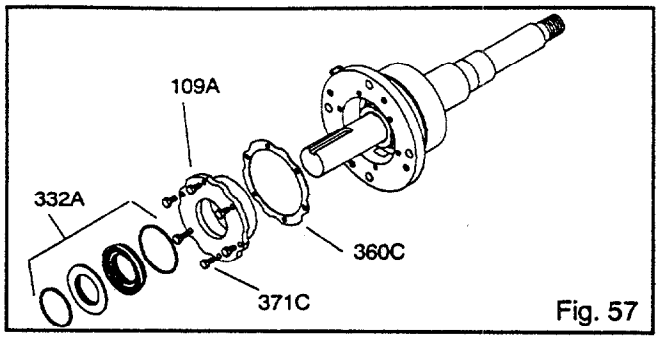


Fig. 57

9. Remove bearing housing (134) from shaft (122) with bearings (112A) (Fig. 58).

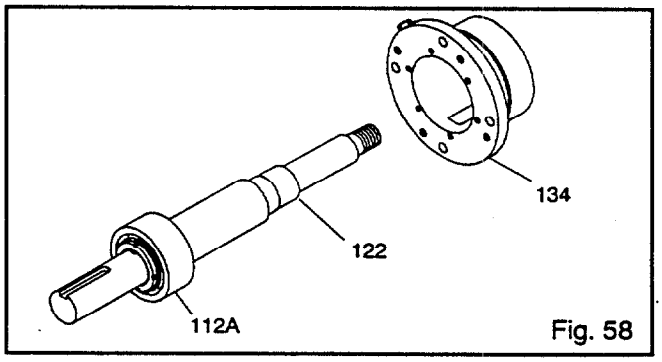


Fig. 58

10. Remove bearing locknut (136) and bearing lockwasher (382) (Fig. 59).
11. Remove outboard bearing (112A).

NOTE: When pressing bearings off the shaft, use force on the inner race only.

NOTE: Save bearings for inspection.

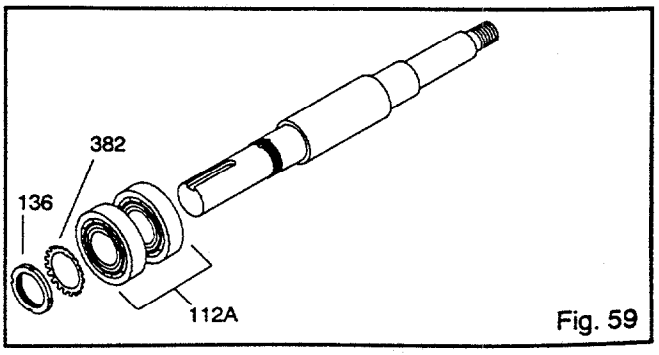


Fig. 59

23. DISASSEMBLY OF BEARING FRAME

1. Remove oil fill plug (113A), oil drain plug (408A), sight glass (319), sight oiler plug (408J), four (4) oil mist/grease connection plugs (408H), and oil cooler inlet and outlet plugs (408L, 408M) from bearing frame (228A).
2. MTX, LTX: Remove bearing frame foot-to-frame bolts (370F), and frame foot (241)
3. Proceed to Parts Inspection.

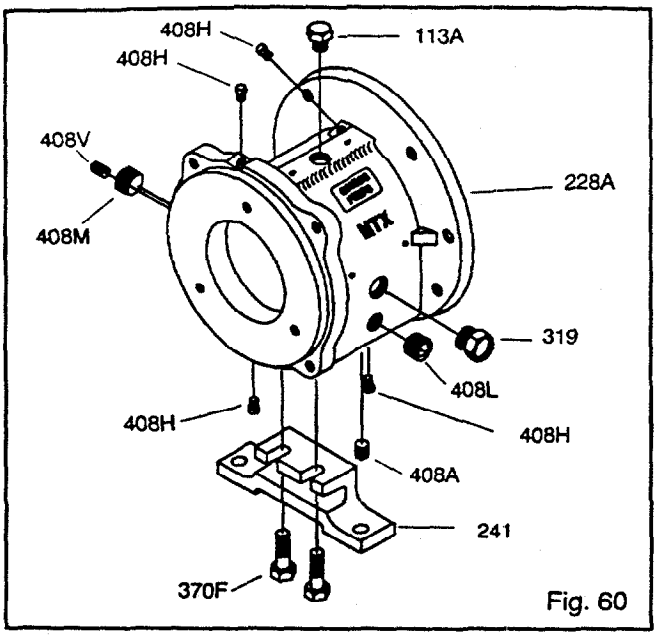


Fig. 60

INSPECTIONS

The Model 3196 parts must be inspected to the following criteria before they are reassembled to insure the pump will run properly. Any part not meeting the required criteria should be replaced.

NOTE: Clean parts in solvent to remove oil, grease or dirt. Protect machined surfaces against damage during cleaning.

Casing

The casing (100) should be inspected for excessive wear or pitting. It should be repaired or replaced if it exceeds the following criteria (Fig. 61).

1. Localized wear or grooving greater than 1/8 in. (3.2 mm) deep.
2. Pitting greater than 1/8 in. (3.2 mm) deep.
3. Inspect case gasket seat surface for irregularities.

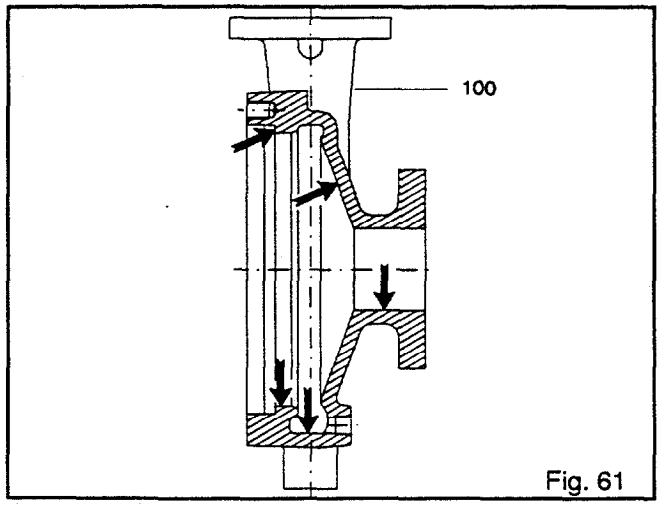


Fig. 61

Impeller

1. Inspect impeller (101) vanes for damage. Replace if grooved deeper that 1/16 in. (1.6 mm) or if worn evenly more than 1/32 in. (0.8 mm). (Area "a" in Fig. 62)
2. Inspect pumpout vanes for damage. Replace if worn more than 1/32 in. (0.8 mm). (Area "b" in Fig. 62)
3. Inspect leading and trailing edges of the vanes for pitting, and erosion or corrosion damage. (Area "c" in Fig. 62.).

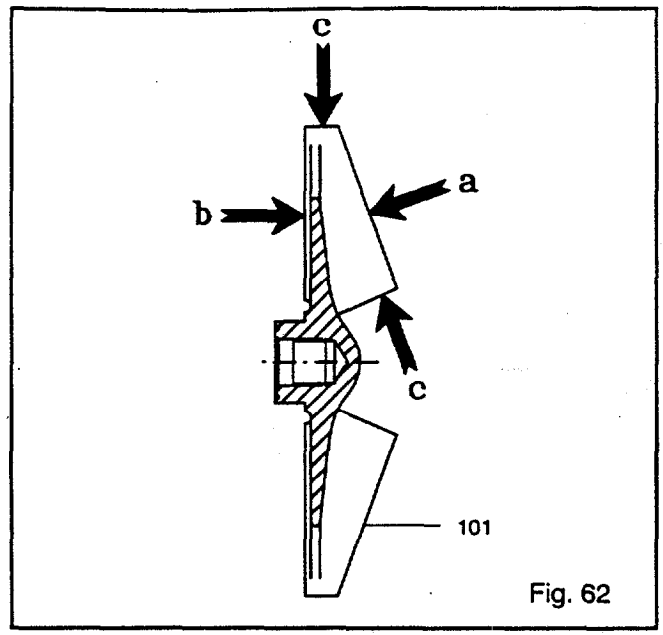


Fig. 62

Frame Adapter

1. Check frame adapter (108) for cracks or excessive corrosion damage. Replace if any of these conditions exist (Fig. 63).
2. Make sure gasket surface is clean.

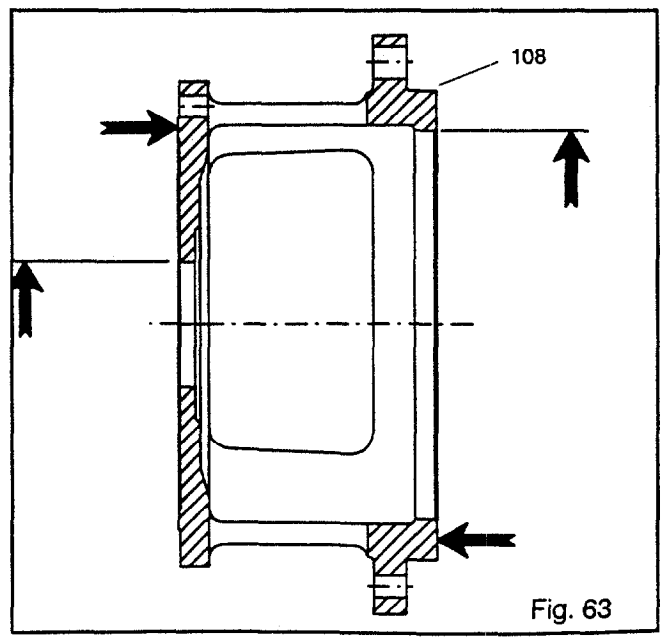


Fig. 63

Shaft and Sleeve

1. Check bearing fits. If any are outside the tolerance in Table 8, replace the shaft (122) (Fig. 64A).
2. Check shaft straightness. Replace shaft if runout exceeds values in Table 12.
3. Check shaft and sleeve (126) surface for grooves, pitting. Replace if any are found (Fig. 64B).

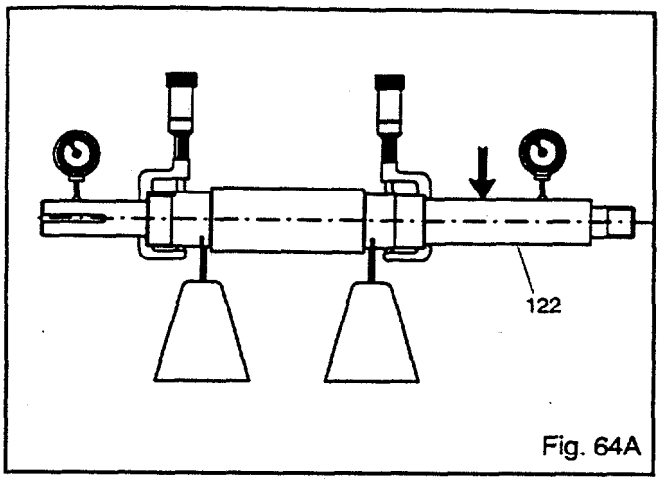


Fig. 64A

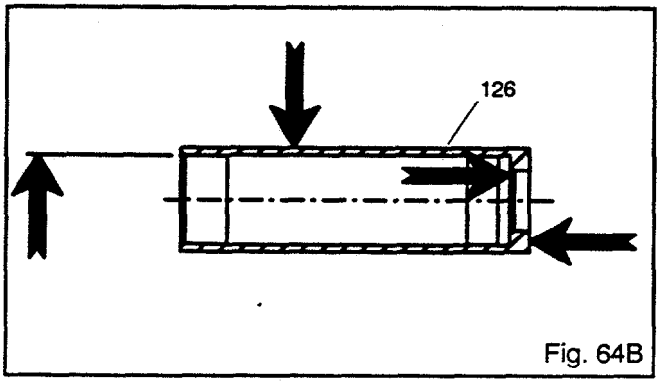


Fig. 64B

Bearing Frame

1. Visually inspect bearing frame (228) and frame foot (241) for cracks. Check frame inside surfaces for rust, scale or debris. Remove all loose and foreign material (Fig. 65,66).
2. Make sure all lubrication passages are clear.
3. If frame has been exposed to pumpage inspect for corrosion or pitting.
4. Inspect inboard bearing bore according to Table 2.

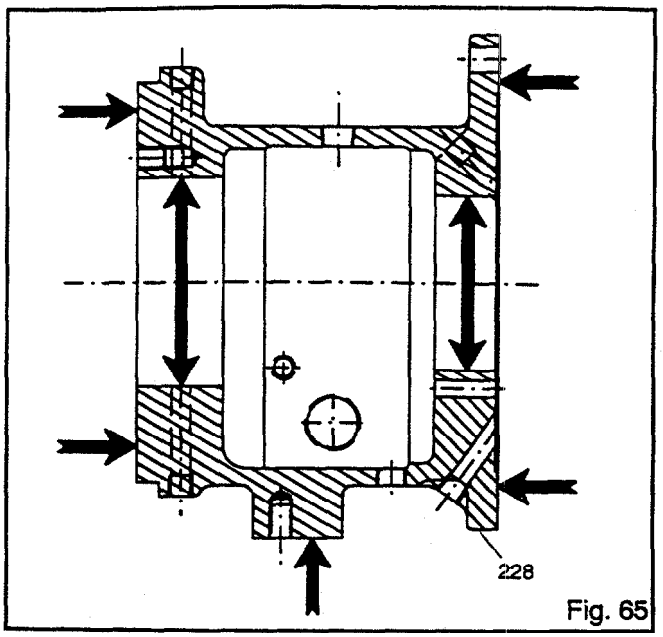


Fig. 65

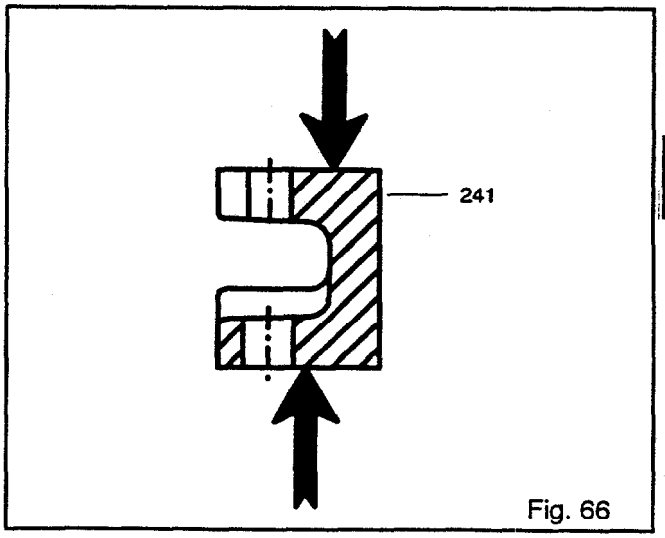


Fig. 66

6

Dynamic Seal Repeller

1. Inspect dynamic seal repeller (262) vanes for damage. Replace if grooved deeper than 1/16 in. (1.6 mm) or if worn evenly more than 1/32 in. (0.8 mm) (Fig. 67).
2. Inspect sleeve surface for grooves, pitting or other damage. Replace if damaged.

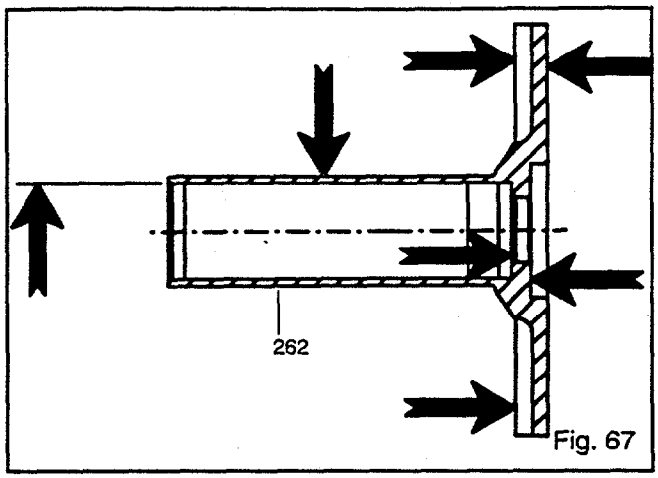


Fig. 67

Seal Chamber/Stuffing Box Cover and Dynamic Seal Backplate

1. Make sure seal chamber/stuffing box cover (184) and dynamic seal backplate (444) gasket surface is clean, at adapter face (Fig. 68, 69, 70).
2. Replace if any pitting or wear greater than 1/8 in. (3.2 mm) deep.

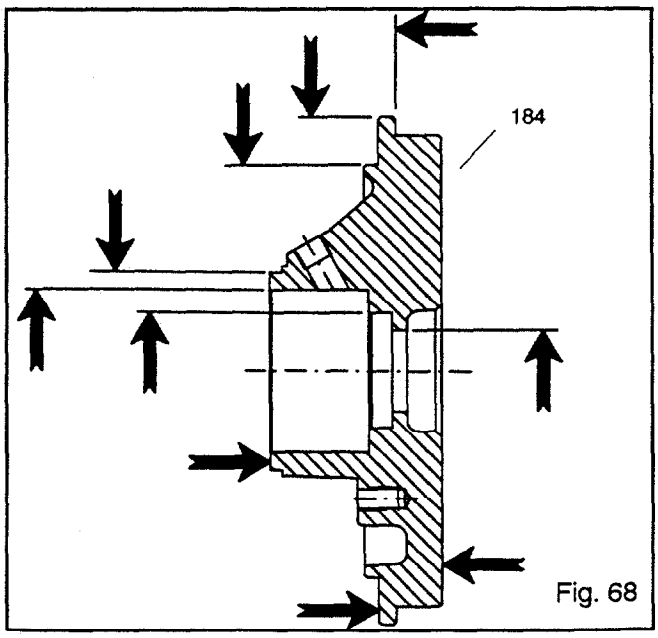


Fig. 68

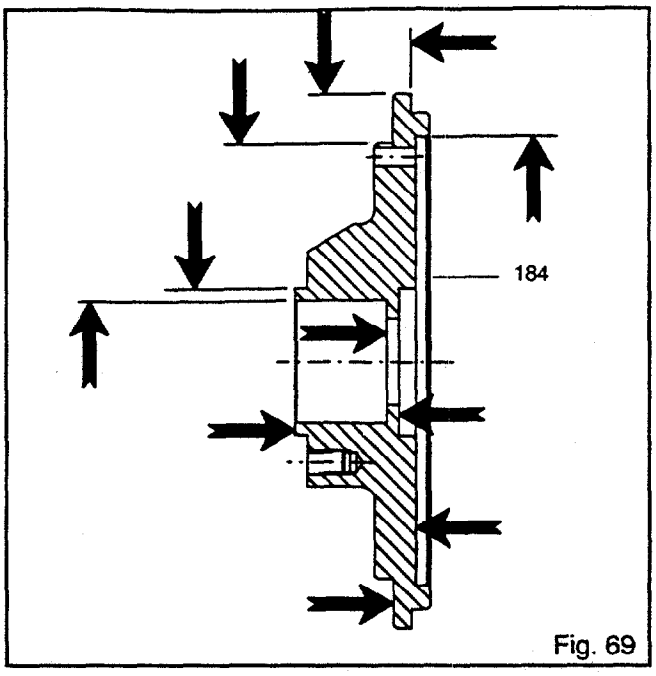


Fig. 69

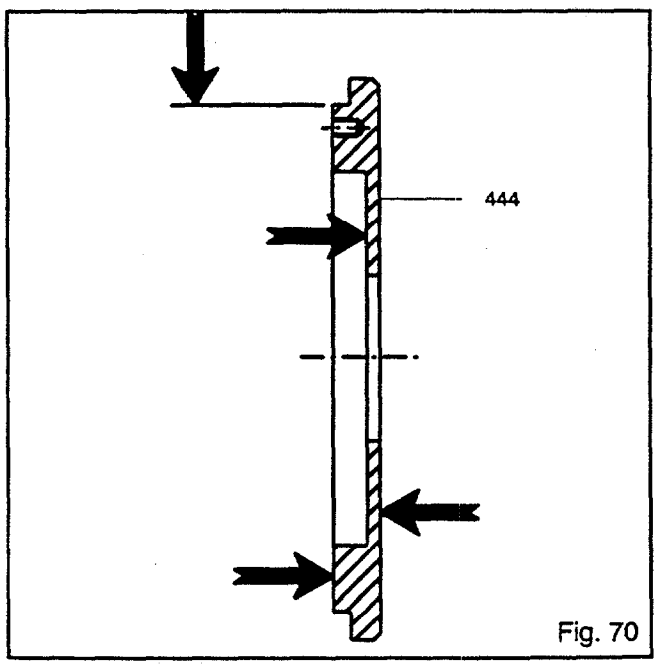


Fig. 70

Bearings

1. Ball bearings (112A, 168A) should be inspected for contamination and damage. The condition of the bearings will provide useful information on operating conditions in the bearing frame. Lubricant condition and residue should be noted, oil analysis is often helpful. Bearing damage should be investigated to determine cause. If cause is not normal wear, it should be corrected before pump is returned to service.

DO NOT RE-USE BEARINGS.

Bearing Housing

1. Inspect.bearing housing (134) bore according to Table 8. Replace if dimensions exceed Table 8 values.
2. Visually inspect for cracks and pits.

   STX, MTX - Snap ring groove must not be cracked (Fig. 71).

   LTX - Grooves and holes must be clear (Fig. 72).

   XLT-X, X17 - Gasket surface must be clean (Fig. 73).

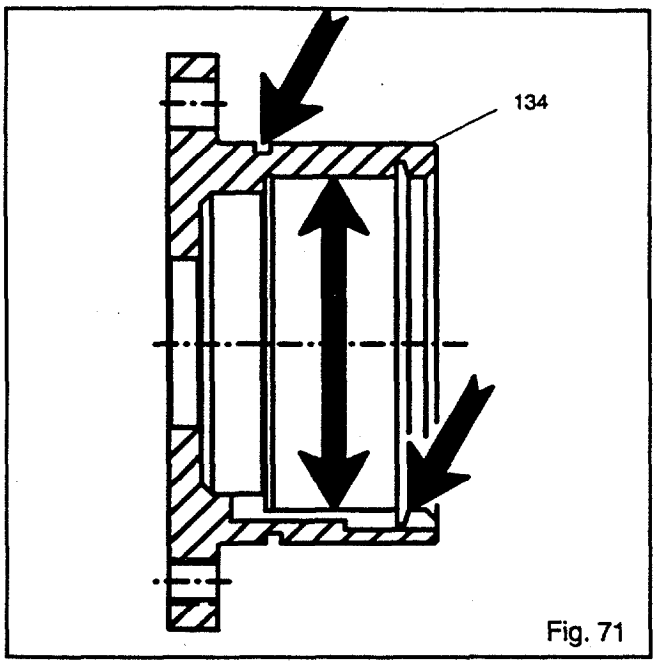


Fig. 71

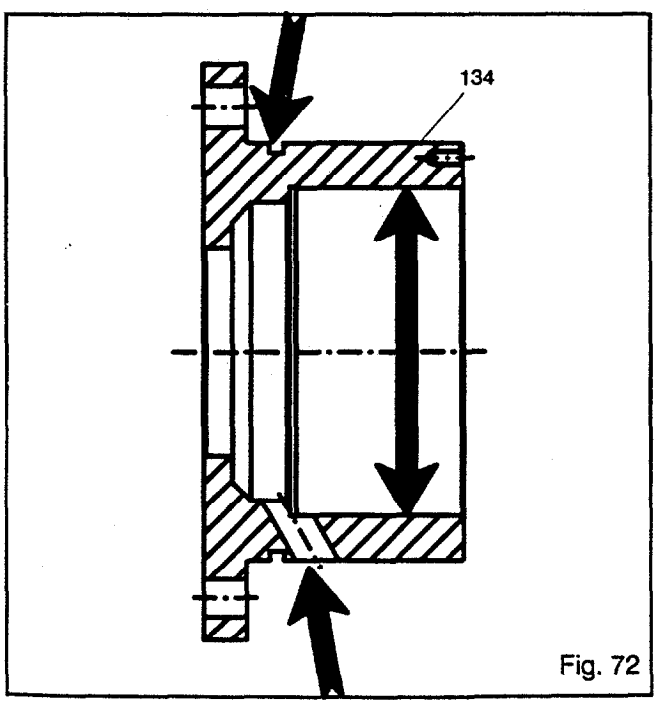


Fig. 72

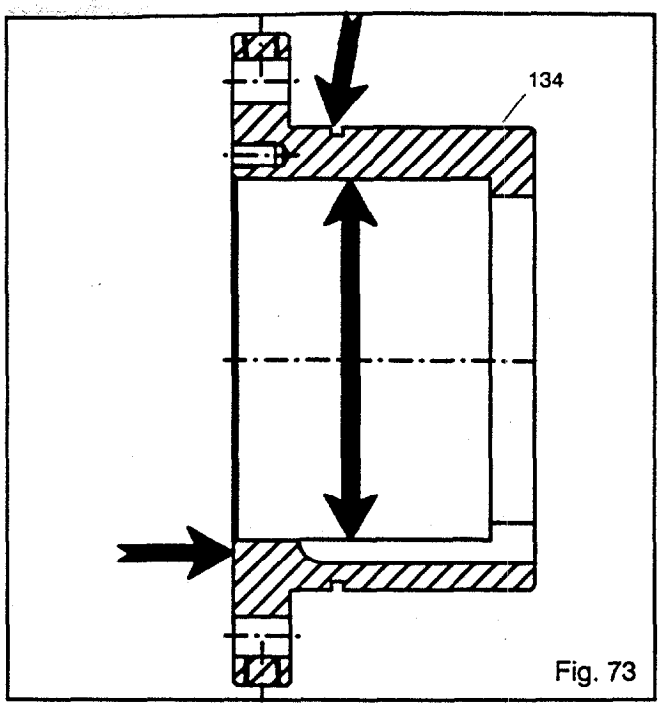


Fig. 73

Labyrinth Seals

1. Labyrinth seal (332A, 333A) O-rings should be inspected for cuts and cracks. Replace as needed.

Table 8
3196 Bearing Fits & Tolerances

according to ABEC I standard

	STX in. (mm)	MTX in. (mm)	LTX in. (mm)	XLT-X, X17 in. (mm)
Shaft O.D. Inboard	1.3785 (35.013) 1.3781 (35.002)	1.7722 (45.013) 1.7718 (45.002)	2.1660 (55.015) 2.1655 (55.002)	2.5597 (65.015) 2.5592 (65.002)
	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0012 (0.030) tight 0.0001 (0.002) tight	0.0012 (0.030) tight 0.0001 (0.002) tight
Bearing I.D. Inboard	1.3780 (35.000) 1.3775 (34.988)	1.7717 (45.000) 1.7712 (44.988)	2.1654 (55.000) 2.1648 (54.985)	2.5591 (65.000) 2.5585 (64.985)
Frame I.D. Inboard	2.8346 (72.000) 2.8353 (72.019)	3.9370 (100.000) 3.9379 (100.022)	4.7244 (120.000) 4.7253 (120.022)	5.5118 (140.000) 5.5128 (140.025)
	0.0012 (0.032) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose	0.0017 (0.043) loose 0.0000 (0.000) loose
Bearing O.D. Inboard	2.8346 (72.000) 2.8341 (71.987)	3.9370 (100.000) 3.9364 (99.985)	4.7244 (120.000) 4.7238 (119.985)	5.5118 (140.000) 5.5111 (139.982)
Shaft O.D. Outboard	1.1815 (30.011) 1.1812 (30.002)	1.7722 (45.013) 1.7718 (45.002)	1.9690 (50.013) 1.9686 (50.002)	2.5597 (65.015) 2.5592 (65.002)
	0.0008 (0.021) tight 0.0001 (0.002) tight	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0012 (0.030) tight 0.0001 (0.002) tight
Bearing I.D. Outboard	1.1811 (30.000) 1.1807 (29.990)	1.7717 (45.000) 1.7712 (44.988)	1.9685 (50.000) 1.9680 (49.988)	2.5591 (65.000) 2.5585 (64.985)
Housing I.D. Outboard	2.8346 (72.000) 2.8353 (72.019)	3.9370 (100.000) 3.9379 (100.022)	4.3307 (110.000) 4.3316 (110.022)	5.5118 (140.000) 5.5128 (140.025)
	0.0012 (0.032) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose	0.0017 (0.043) loose 0.0000 (0.000) loose
Bearing O.D. Outboard	2.8346 (72.000) 2.8341 (71.987)	3.9370 (100.000) 3.9364 (99.985)	4.3307 (110.000) 4.3301 (109.985)	5.5118 (140.000) 5.5111 (139.982)

REASSEMBLY

Refer to Table 9 for torque values while reassembling pump.

Table 9
Bolt Torque Table

LOCATION		LUBRICATED THREADS	DRY THREADS
CASING BOLTS (370)	6" STX	30 FT-LBS (40 N-m)	45 FT-LBS (60 N-m)
	8" STX	20 FT-LBS (27 N-m)	30 FT-LBS (40 N-m)
	MTX, LTX	30 FT-LBS (40 N-m)	45 FT-LBS (60 N-m)
	XLT-X, X17	30 FT-LBS (40 N-m)	45 FT-LBS (60 N-m)
FRAME - TO - ADAPTER BOLTS (370B)		20 FT-LBS (27 N-m)	30 FT-LBS (40 N-m)
BEARING CLAMP RING BOLTS (236A) Duplex Bearing Only	STX, MTX	10 IN-LBS (1.1 N-m)	17 IN-LBS (1.9 N-m)
	LTX	55 IN-LBS (6.2 N-m)	83 IN-LBS (9.4 N-m)
BEARING END COVER BOLTS (371C)	XLT-X, X17	9 FT-LBS (12 N-m)	12 FT-LBS (16 N-m)
DYNAMIC SEAL CAP SCREWS (265)	STX, MTX LTX	55 IN-LBS (6.2 N-m)	83 IN-LBS (9.4 N-m)
	XLT-X, X17	9 FT-LBS (12 N-m)	12 FT-LBS (16 N-m)

Refer to Table 10 for shaft end play while reassembling pump.

Table 10
3196 Shaft End Play

	STX in. (mm)	MTX in. (mm)	LTX in. (mm)	XLT-X, X17 in. (mm)
Double Row	.0011 (.028) .0019 (.047)	.0013 (.033) .0021 (.054)	not applicable	.0014 (.036) .0023 (.058)
Duplex	.0007 (.018) .0010 (.026)	.0009 (.022) .0012 (.030)	.0010 (.026) .0015 (.038)	.0010 (.026) .0015 (.038)

Table 11
3196 Bearing Type

Frame	Inboard	Outboard	
		Double Row	Duplex
STX	6207	5306A / C3	7306 BECBM
MTX	6309	5309A / C3	7309 BECBM
LTX	6311	not applicable	7310 BECBM
XLT-X, X17	6313	5313A / C3	7313 BECBY

Table 12
3196 Shaft Runout Tolerances

	Sleeve Fit in. (mm)	Coupling Fit in. (mm)
With Sleeve	.001 (.026)	.001 (.026)
Less Sleeve	.002 (.051)	.001 (.026)

Note: Bearing type is based on SKF/MRC designation.

Assembly of Rotating Element and Bearing Frame

STX, MTX

NOTE: Make sure that threads are clean and apply thread sealant to pipe threads and fittings.

1. Install oil fill plug (113A), oil drain plug (408A), sight window (319), sight oiler plug (408J), 4 oil mist connection plugs (408H) or grease fittings (193) and relief plugs (113), and oil cooler inlet and outlet plugs (408L, 408M) in bearing frame (228). (Fig. 74)
2. Attach bearing frame foot (241) with bolts (370F). Hand tighten.

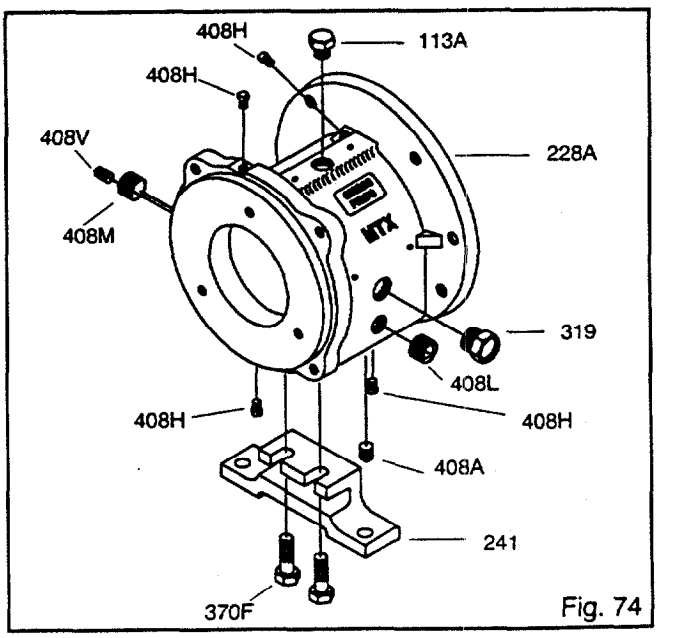


Fig. 74

3. Install outboard bearing (112A) on shaft (122) (Fig. 75).

NOTE: Regreaseable bearing has a single shield. The outboard bearing is installed with shield toward impeller.

NOTE: There are several methods used to install bearings. The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

4. Place lockwasher (382) on shaft (122). Place tang of lockwasher in keyway of shaft.
5. Thread locknut (136) onto shaft (122). Tighten locknut until snug. Bend any tang of lockwasher into a slot of locknut.

NOTE: Tighten locknut if necessary to align the closest tab of lockwasher with slot on locknut.

6. Place bearing retaining ring (361A) over shaft (122), flat side facing bearing.
7. Install inboard bearing (168A) on shaft (122).

NOTE: Regreaseable bearing has a single shield. The inboard bearing is installed with shield away from impeller.

NOTE: There are several methods used to install bearings, The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

NOTE: Coat internal surfaces of bearings with lubricant to be used in service.

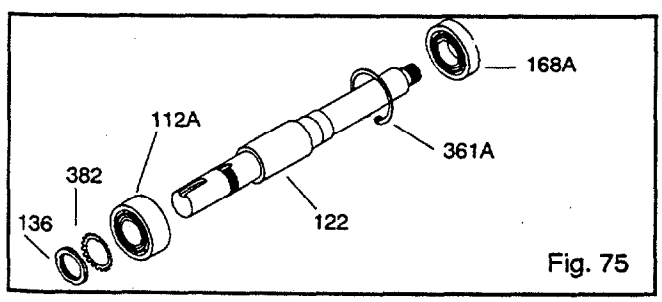


Fig. 75

8. Install new O-ring (496) (Fig. 76).
9. Coat outside of outboard bearing (112A) and bearing housing (134) bore with oil.
10. Install bearing housing (134) onto shaft/bearing assembly.

NOTE: Do not force assembly together.

11. Insert retaining ring (361A) into groove in housing (134) bore. Check shaft for free turning.

NOTE: The space between the ends of retaining ring should be located in the oil return groove so as not to obstruct oil flow.

12. Install outboard labyrinth oil seal (332A) into bearing housing (134). It is an O-ring fit. Position the labyrinth seal drain slots at the bottom (6 o'clock) position.

NOTE: Make sure the keyway edges are free of burrs.

NOTE: Cover the keyway lengthwise with a piece of electrical tape prior to installing the labyrinth seal. This will protect the O-rings.

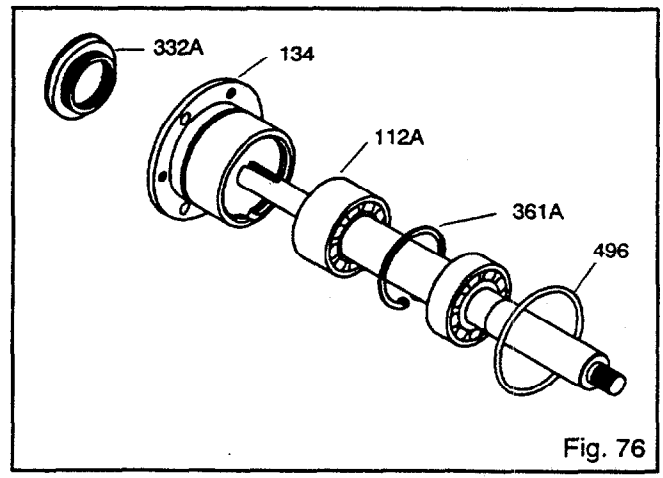


Fig. 76

13. Coat outside of bearing housing (134) with oil (Fig. 77).
14. Coat all internal surfaces of bearing frame (228A) with oil.
15. Install shaft assembly into frame (228A). Check shaft for free turning.
16. Install clamping bolts (370C) into bearing housing (134). Hand tighten.

17. Install jacking bolts (370D) with locking nuts (423) into housing (134). Hand tighten.

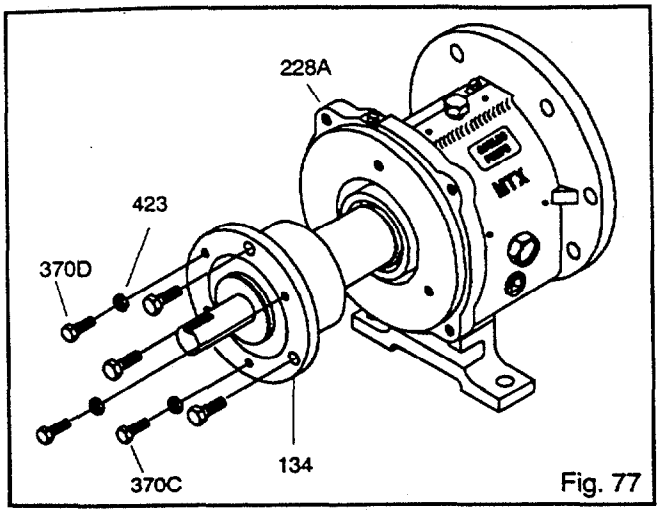


Fig. 77

LTX

NOTE: Make sure that threads are clean and apply thread sealant to pipe threads and fittings.

1. Install the oil fill plug (113A), oil drain plug (408A), sight window (319), sight oiler plug (408J), 4 oil mist connection plugs (408H) or grease fittings (193) and grease relief plugs (113), and oil cooler inlet and outlet plugs (408L, 408M) in bearing frame (228) (Fig. 78).
2. Attach bearing frame foot (241) with bolts (370F). Hand tighten.

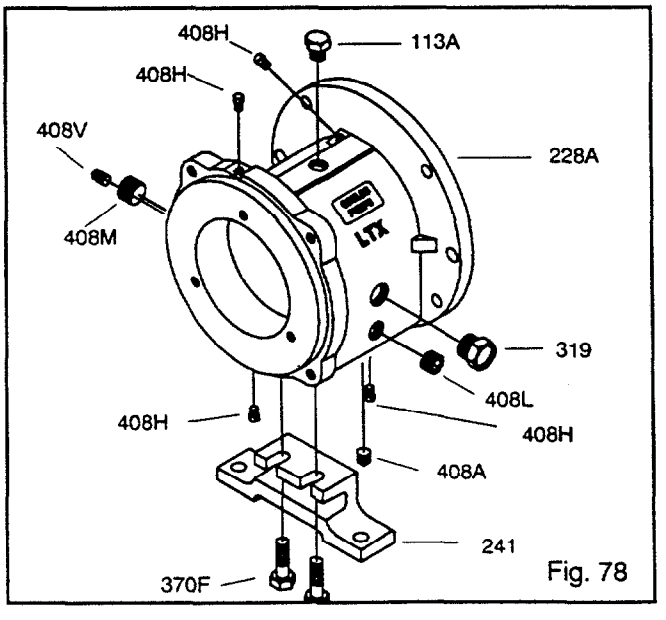


Fig. 78

3. Install oil flinger (248A) on shaft (122) if removed (Fig. 79).

NOTE: The oil flinger is a press fit onto shaft. Use a driver of proper size to prevent damage to oil flinger.

4. Place bearing clamp ring (253B) over shaft (122). Note orientation.
5. Install outboard bearings (112A) on shaft (122).

⚠ CAUTION

The LTX uses duplex bearings mounted back to back. Make sure orientation of the bearings is correct.

NOTE: There are several methods used to install bearings, The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

6. Place lockwasher (382) on shaft (122). Place tang of lockwasher in keyway of shaft.
7. Thread locknut (136) onto shaft (122). Tighten locknut until snug. Bend any tang of lockwasher (382) into a slot of locknut.

NOTE: Tighten locknut if necessary to align the closest tab of lockwasher with slot on locknut.

8. Install inboard bearing (168A) on shaft (122).

NOTE: Regreaseable bearing has a single shield. The inboard bearing is installed with shield away from impeller.

NOTE: There are several methods used to install bearings, The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

NOTE: Coat internal surfaces of bearings with lubricant to be used in service.

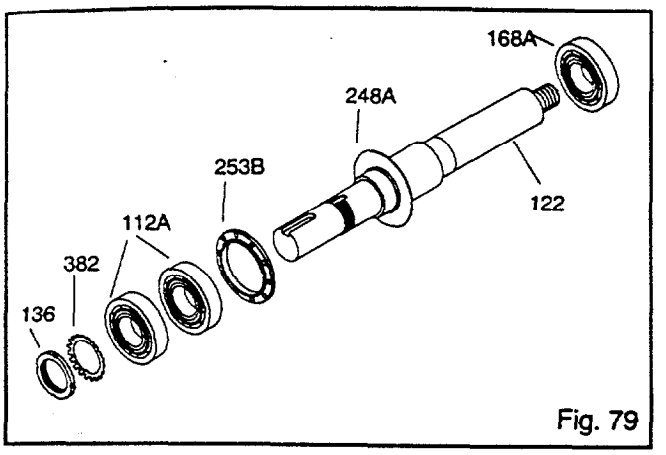


Fig. 79

9. Coat outside of outboard bearing (112A) and bearing housing (134A) bore with oil.
10. Install bearing housing (134) onto shaft/bearing assembly (Fig. 80).

NOTE: Do not force assembly together.

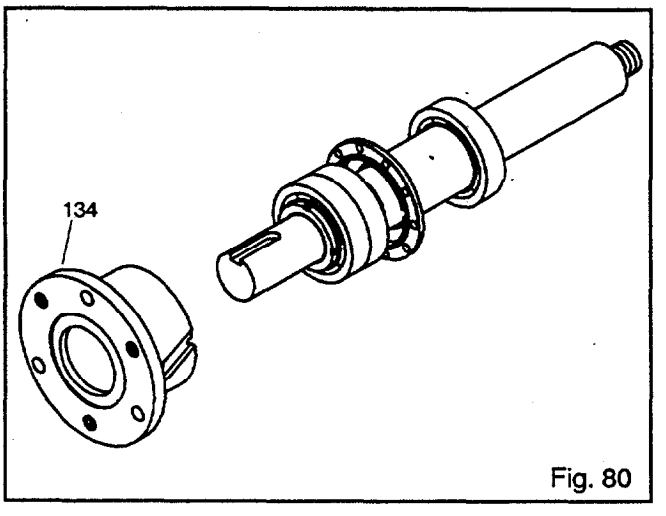


Fig. 80

11. Install clamp ring bolts (236A). Check shaft for free turning. Refer to Table 9 for bolt torque values (Fig. 81).

⚠ CAUTION

Tighten clamp ring bolts (236A) in a criss cross pattern.

12. Install new O-ring (496).
13. Install outboard labyrinth oil seal (332A) into bearing housing (134). It is an O-ring fit. Position the labyrinth seal drain slots at the bottom (6 o'clock) position.

NOTE: Make sure the keyway edges are free of burrs.

NOTE: Cover the keyway lengthwise with a piece of electrical tape prior to installing the labyrinth seal. This will protect the O-rings.

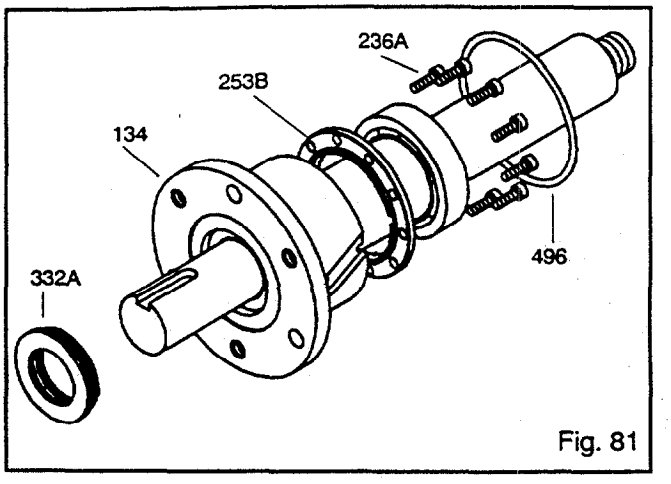


Fig. 81

14. Coat outside of bearing housing (134A) with oil.
15. Coat all internal surfaces of bearing frame (228) with oil.
16. Install shaft assembly into frame (228A). Check shaft for free turning.
17. Install clamping bolts (370C) into bearing housing (134A). Hand tighten.
18. Install jacking bolts (370D) with locking nuts (423) into housing (134A). Hand tighten.

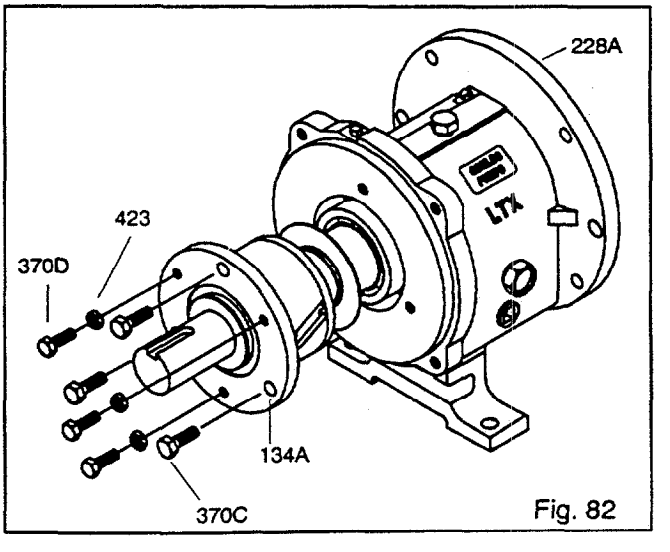


Fig. 82

XLT-X, X17

NOTE: Make sure that threads are clean and apply thread sealant to pipe threads and fittings.

1. Install oil fill plug (113A), oil drain plug (408A), sight glass (319), sight oiler plug (408J), 4 oil mist connection plugs (408H), or grease fittings (193) and grease relief plugs (113), and oil cooler inlet and outlet plugs (408L, 408M) in bearing frame (228A) (Fig. 83).

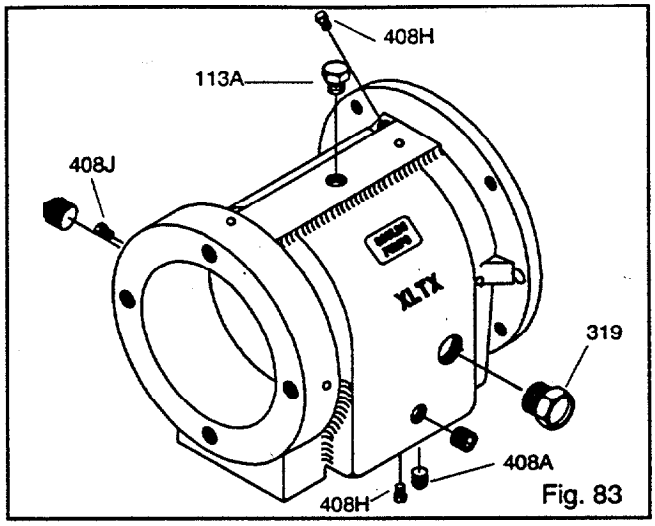


Fig. 83

2. Install outboard bearing (112A) on shaft (122) (Fig. 84).

NOTE: Regreaseable bearing has a single shield. The outboard bearing is installed with shield toward impeller.

NOTE: There are several methods used to install bearings, The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

⚠ WARNING

Shaft (122) may be heavy. Use care when handling.

3. Place lockwasher (382) on shaft (122). Place tang of lockwasher in keyway of shaft.

4. Thread locknut (136) onto shaft (122). Tighten locknut until snug. Bend any tang of lockwasher (382) into a slot of locknut.

NOTE: Tighten locknut if necessary to align the closest tab of lockwasher with slot on locknut.

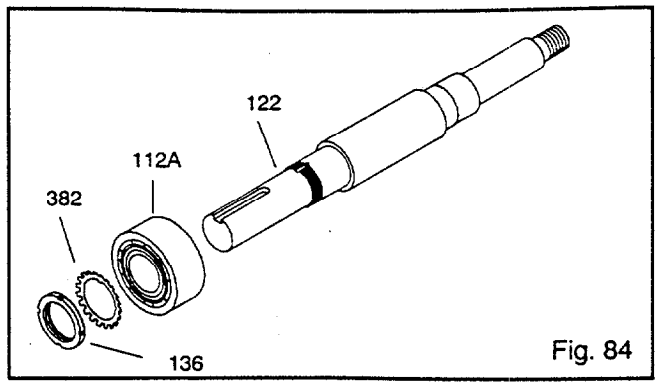


Fig. 84

5. Coat outside of outboard bearing (112A) and bore of bearing housing (134) with oil.

6. Install bearing housing (134) onto shaft/bearing assembly (Fig. 85).

NOTE: Do not force assembly together.

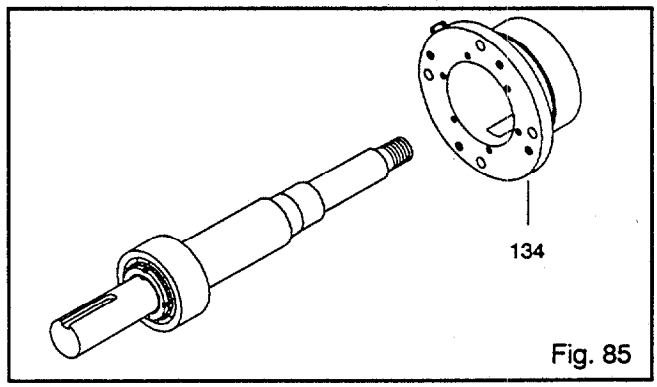


Fig. 85

7. Install gasket (360C), end cover (109A), bolts (371C). Refer to Table 9 for bolt torque values. Check shaft for free turning.

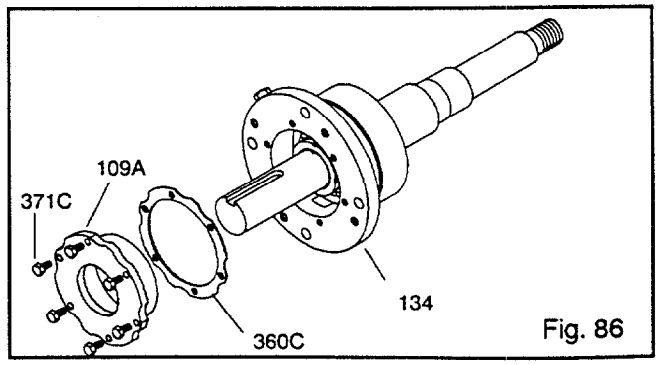


Fig. 86

8. Install inboard bearing (168A) on shaft (122) (Fig. 87).

NOTE: Regreaseable bearing has a single shield. The inboard bearing is installed with shield away from impeller.

NOTE: There are several methods used to install bearings, The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

NOTE: Coat internal surfaces of bearings with lubricant to be used in service.

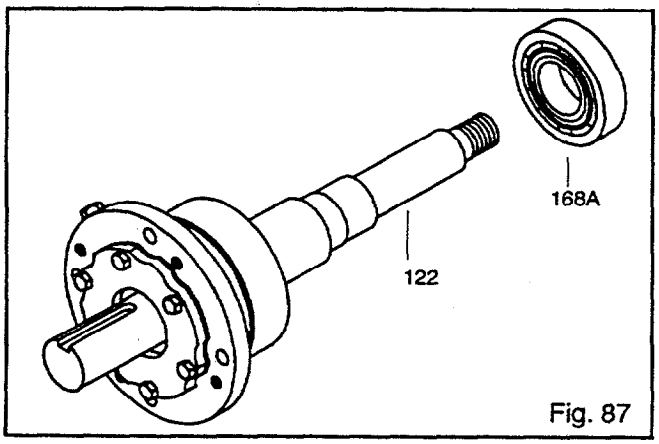


Fig. 87

9. Install new O-ring (496) (Fig. 88).

10. Install outboard labyrinth oil seal (332A) into end cover (109A). It is an O-ring fit. Position the labyrinth seal drain slots at the bottom 6 o'clock position (Fig. 88).

NOTE: Make sure the keyway edges are free of burrs.

NOTE: Cover the keyway lengthwise with a piece of electrical tape prior to installing the labyrinth seal. This will protect the O-rings.

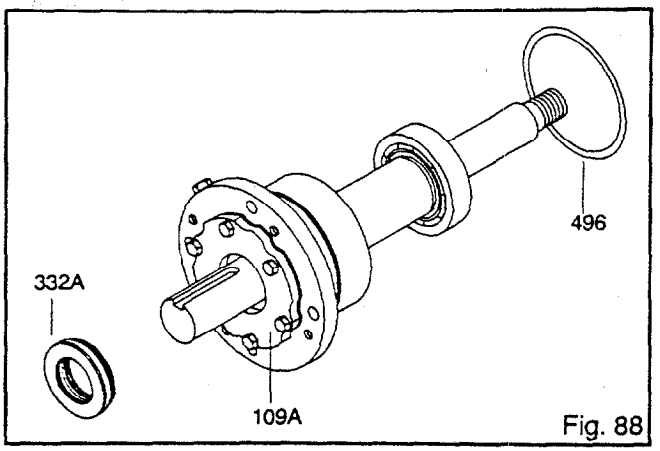


Fig. 88

11. Coat outside of bearing housing (134) with oil.

12. Coat all internal surfaces of bearing frame (228A) with oil.

13. Install shaft assembly into frame (228A). Check shaft for free turning (Fig. 89).

14. Install clamping bolts (370C) into bearing housing (134). Hand tighten.

15. Install jacking bolts (370D) with locking nuts (423) into housing (134). Hand tighten.

16. Attach bearing frame foot (241) with bolts (370F). Hand tighten.

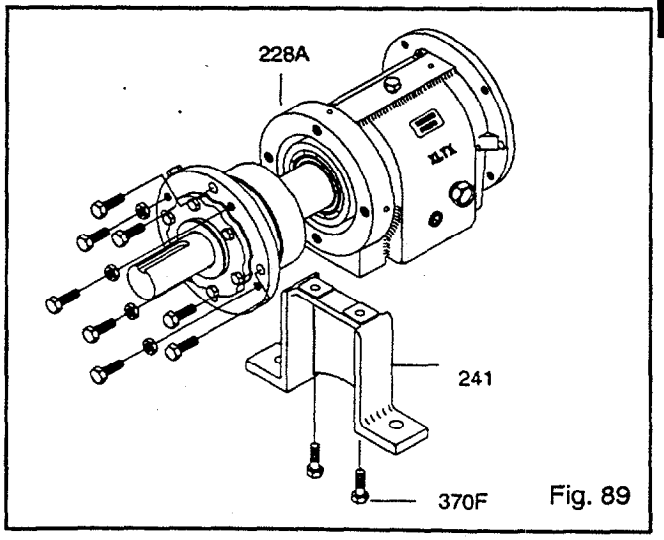


Fig. 89

6

STX, MTX with Duplex Bearings

1. Install the oil fill plug (113A), oil drain plug (408A), sight window (319), sight oiler plug (408J), 4 oil mist connection plugs (408H), or grease fittings (193) and grease relief plugs (113), and oil cooler inlet and outlet plugs (408L, 408M) in bearing frame (228) (Fig. 90).

2. Attach bearing frame foot (241) with bolts (370F). Hand tighten (Fig. 90).

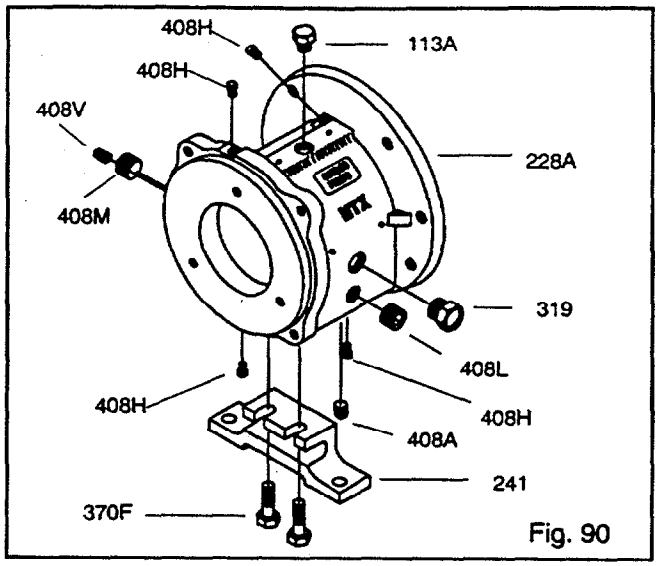


Fig. 90

NOTE: There are several methods used to install bearings, The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

3. Install outboard bearings (112A) on shaft (122).

⚠ CAUTION

Duplex bearings are mounted back to back. Make sure orientation of bearings are correct.

4. Place lockwasher (382) on shaft (122). Place tang of lockwasher in keyway of shaft (Fig. 91).

5. Thread locknut (136) onto shaft (122). Tighten locknut until snug. Bend any tang of lockwasher (382) into a slot of locknut.

NOTE: Tighten locknut if necessary to align the closest tab of lockwasher with slot on locknut.

6. Place bearing clamp ring (253B) over shaft (122). Note orientation.

7. Install inboard bearing (168A) on shaft (122).

NOTE: Regreaseable bearing has a single shield. The inboard bearing is installed with shield away from impeller.

NOTE: Coat internal surfaces of bearings with lubricant to be used in service.

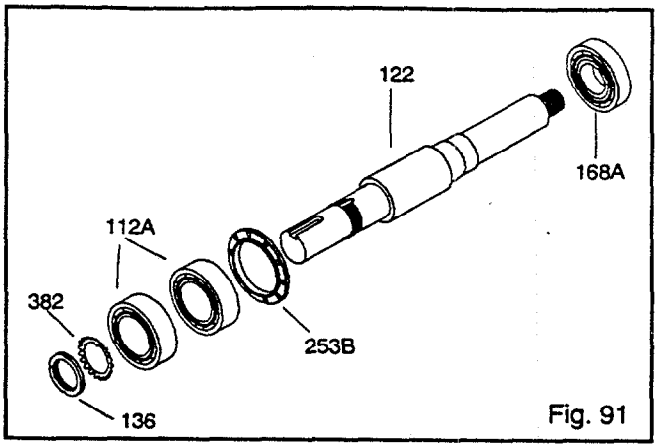


Fig. 91

8. Coat outside of outboard bearing (112A) and bore of bearing housing (134) with oil.

9. Lower shaft/bearing assembly into bearing housing (134) (Fig. 92).

NOTE: Do not force assembly together.

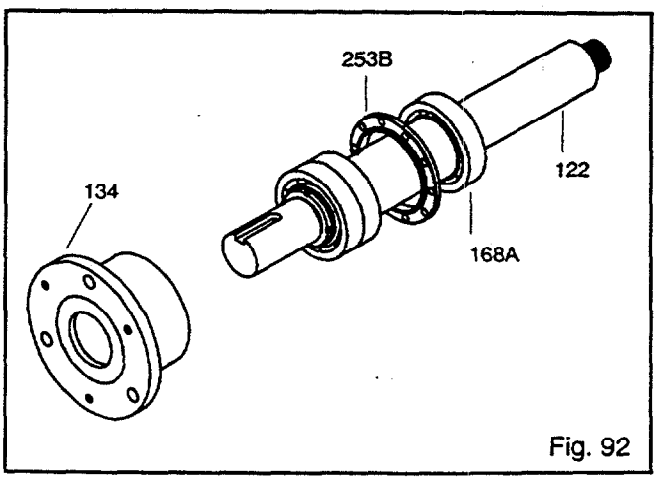


Fig. 92

10. Install clamp ring (253B) with bolts (236A). Tighten bolts in a criss-cross pattern. Check shaft for free turning. Refer to Table 9 for bolt torque values (Fig. 93).

11. Install new O-ring (496).

12. Install outboard labyrinth oil seal (332A) into bearing housing (134). It is an O-ring fit. Position the labyrinth seal drain slots at the bottom 6 o'clock position (Fig. 93).

NOTE: Make sure the keyway edges are free of burrs.

NOTE: Cover the keyway lengthwise with a piece of electrical tape prior to installing the labyrinth seal. This will protect the O-rings.

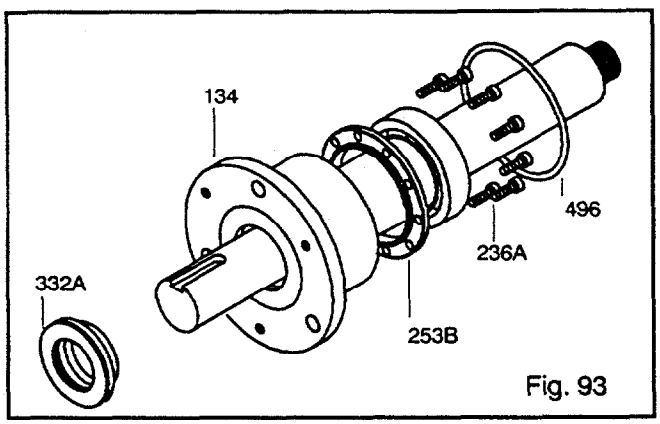


Fig. 93

13. Coat outside of bearing housing (134) with oil.

14. Coat all internal surfaces of bearing frame (228A) with oil.

15. Install shaft assembly into frame (228A). Check shaft for free turning (Fig. 94).

16. Install clamping bolts (370C) into bearing housing (134A). Hand tighten.

17. Install jacking bolts (370D) with locking nuts (423) into housing (134A). Hand tighten.

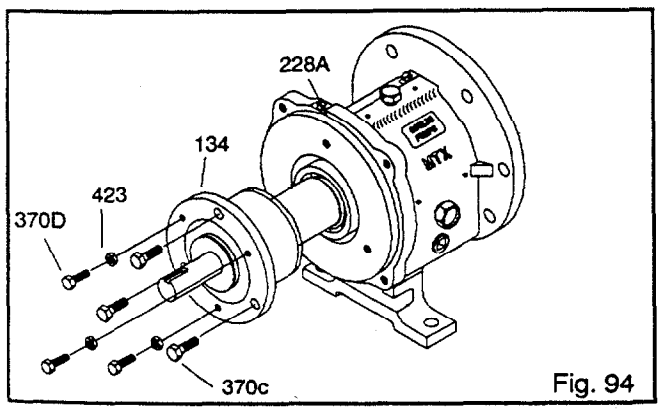


Fig. 94

XLT-X, X17 with Duplex Bearings

NOTE: Make sure that threads are clean and apply thread sealant to pipe threads and fittings.

1. Install the oil fill plug (113A), oil drain plug (408A), sight window (319), sight oiler plug (408J), 4 oil mist connection plugs (408H), or grease fittings (193) and grease relief plugs (113), and oil cooler inlet and outlet plugs (408L, 408M) in bearing frame (228) (Fig. 95).

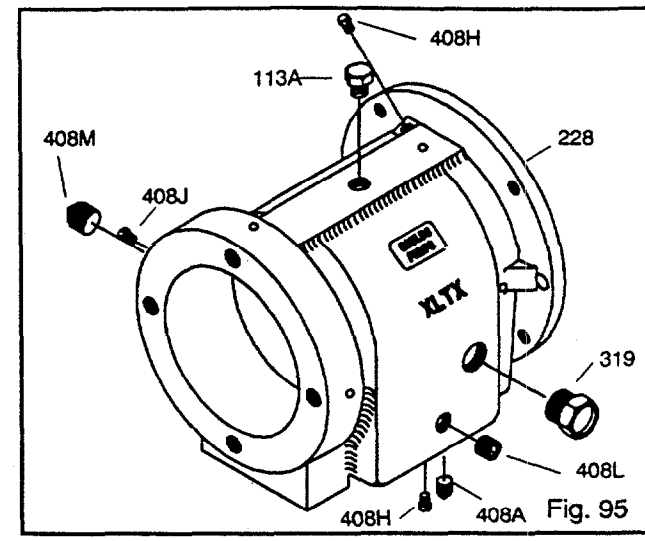


Fig. 95

2. Install outboard bearings (112A) on shaft (122) (Fig. 96).

NOTE: There are several methods used to install bearings, The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury

⚠ CAUTION

Duplex bearings are mounted back to back. Make sure orientation of bearings are correct.

3. Place lockwasher (382) on shaft (122). Place tang of lockwasher in keyway of shaft.

4. Thread locknut (136) onto shaft (122). Tighten locknut until snug. Bend any tang of lockwasher (382) into a slot of locknut.

NOTE: Tighten locknut if necessary to align the closest tab of lockwasher with slot on locknut.

6

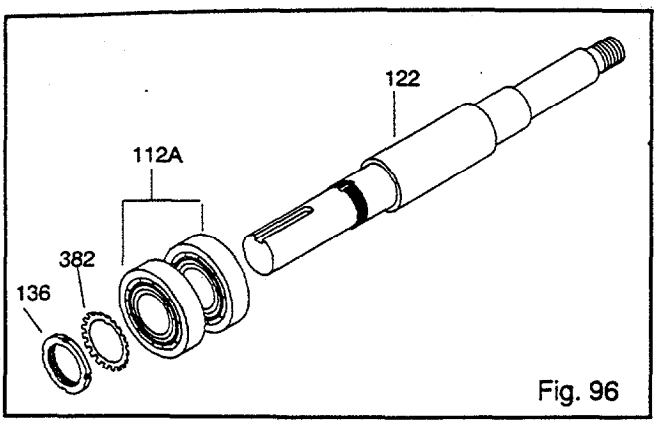


Fig. 96

5. Coat outside of outboard bearing (112A) and bore of bearing housing (134) with oil.
6. Install bearing housing (134) onto shaft/bearing assembly (Fig. 97).

NOTE: Do not force assembly together.

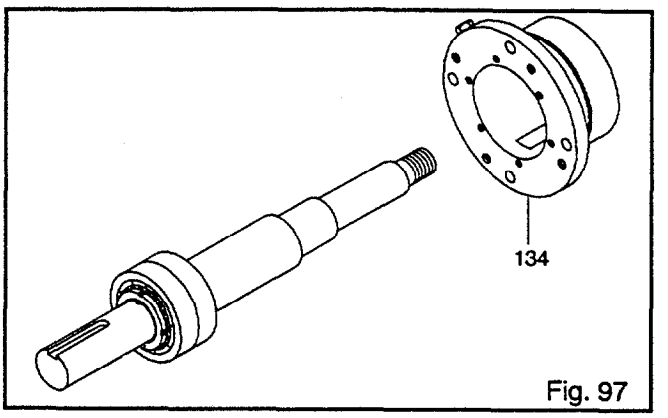


Fig. 97

7. Install gasket (360C), end cover (109A), and bolts (371C). Refer to Table 9 for bolt torque values. Check shaft for free turning (Fig. 98).

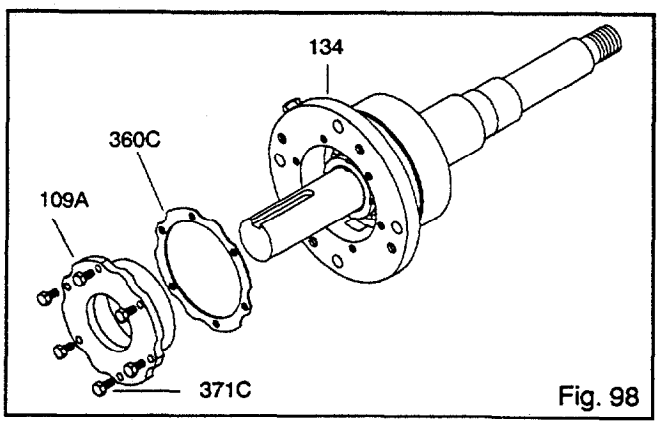


Fig. 98

8. Install inboard bearing (168A) on shaft (122) (Fig. 99).

NOTE: Regreaseable bearing has a single shield. The inboard bearing is installed with shield away from impeller.

NOTE: There are several methods used to install bearings, The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

⚠ WARNING

Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

NOTE: Coat internal surfaces of bearings with lubricant to be used in service.

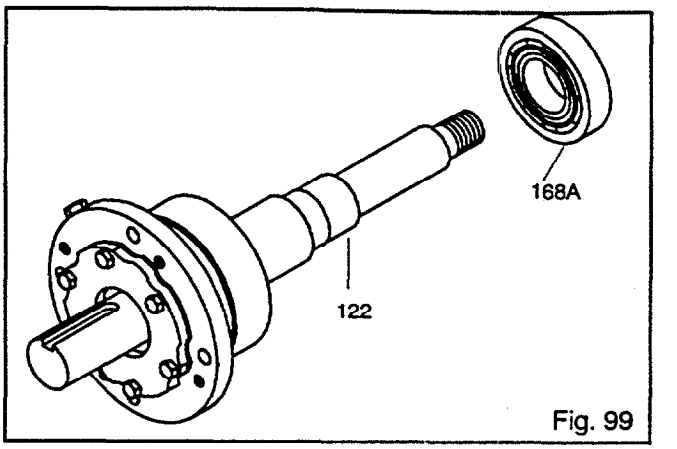


Fig. 99

9. Install new O-ring (496) (Fig. 100).
10. Install outboard labyrinth oil seal (332A) into end cover (109A). It is an O-ring fit. Position the labyrinth seal drain slots at the bottom 6 o'clock position.

NOTE: Make sure the keyway edges are free of burrs.

NOTE: Cover the keyway lengthwise with a piece of electrical tape prior to installing the labyrinth seal. This will protect the O-rings.

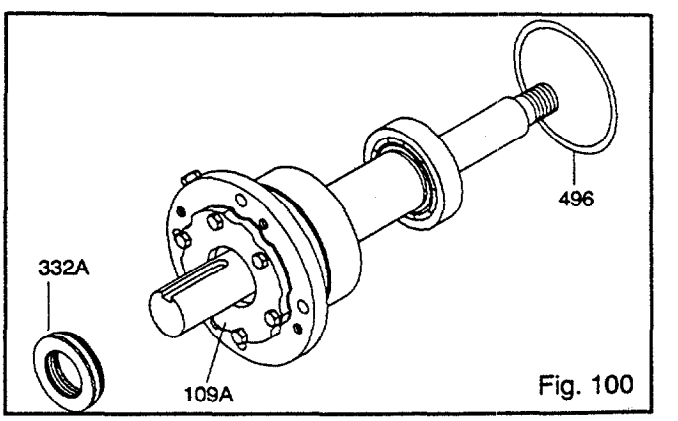


Fig. 100

11. Coat outside of bearing housing (134) with oil.

12. Coat all internal surfaces of bearing frame (228A) with oil.

13. Install shaft assembly into frame (228A). Check shaft for free turning (Fig. 101).

14. Install clamping bolts (370C) into bearing housing (134). Hand tighten.

15. Install jacking bolts (370D) with locking nuts (423) into housing (134). Hand tighten.

16. Attach bearing frame foot (241) with bolts (370F). Hand tighten.

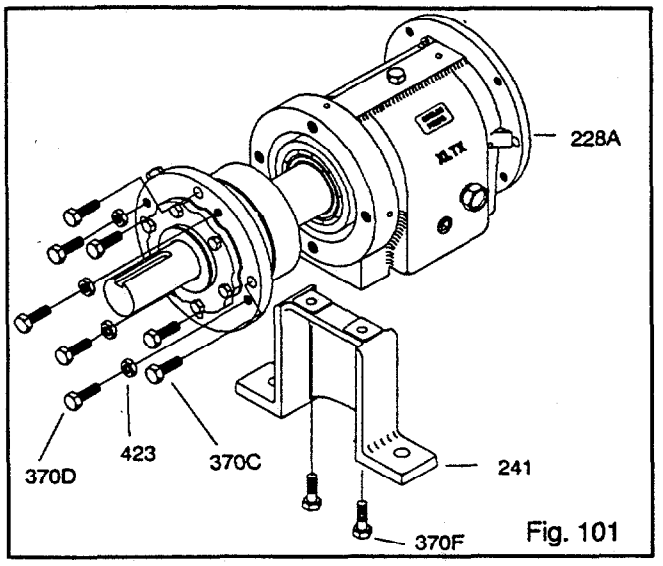


Fig. 101

ALL MODELS

1. Support frame assembly in horizontal position.

2. Check shaft end play. Move shaft forward then backward by hand, noting indicator movement. If total indicator reading is greater than Table 10, page 51, values, disassemble and determine cause (Fig. 102).

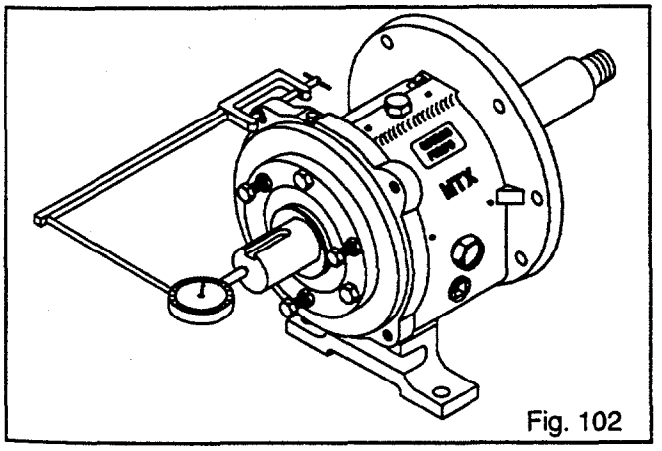


Fig. 102

3. Check shaft/sleeve runout. Put on shaft sleeve (126) if used, and thread on impeller, hand tight. Rotate shaft 360 degrees. If total indicator reading is greater then .002 in., disassemble and determine cause. Remove impeller and shaft sleeve (Fig. 103).

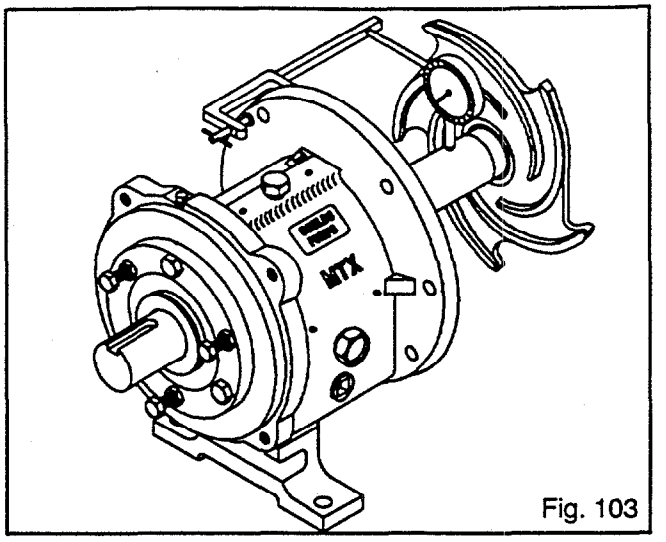


Fig. 103

4. Check frame face run out. Rotate shaft so indicator rides along the fit for 360 degrees. If total indicator reading is greater than 0.001 in. (.025 mm) disassemble and determine cause (Fig. 104).

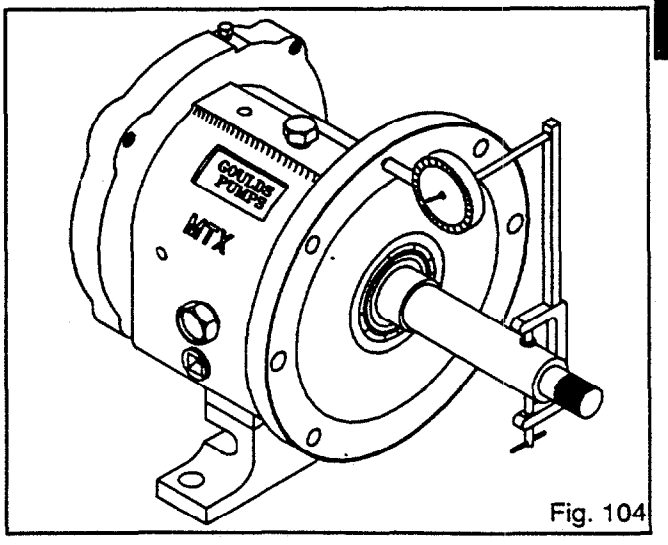


Fig. 104

5. Place manila gasket (360D) on frame (228) (Fig. 105).

NOTE: The gasket is designed to fit one way only. The dowel pins (469B) may be started in their holes to hold the gasket in place.

6

6. Install frame adapter (108), onto frame assembly. Align bolt holes and dowel locations with those on frame (Fig. 105).

7. Install dowel pins (469B), and bolts (370B). Tighten bolts to Table 9, page 51, torque specifications, in a criss-cross pattern.

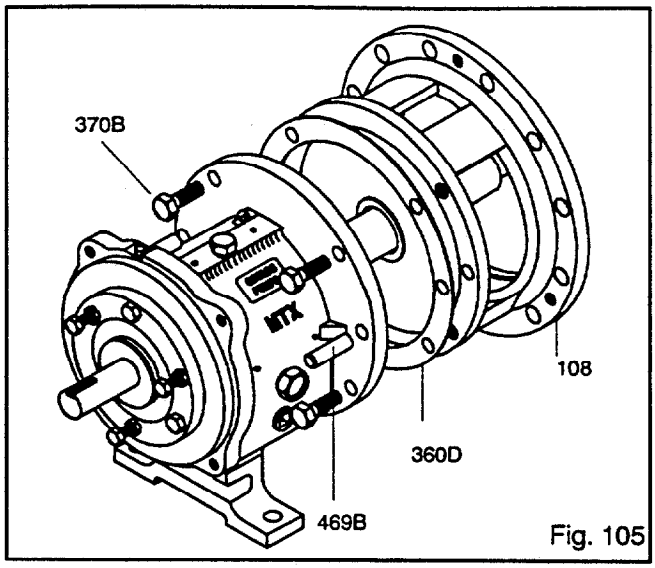


Fig. 105

8. Check adapter fits. Rotate shaft through 360 degrees. If total indicator reading is greater than .005 in. (.13 mm), determine the cause and correct before proceeding (Fig. 106).

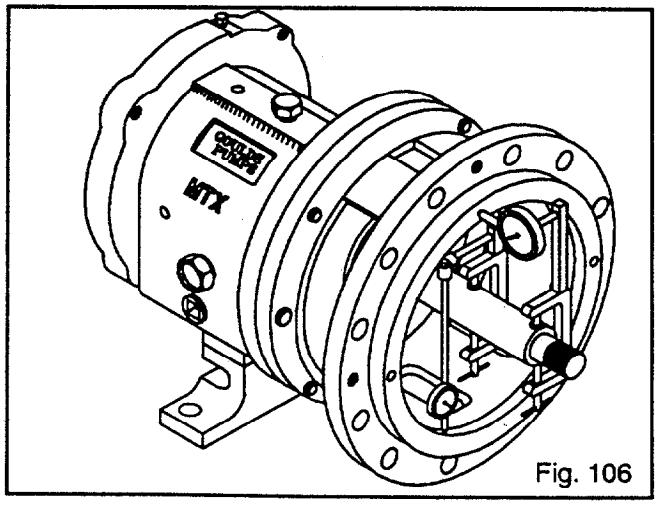


Fig. 106

9. Install inboard labyrinth oil seal (333A) into adapter (108) / bearing frame (228). It is an O-ring fit. Position the labyrinth seal drain slots at the bottom (6 o'clock) position. (Fig. 107A, 107B)

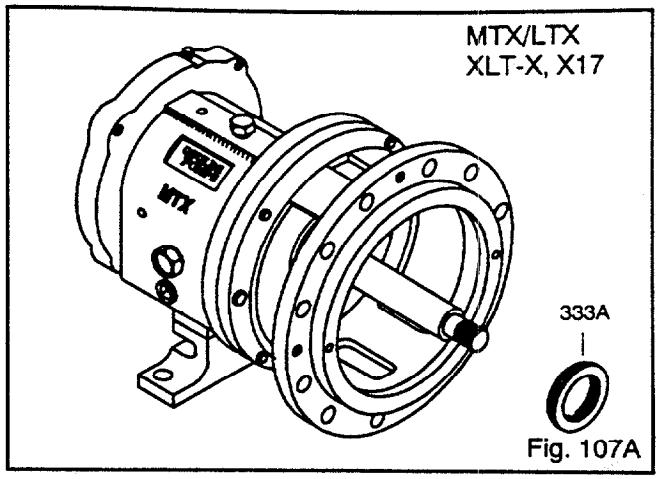


Fig. 107A

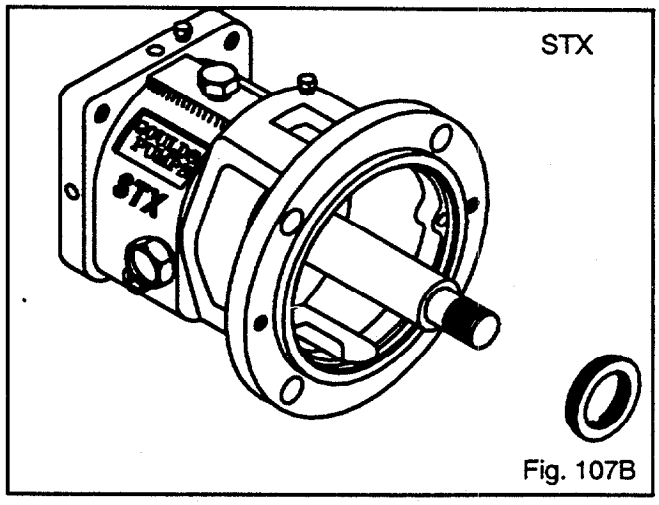


Fig. 107B

Pumps With Mechanical Seals:

1. Install seal chamber cover (184) with nuts (370H).

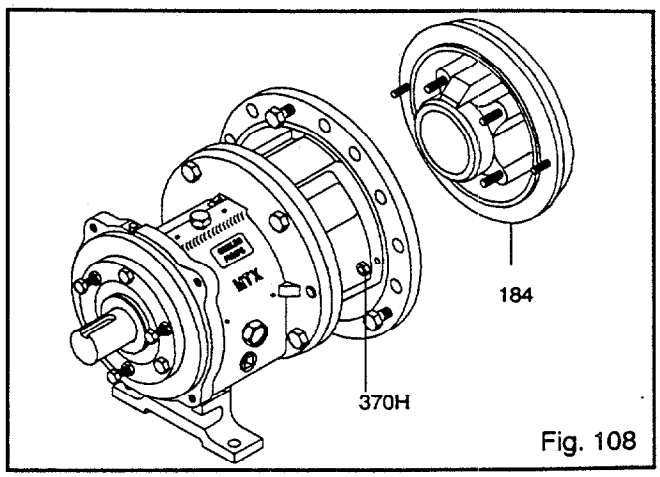


Fig. 108

2. Check seal chamber cover run-out. Rotate indicator through 360 degrees. If total indicator reading is greater than 0.005 in. (.13 mm), determine cause and correct before proceeding (Fig. 109).

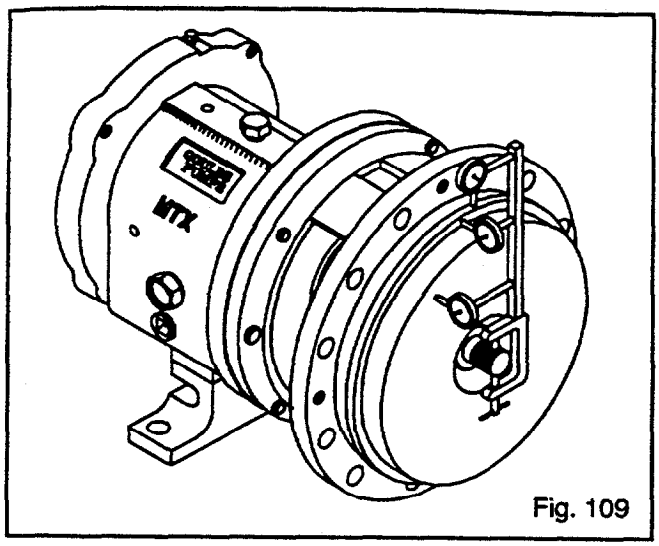


Fig. 109

3. Install shaft sleeve (126) if used (Fig. 110).

NOTE: Make sure sleeve is fully seated.

⚠ WARNING

Wear a heavy set of work gloves when handling impeller (101) as sharp edges may cause physical injury.

4. **STX, MTX, LTX** - Install impeller (101) with O-ring (412A).

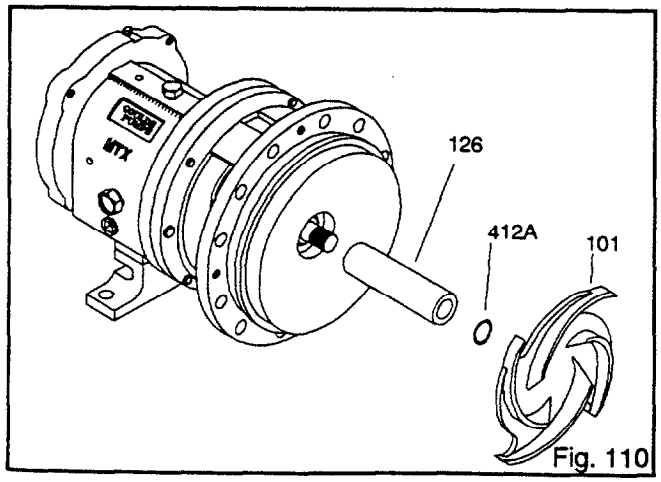


Fig. 110

4a. **XLT-X & X17** - Install impeller (101) with O-ring (412A). Install new teflon washer (428D) on plug (458Y) and install in nose of impeller.

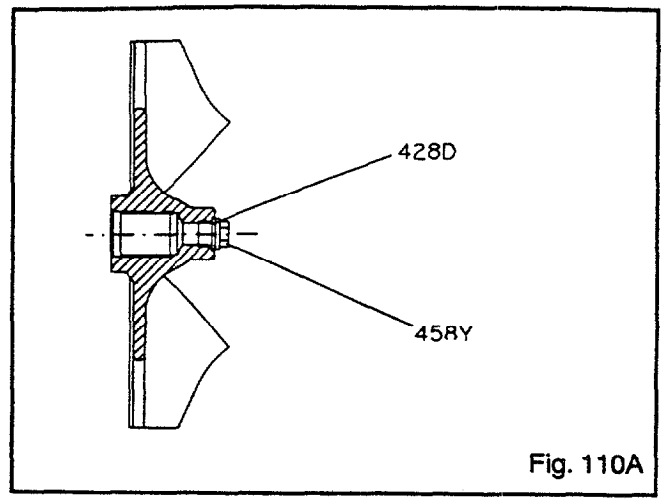


Fig. 110A

5. Put shaft wrench and coupling key on shaft. When impeller (101) makes firm contact with sleeve (126), raise shaft wrench (counterclockwise, viewed from impeller end of shaft) off bench and slam it down (clockwise, viewed from impeller end of shaft). A few sharp raps will tighten impeller (101) properly (Fig. 111).

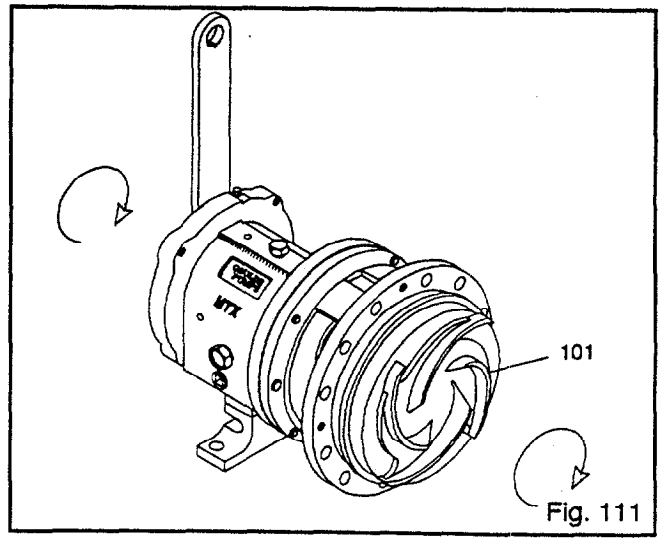


Fig. 111

6

6. Loosen clamp bolts (370C), and jacking bolts (370D). Measure gap between impeller (101) and seal chamber/stuffing box cover (184) with a feeler gauge. When 0.030 in. clearance is reached, tighten clamp bolts (370C), jacking bolts (370D), and locking nuts (423) (Fig. 112)

NOTE: This approximates the impeller position when set at 0.015 in. (.38 mm) from casing. Final impeller adjustment must be made after installation into casing.

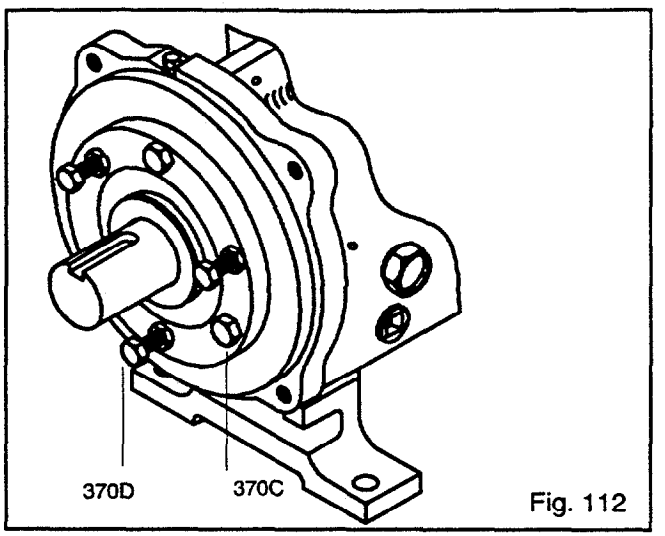


Fig. 112

7. Check impeller (101) runout. Check vane tip to vane tip. If total indicator reading is greater than 0.005 in. (.13 mm), determine cause and correct before proceeding (Fig. 113).

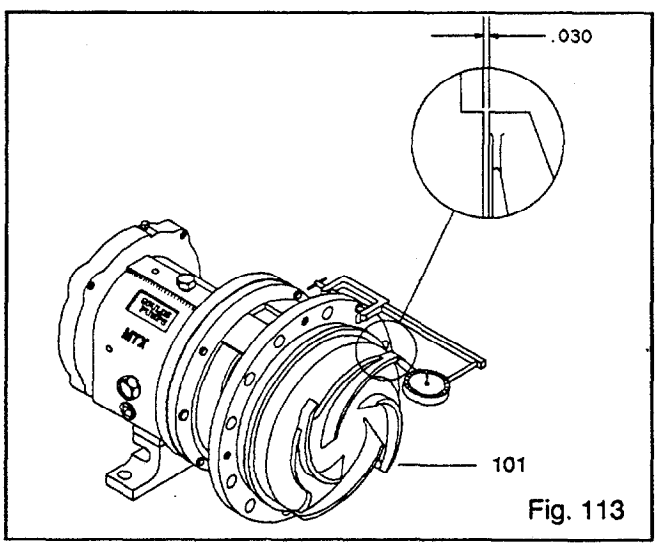


Fig. 113

8. Blue the shaft sleeve (126) or shaft (122) if no sleeve is used. Scribe a mark at gland gasket face of seal chamber/stuffing box cover (184). This will be the datum for installation of mechanical seal (Fig. 114).

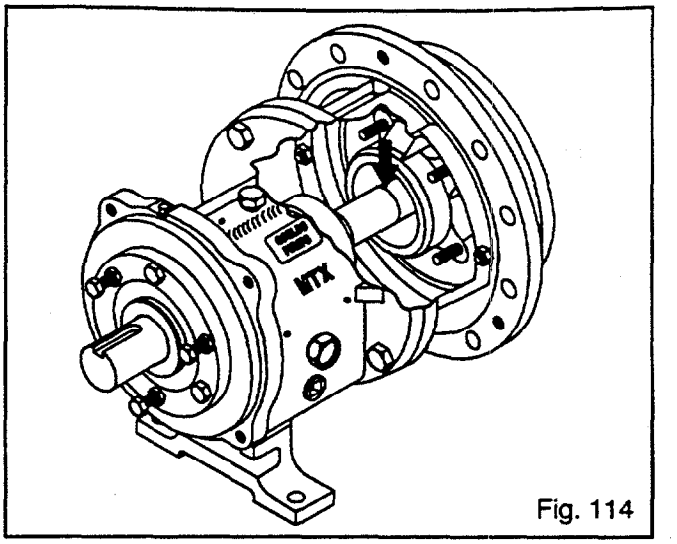


Fig. 114

9. Remove the impeller (101), and shaft sleeve (126) if used.

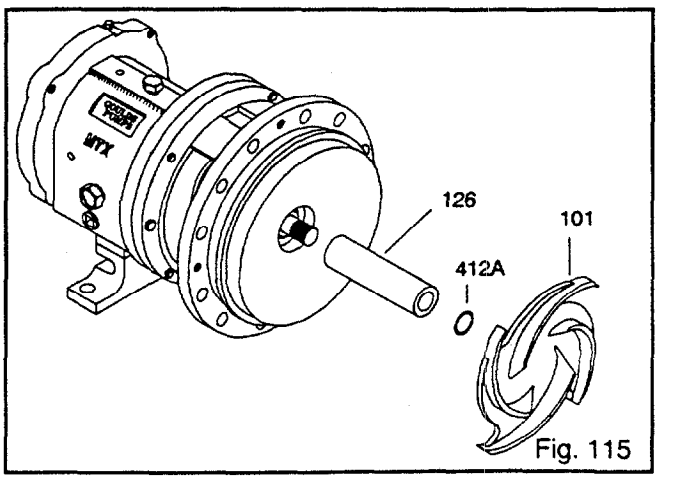


Fig. 115

10. Remove seal chamber cover (184).

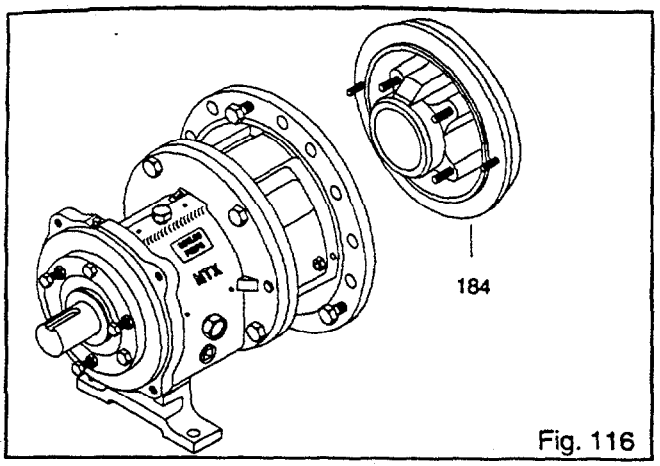


Fig. 116

11. Install stationary seat into gland (107) per seal manufacturer's instructions.

12. Slide gland (107) with stationary seat over shaft, up to adapter face.

13. Install mechanical seal on shaft (122) or shaft sleeve (126) per seal manufacturer's instructions. Install shaft sleeve (126) if used (with seal).

NOTE: Anti-galling compound can be applied to the sleeve bore to aid in disassembly.

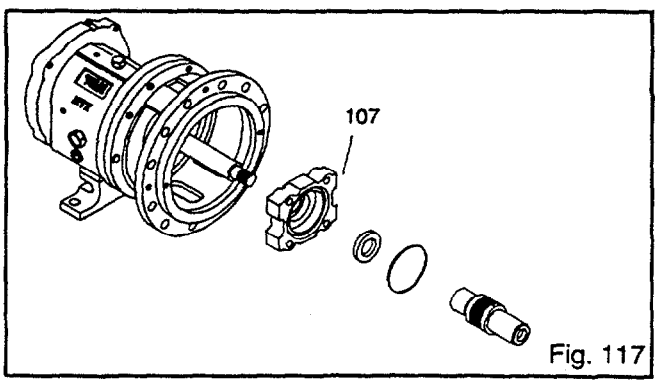


Fig. 117

14. Install seal chamber cover (184) with nuts (370H).

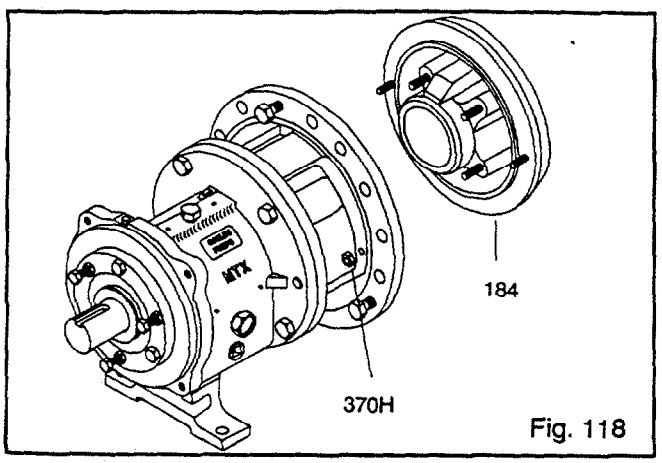


Fig. 118

⚠ WARNING

Wear a heavy set of work gloves when handling impeller (101) as sharp edges may cause physical injury.

15. Install impeller (101) with new O-ring (412A). Put shaft wrench and coupling key on shaft. When impeller (101) makes firm contact with sleeve (126), raise shaft wrench (counterclockwise when viewed from impeller end of shaft) off bench and slam it down (clockwise when viewed from impeller end of shaft). A few sharp raps will tighten impeller (101) properly.

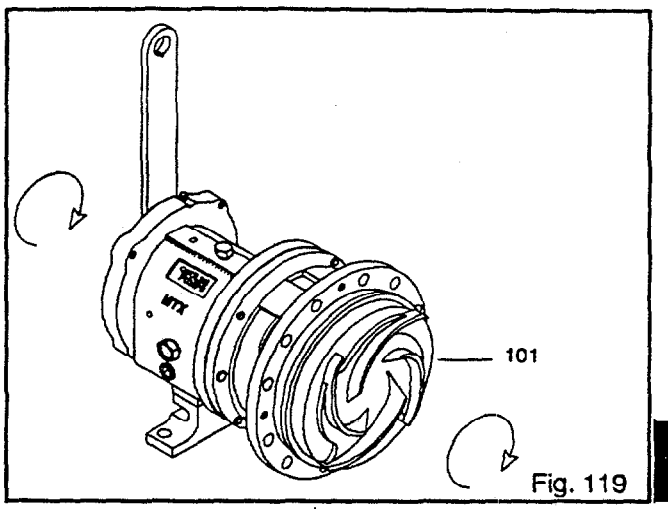


Fig. 119

16. Install gland (107) with nuts (355).

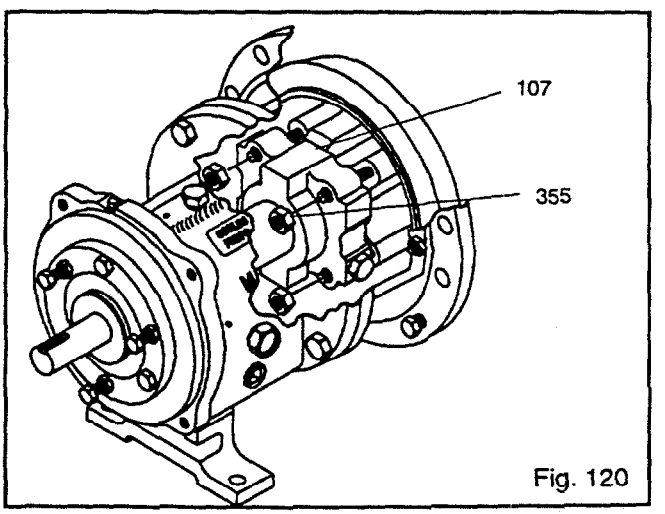


Fig. 120

Pumps With Packing:

1. Install stuffing box cover (184) with nuts (370H).

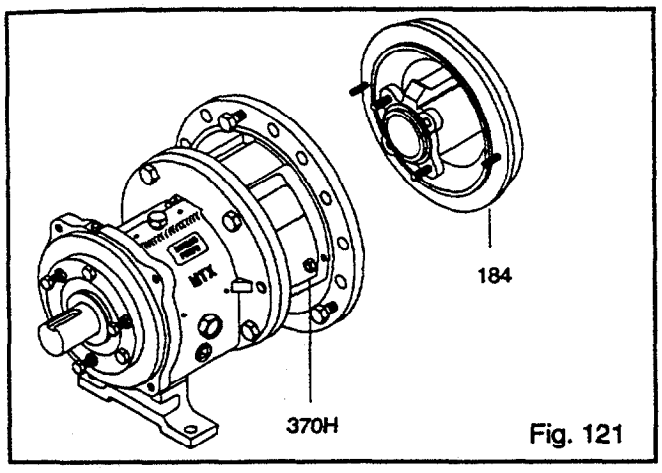


Fig. 121

2. Check stuffing box cover run-out. Rotate indicator through 360 degrees. Total indicator reading greater than 0.005 in. (.13 mm) indicates a problem (Fig. 122).

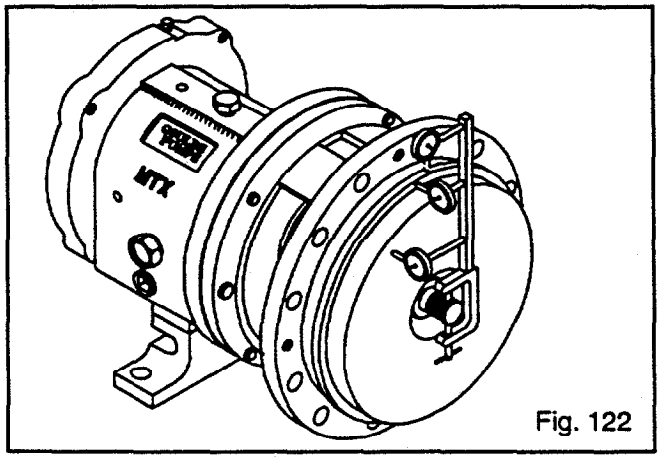


Fig. 122

3. Install shaft sleeve (126) (Fig. 123).

NOTE: Anti-galling compound, can be applied to the sleeve bore to aid in disassembly.

NOTE: Make sure sleeve is fully seated.

⚠ WARNING

Wear a heavy set of work gloves when handling impeller (101) as sharp edges may cause injury.

4. Install impeller (101) with O-ring (412A). Put shaft wrench and coupling key on shaft. When impeller (101) makes firm contact with sleeve (126), raise shaft wrench (counterclockwise when viewed from impeller end of shaft) off bench and slam it down (clockwise when viewed from impeller end of shaft). A few sharp raps will tighten impeller properly (Fig. 124).

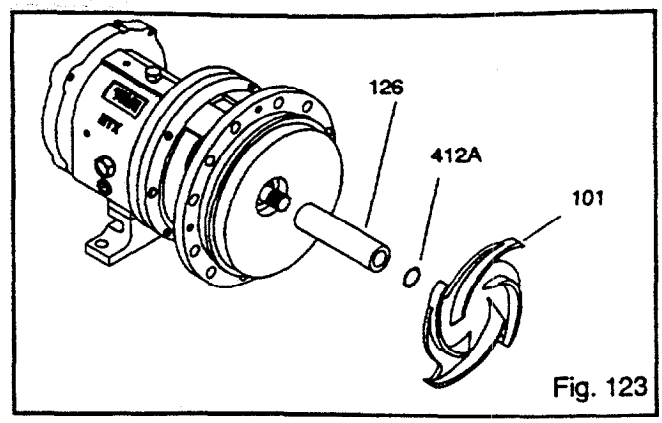


Fig. 123

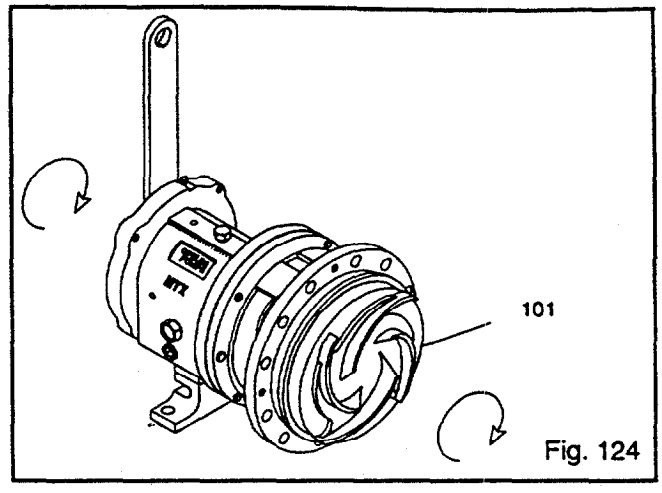


Fig. 124

5. Loosen clamp bolts (370C), and jacking bolts (370D) (Fig. 124). Measure gap between impeller (101) and seal chamber/stuffing box cover (184) with a feeler gauge. When 0.030 in. (.76 mm) clearance is reached, tighten clamp bolts (370C), jacking bolts (370D), and locking nuts (423) (Fig. 125).

NOTE: This approximates the impeller position when set at 0.015 in. (.38 mm) from casing.

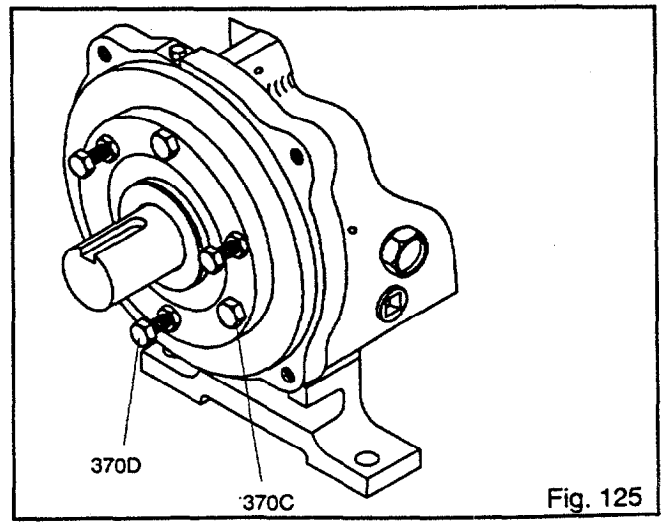


Fig. 125

6. Check impeller runout. Check vane tip to vane tip. Total indicator reading greater than 0.005 in. (.13 mm) indicates a problem (Fig. 126).

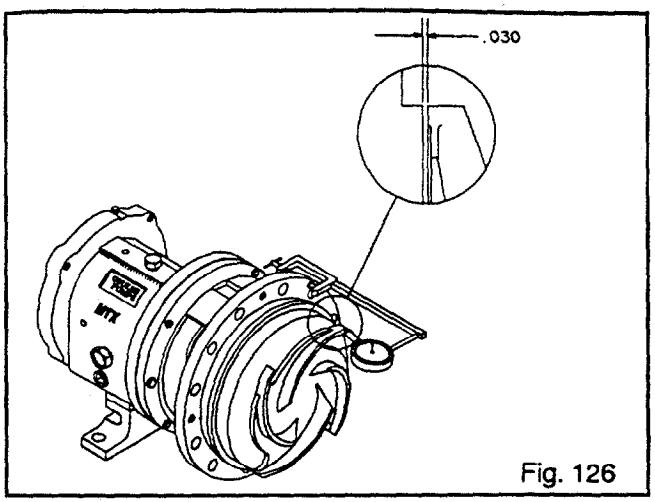


Fig. 126

7. Install packing and gland according to Section 4, Operation.

Pumps With Dynamic Seals:

1. Place backplate (444) flat side down on the bench (Fig. 127).
2. Place repeller (262) in backplate (444), sleeve side up.
3. Place teflon gasket (264) on backplate (444), lining up holes.
4. Place stuffing box cover (184) on backplate (444), lining up holes.
5. Install four (4) socket head cap screws (265), tighten securely.
6. Install new sealing element into gland.
7. Install gasket (360Q) and gland (107) on stuffing box cover (184). Install nuts (355).

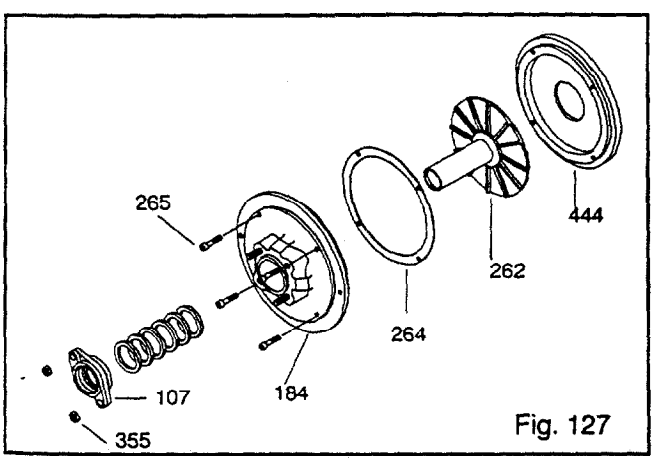


Fig. 127

8. Install dynamic seal assembly. Install nuts (370H) (Fig. 128).

NOTE: Anti-galling compound, can be applied to the sleeve bore to aid in disassembly.

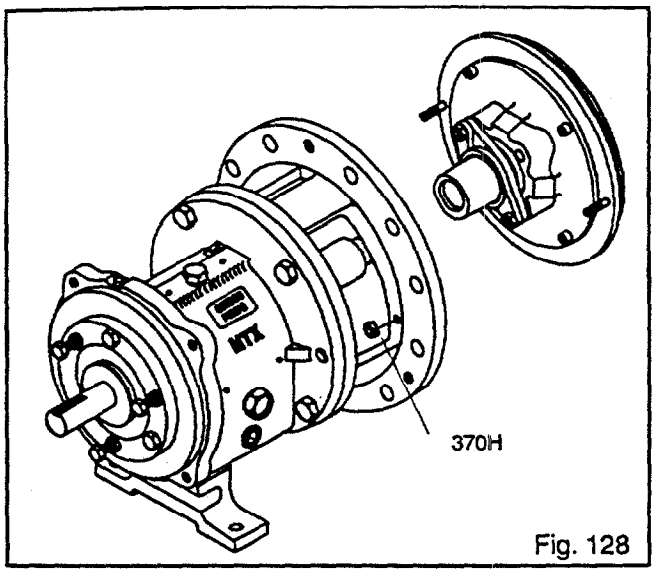


Fig. 128

9. Check stuffing box cover run-out. Rotate indicator through all 360 degrees. Total indicator reading greater than 0.005 in. indicates a problem (Fig. 129).

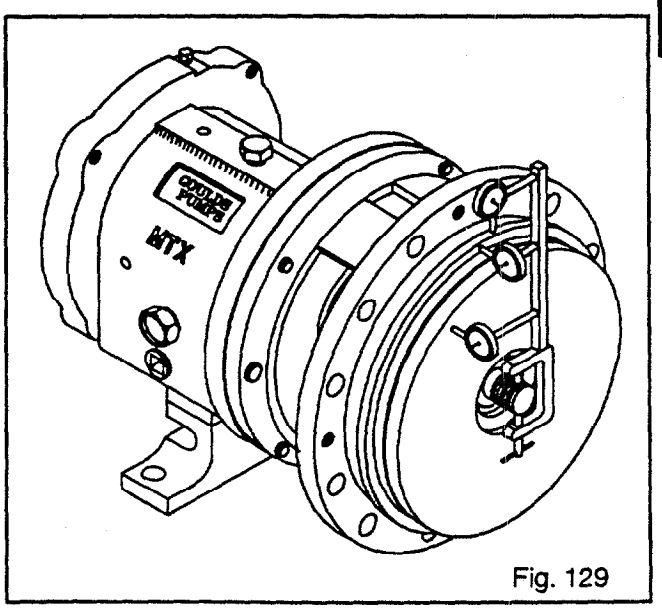


Fig. 129

6

Reinstall Back Pull-Out Assembly

⚠ WARNING

Back pull-out assembly weighs more than 50 lbs. Do not handle unassisted as physical injury may occur.

1. Clean casing fit and install casing gasket (351) in place on seal chamber/stuffing box cover.
2. Loosen clamping bolts (370C) and jacking bolts (370D) on bearing housing (Fig. 130).

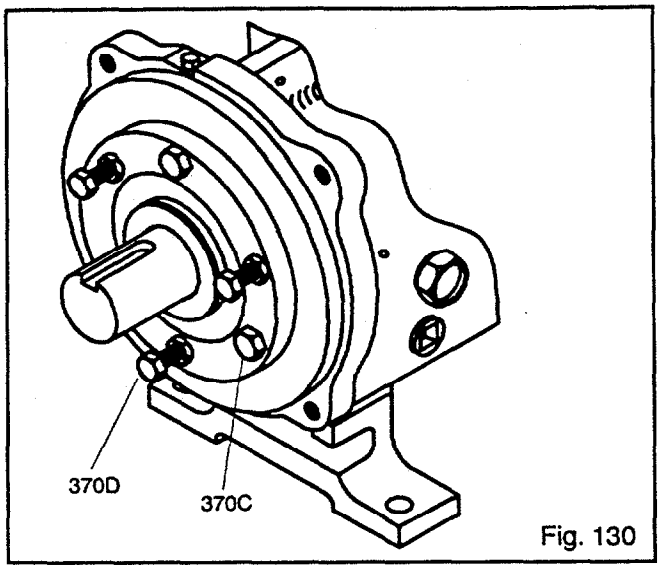


Fig. 130

3. Install back pull-out assembly in casing (Fig. 131).

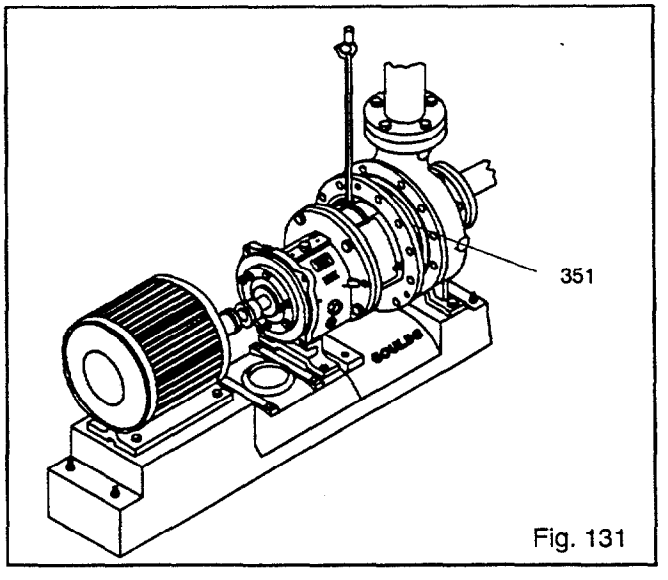


Fig. 131

4. Install casing bolts (370), finger tight. Casing bolts (370) may be coated with anti-galling compound to aid disassembly. Tighten the casing bolts per Table 9 torque values, page 51. Install casing jack screws (418), snug tight (Fig. 132).

⚠ CAUTION

Do not overtighten casing jack screws (418).

4a. Replace shims under frame foot and tighten frame foot to bedplate. To insure that the proper shim is used, a dial indicator should be mounted to measure distance between top of frame and bedplate. This distance should not change as frame foot bolting is tightened.

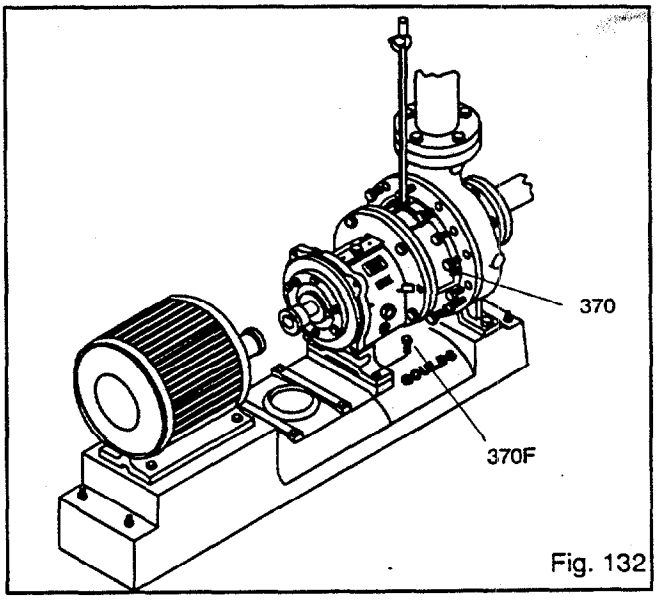


Fig. 132

5. Check total travel of impeller in casing. With new parts acceptable range is 0.030 in. (.76 mm). to 0.065 in. (1.65 mm). If outside this range improper parts or installation, or too much pipe strain is present. Determine cause and correct.
6. Adjust impeller clearance according to procedure outlined in Section 5, Preventive Maintenance.
7. Replace auxiliary piping at this time.
8. Fill pump with proper lubricant. Refer to Section 5, Preventive Maintenance for requirements.

POST ASSEMBLY CHECKS

After completion of these operations check whether it is possible to rotate shaft easily by hand. If all is proper, continue with pump start-up

Assembly Troubleshooting	
Symptom	**Cause**
Excessive shaft end play.	Bearing internal clearance too great. Replace bearings with correct type. Snap ring loose in bearing housing groove. Reseat.
Excessive shaft/sleeve runout.	Sleeve worn. Replace Shaft bent. Replace.
Excessive bearing frame flange runout.	Shaft bent. Replace. Bearing frame flange distorted. Replace.
Excessive frame adapter runout.	Corrosion. Replace. Adapter to frame gasket not seated properly. Reseat.
Excessive seal chamber/stuffing box cover runout.	Seal chamber/stuffing box cover not properly seated in frame adapter. Corrosion or wear. Replace.
Excessive impeller vane tip runout.	Bent vane(s). Replace impeller.

PARTS LIST WITH MATERIALS OF CONSTRUCTION

Item	Qty per pump	Part Name	All D.I.	D.I. w/ 316SS Impeller	All 316SS	All CD4MC	All Alloy 20	All 317SS	All Monel	All Nickel	All HastC	All Hast B	All Titanium
100	1	Casing	1012	1012	1203	1216	1204	1209	1119	1601	1215	1217	1220
101	1	Impeller	1013	1203	1203	1216	1204	1209	1119	1601	1215	1217	1220
105	1	Lantern Ring	Teflon										
106	1 Set	S.B. Packing	Non-Asbestos Braid										
107	1	Gland—Packed Box	1203			1204		1209	1119	1601	1215	1217	1220
108	1	Frame Adapter	1013										
109C	1	Outbd Bearing End Cover	1001										
112	1	Outboard Bearing	Double row angular contact (duplex pair for LTX)										
113	2	Plug—Grease Relief	2210										
113A	1	Plug—Oil Fill	2210										
122	1	Shaft—Less Sleeve	▲	2229			2230	2232	2229	2229	2229	2229	2229
122	1	Shaft—With Sleeve	2238					2232	2229	2229	2229	2229	2229
126	1	Shaft Sleeve	2229			2230		2232	2150	2155	2248	2247	2156
134	1	Bearing Housing	1001										
136	1	Bearing Locknut	Steel										
168A	1	Inboard Bearing	Single Row Ball										
184	1	Seal Chamber/S.B. Cover	1012	1012	1203	1216	1204	1209	1119	1601	1215	1217	1220
193	2	Grease Fitting	Steel										
228	1	Bearing Frame	STX-1013 All Others-1001										
236A	10	Cap Screw—Brg Clamp Ring	2210										
241	1	Frame Foot	1001										
248A	1	Oil Thrower	2210										
250	1	Gland—Mech Seal	Material Varies										
253B	1	Brg Clamp Ring	2210										
319	1	Sight Glass	Glass / Steel										
332A	1	Outboard Laby Seal w/O-rings	Carbon Filled Teflon with Viton O-rings										
333A	1	Inboard Laby Seal w/O-rings	Carbon Filled Teflon with Viton O-rings										
351	1	Casing Gasket	Aramid Fiber w/EPDM Binder										
353	4	Gland Stud	2229						2150				
355	4	Gland Stud Nut	2228						2150				
358A	1	Plug—Casing Drain	2210	2229		2230		2232	2150	2155	2248	2247	2156
360D	1	Gasket—Frame to Adapter	Vellumoid										
360Q	1	Gasket—Gland to S. B. Cover	Material Varies										
361A	1	Retaining Ring	Steel										
370	★	Bolt—Adapter to Case	2210		2228								
370B	4	Bolt—Frame to Adapter	2210										
370C	*	Clamp Bolt—Brg Housing	2210										
370D	*	Jack Bolt—Brg Housing	2210										
370F	2	Bolt—Frame Foot to Frame	2210										
370G	6	Bolt—End Cover to Brg Housing	2210										
370H	2	Stud—S. B. Cover to Adapter	2228										
382	1	Bearing Lockwasher	Steel										
383	1	Mechanical Seal	Material Varies										
408A	1	Plug—Oil Drain	2210										
408H	4	Plug —Oil Mist Connection	2210										
408J	1	Plug—Oiler	2210										
408L	1	Plug—Oil Cooler Inlet	2210										
408M	1	Plug—Oil Cooler Outlet	2210										
408N	1	Plug—Sight Glass	2210										
418	3	Jack Bolt—Adapter to Case	2228										
423	3	Jam Nut—Brg Hsg Jack Bolt	2210										
423B	2	Hex Nut—S.B.Cover to Adapter	2228										
428D	❑	Gasket, Plug	Teflon										
458Y	X	Impeller Plug	2229			2230		2232	2150	2155	2248	2247	2156
469B	2	Dowel Pin—Frame to Adapter	Steel										
496	1	O-ring Bearing Housing	Buna N										
496A	1	O-ring —Impeller	Teflon										
497F	1	O-ring—Outboard Laby Rotor	Viton										
497G	1	O-ring—Outboard Laby Stator	Viton										
497H	1	O-ring—Inboard Laby Rotor	Viton										
497J	1	O-ring—Inboard Laby Stator	Viton										
529	1	Lockwasher—Frame Foot to Frame	Steel										

* 3 for STX, MTX, LTX
4 for XLT-X, X17

★ Qty 4 for 6" STX
8 for 8" STX
8 for 8" MTX
12 for 10" MTX, LTX
16 for 13" MTX, LTX, XLT-X
24 for 15" XLT-X
12 for X17

▲ 2229 for Mech Seals
2237 all other

X XLT-X & X17 only Qty 1

❑ XLT-X & X17 for repairs only Qty 1

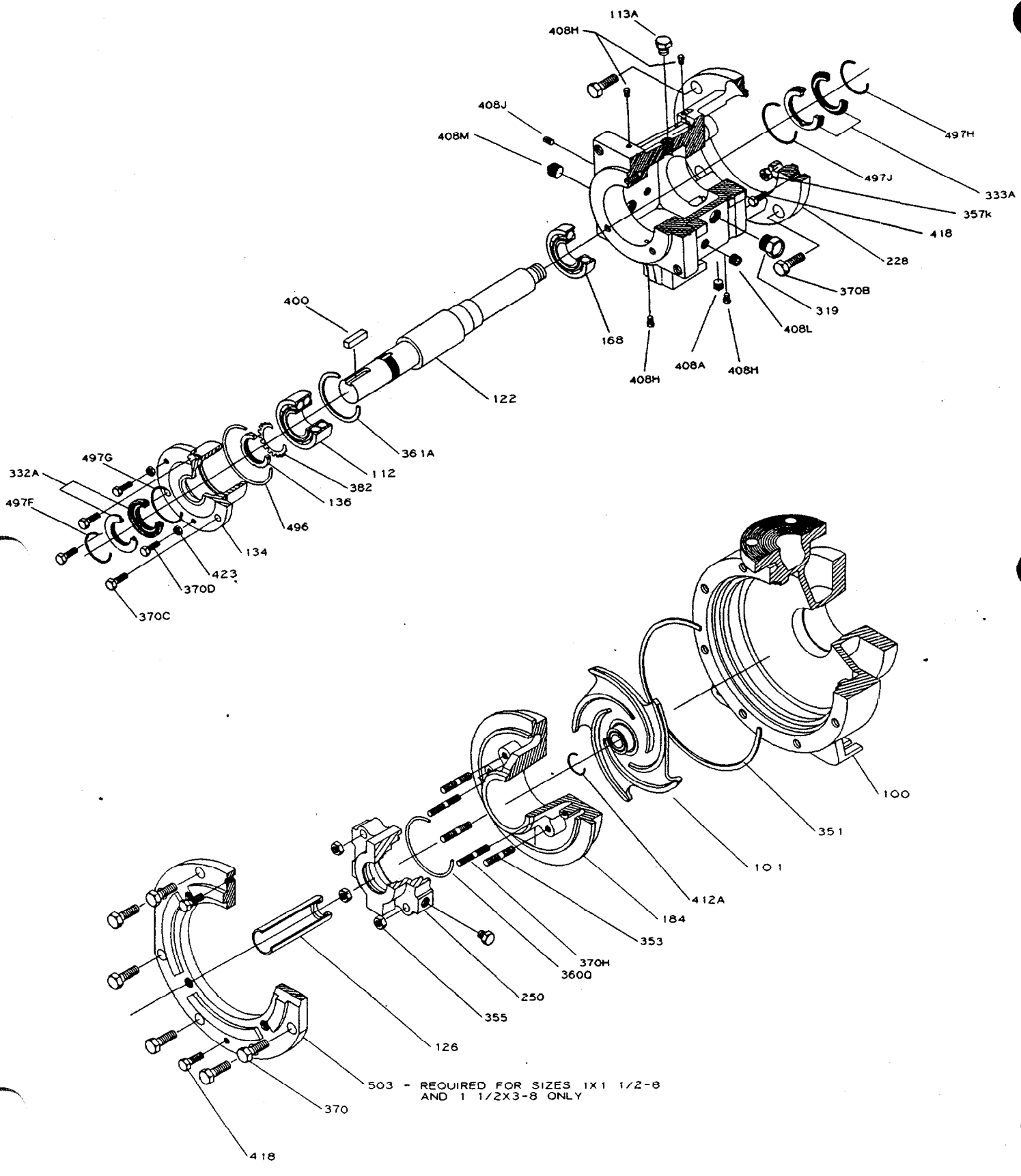
MATERIAL CROSS REFERENCE CHART

Material	Goulds Pumps Material Code	ASTM	DIN	ISO	JIS
Cast Iron	1001	A48 CLASS 20			
Ductile Iron	1012	A395 Gr60-40-18			
Ductile Iron	1013	A536 Gr60-42-10			
Monel	1119	A494 GrM-35-1			
316SS	1203	A744 CF-8M	1.4408		G5121 (SC514)
Alloy 20	1204	A744CN-7M	1.4500		
317SS	1209	A744CG-8M	1.4448		
Hastelloy C	1215	A494 CW-2M			
CD4MCu	1216	A744CD4MCU	9.4460		
Hastelloy B	1217	A494 N-7M			
Titanium	1220	B367 GrC-3			
Nickel	1601	A494 GrCZ100			
Monel	2150	B164 UNS N04400			
Nickel	2155	B160 UNS N02200			
Titanium	2156	B348 Gr2			
Carbon Steel	2210	A108Gr1211			
304SS	2228	A276 Type 304			
316SS	2229	A276 Type 316			
Carpenter 20	2230	B473 (N08020)			
317SS	2232	A276			
4150 Steel	2237	A322Gr4150			
4140 Steel	2238	A434Gr4140			
Alloy B-2	2247	B335 (N10665)			
Alloy C-276	2248	B574 (N10276)			

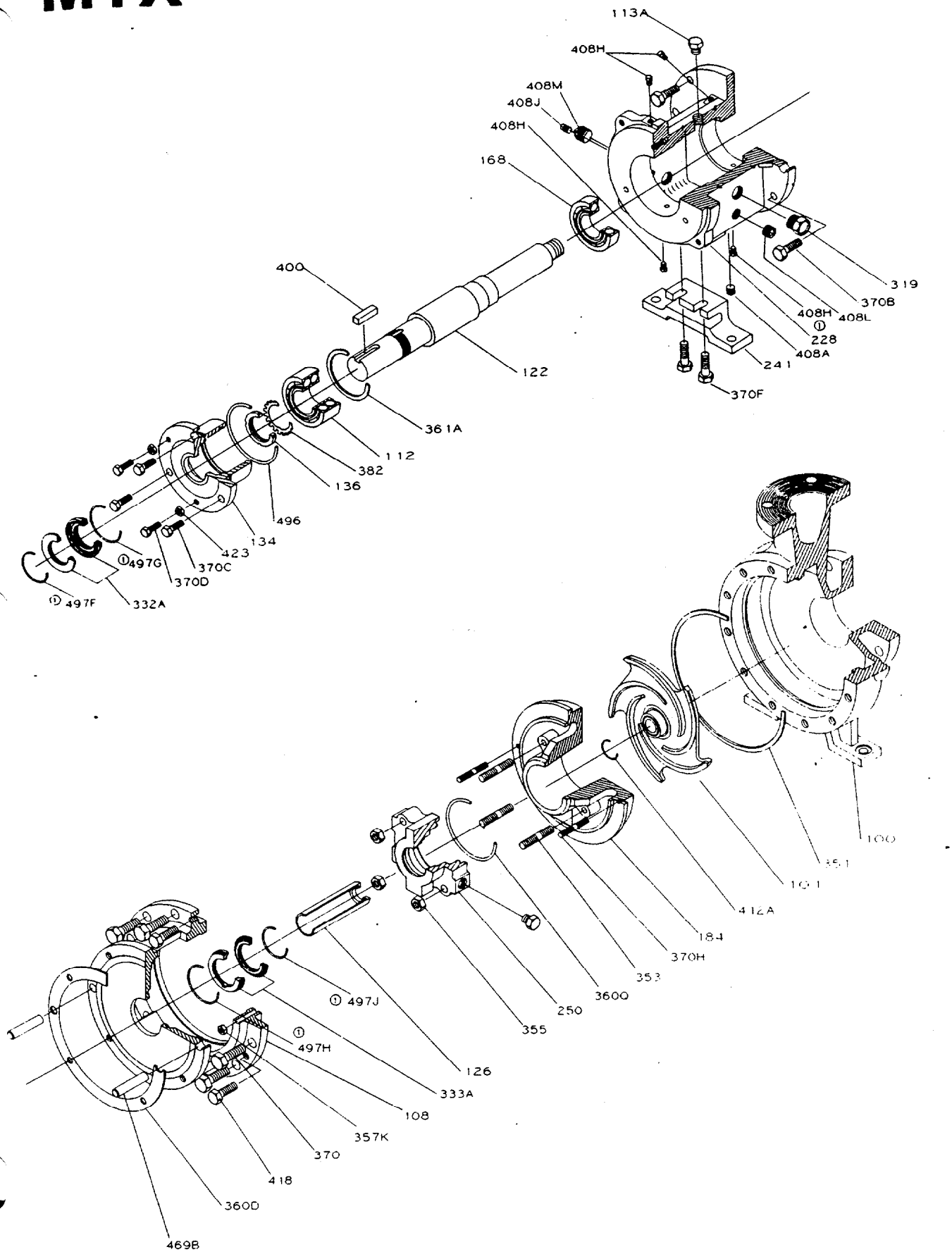
Fasteners/Plugs

Material	Goulds Pumps Material Code	ASTM
Carbon Steel	2210	A307Gr.B.
Stainless Steel	2228	F593Gr1
316 Stainless Steel	2229	F593Gr2

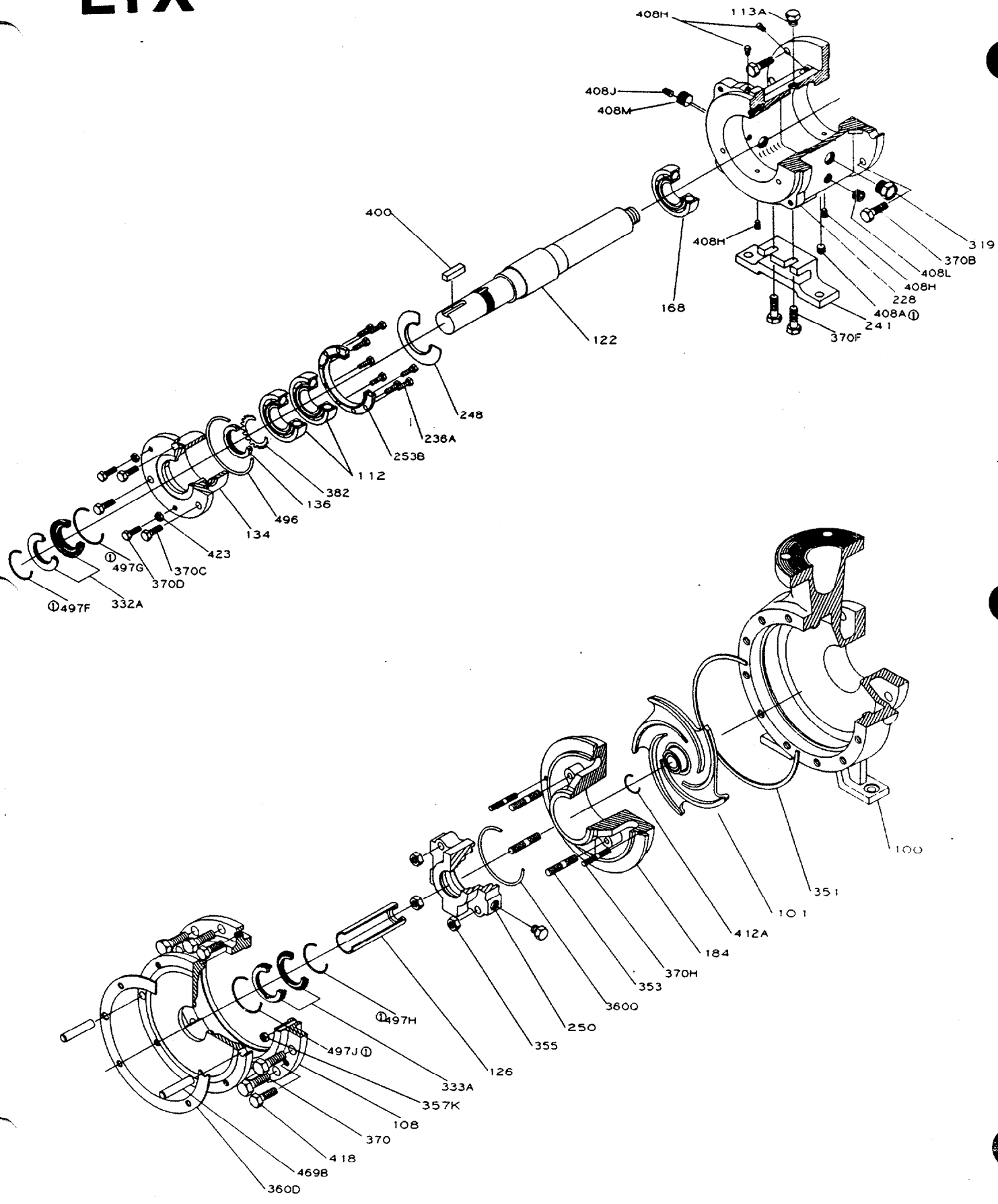
STX


113A
408H
408J
408M
497H
497J
333A
357k
418
228
370B
319
408L
408H
408A
408H
168
400
122
361A
112
382
136
496
134
423
370D
370C
497G
332A
497F
100
351
101
412A
184
353
370H
360Q
250
355
126
503 - REQUIRED FOR SIZES 1X1 1/2-8
AND 1 1/2X3-8 ONLY
370
418

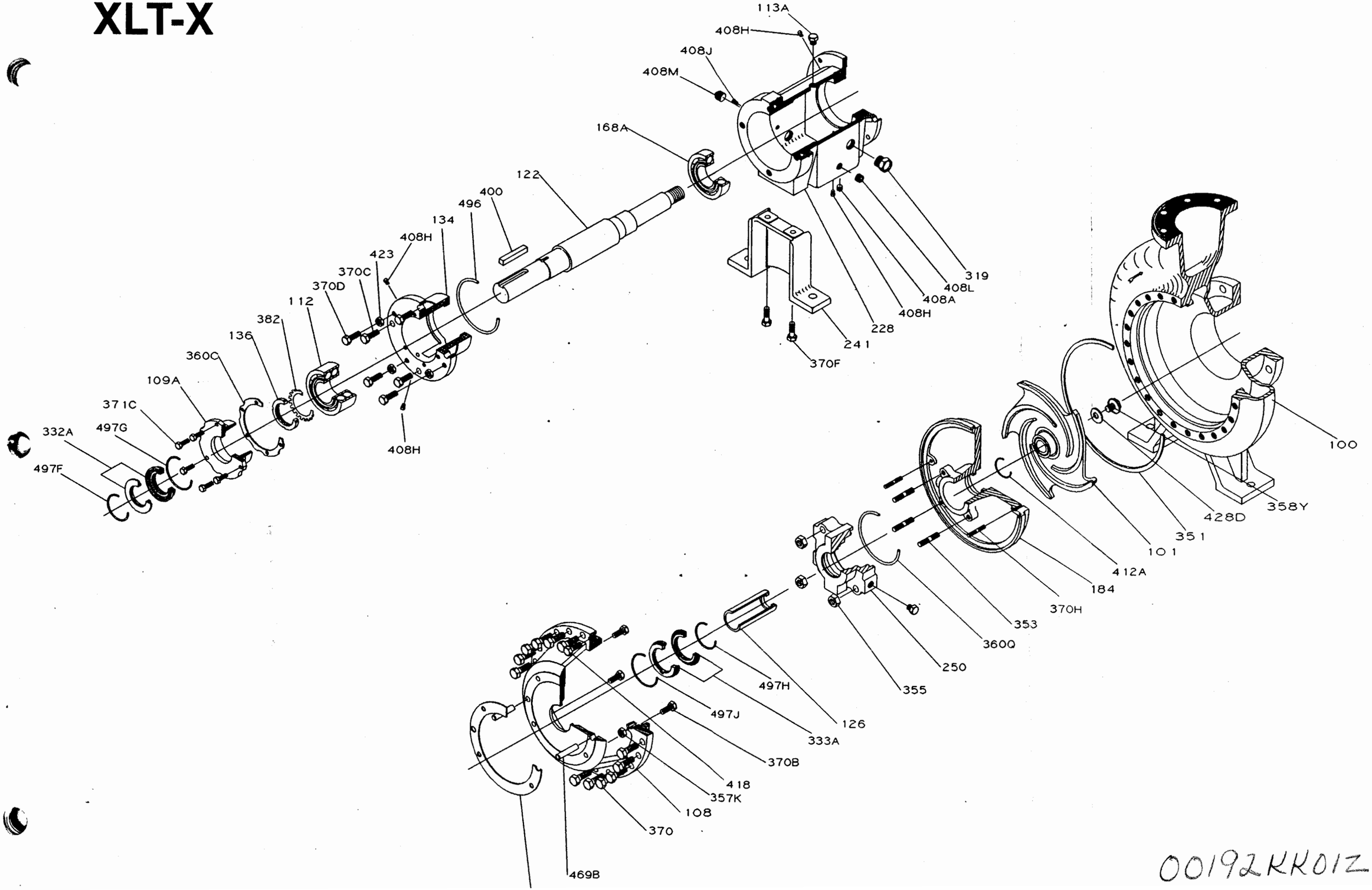
MTX


113A
408H
408M
408J
408H
168
400
319
370B
408H
①
408L
228
408A
241
370F
122
361A
112
382
136
496
134
423
370C
370D
①497G
①497F
332A
100
351
101
412A
184
370H
353
360Q
250
355
①497J
①497H
126
333A
108
357K
370
418
360D
469B

LTX


408H
113A
408J
408M
400
408H
319
370B
408L
408H
228
408A①
241
370F
168
122
248
238A
253B
112
382
136
496
134
423
①497G
370C
370D
①497F
332A
100
351
101
412A
184
370H
353
3600
250
355
①497H
497J①
126
333A
357K
108
370
418
469B
360D

XLT-X



00192KK012

SPARE PARTS

When ordering spare parts, always state Goulds Serial No., and indicate part name and item number from relevant sectional drawing. It is an imperative for service reliability to have a sufficient stock of readily available spares.

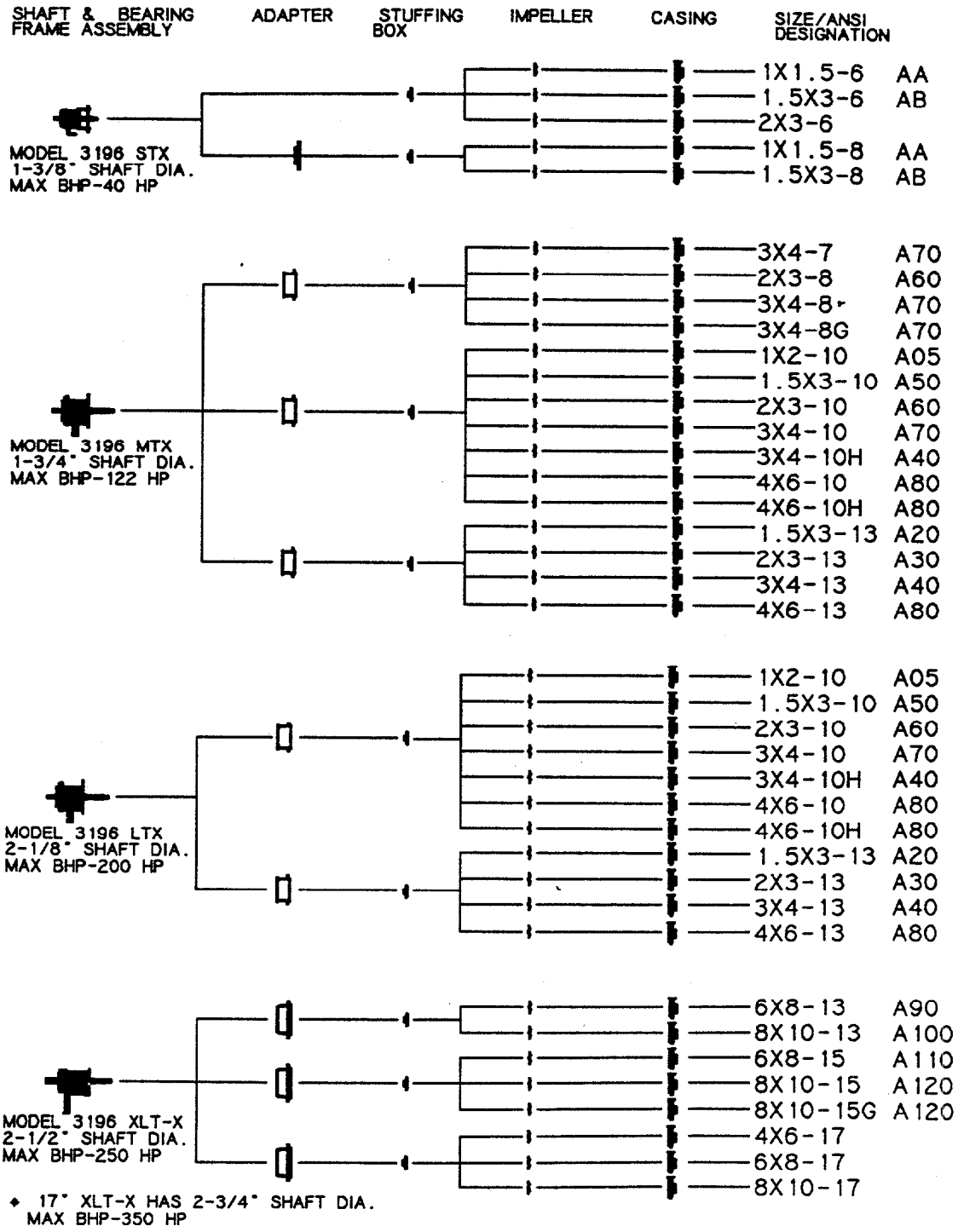
RECOMMENDED SPARE PARTS

Suggested Spare Parts

- Impeller (101)
- Shaft (122A)
- Shaft Sleeve (126)
- Outboard Bearing (112A)
- Inboard Bearing (168A)
- Casing Gasket (351)
- Frame-to-Adapter Gasket (360D)
- Bearing Housing Retaining Ring (361A)
- Bearing Lockwasher (382)
- Bearing Locknut (136)
- Impeller O-Ring (412A)
- Bearing Housing O-Ring (496)
- Outboard Labyrinth Seal Rotary O-Ring (497F)
- Outboard Labyrinth Seal Stationary O-Ring (497G)
- Inboard Labyrinth Seal Rotary O-Ring (497H)
- Inboard Labyrinth Seal Stationary O-Ring (497J)
- Lantern Ring Half (105) (Packed Stuffing Box)
- Stuffing Box Packing (106) (Packed Stuffing Box)
- Packing Gland (107) (Packed Stuffing Box)
- Impeller Gasket (428D) XLT-X & X17

INTERCHANGEABILITY

3196
MODULAR/DIMENSIONAL INTERCHANGEABILITY



HOW TO ORDER

When ordering parts call
1-800-446-8537
or your local Goulds Representative

EMERGENCY SERVICE

Emergency parts service is available
24 hours/day, 365 days/year . . .
Call 1-800-446-8537

APPENDIX I

Lubrication Conversion

	Pumpage Temperature below 350°F (177°C)	Pumpage Temperature above 350°F (177°C)
NLGI Consistency	2	3
Mobil	Mobilux EP2	
Exxon	Unirex N2	Unirex N3
Sunoco	Multipurpose EP	
SKF	LGMT 2	LGMT 3

⚠ CAUTION

Never mix greases of different consistency (NLGI 1 or 3 with NLGI 2) or different thickener soaps (sodium or calcium with lithium). The consistency usually becomes softer and will not provide adequate lubrication to the bearings.

Pumpage temperatures above 350°F (177°C) should be lubricated by a high temperature grease. Mineral oil greases should have oxidation stabilizers and a consistency of NLGI 3.

NOTE: If it is necessary to change grease type or consistency, the bearings must be removed and the old grease removed.

FRAME LUBRICATION CONVERSION

Conversion from Flood Oil to Pure Oil Mist

There are several ways to apply oil mist. Goulds has designed X-Series Power Ends to accept a variety of oil mist configurations. The following instructions are written for two popular systems in use.

NOTE: Make sure that pipe threads are clean and apply thread sealant to plugs & fittings.

NOTE: The LTX Requires that the bearing housing be changed when making the conversion from flood oil to oil mist lubrication. After the proper bearing housing has been installed follow the instructions as they apply to STX, MTX, XLT-X, X17.

A.

1. Attach oil mist inlet to 1/4" NPT connection at top, outboard end of frame (plugged with 408H allen head plug), and top, center of frame (plugged with 113A hex head plug).
2. Attach drain at bottom center of frame 3/8" NPT hole (plugged with 408A magnetic drain plug).
3. Follow oil mist generator manufacturer's instructions for oil mist volume adjustment, and operation.

B.

1. Attach oil mist inlet connection to 1/4" NPT connections at outboard and inboard ends of Power End.
2. Attach vent connection at 1/2" NPT hole located in top center of Power End.
3. Attach drain connection at 3/8" NPT hole located at bottom center of Power End (plugged with 408A magnetic drain plug).
4. Follow oil mist generator manufacturer's instructions for oil mist volume adjustment and operation.

⚠ CAUTION

Oil mist falls under Title III of the Clean Air Act and must be controlled or the user will be subject to penalty.

Conversion from Flood Oil to Regreaseable

NOTE: Make sure that pipe threads are clean and apply thread sealant to plugs and fittings.

NOTE: LTX regreaseable power end requires a changeout of the bearing housing and bearing clamp ring. This housing provides a grease path to the bearings.

1. Plug inboard oil return in bearing frame.

   STX: Use epoxy, keep drilled hole clear.

   MTX, LTX, XLT-X, X17: Use set screw, install from adapter side, bottom in hole.

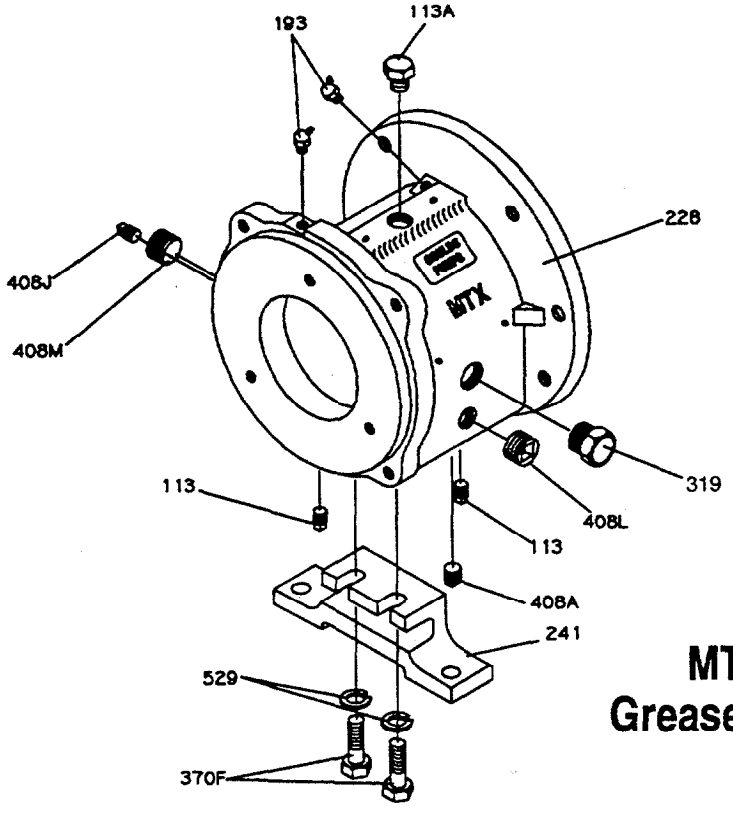
2. Plug outboard oil return slot in bearing housing, keep through holes clear. (does not apply to LTX)

3. Replace both bearings with single shield type. Refer to Assembly Section for installation guidelines.(Ref. Bearing Chart Table 11)

4. Install grease fittings at top, inboard and top, outboard 1/4" NPT connections in bearing frame (plugged with 408H allen head plug).

5. Remove 2 (408H) Allen head plugs from bottom side of frame prior to greasing bearings. Reinstall hex head plugs (113) after bearings have been greased.

ITEM NO.	SIZE	DESCRIPTION	QTY.
113	1/4"-18 NPT	EXT. HEX/SQUARE HEAD PIPE PLUG	2
113A	1/2"-14 NPT	EXT. HEX/SQUARE HEAD PIPE PLUG	1
193	1/4"-18 NPT	GREASE FITTING	2
228	----	BEARING FRAME	1
241	----	FRAME FOOT	1
370F	1/2"	HEX CAP SCREW	2
408A	3/8"-18 NPT	EXT. SQUARE HEAD PIPE PLUG(MAGNETIC)	1
408J	1/4"-18 NPT	EXT. HEX/SQUARE HEAD PIPE PLUG	1
408L	1/2"-14 NPT	SQUARE COUTERSUNK HEADLESS PIPE PLUG	1
408M	1" 11-1/2" NPT	SQUARE COUTERSUNK HEADLESS PIPE PLUG	1
319	1" 11-1/2" NPT	SIGHT WINDOW	1
529	1/2"	LIGHT HELICAL SPRING LOCK WASHER	2



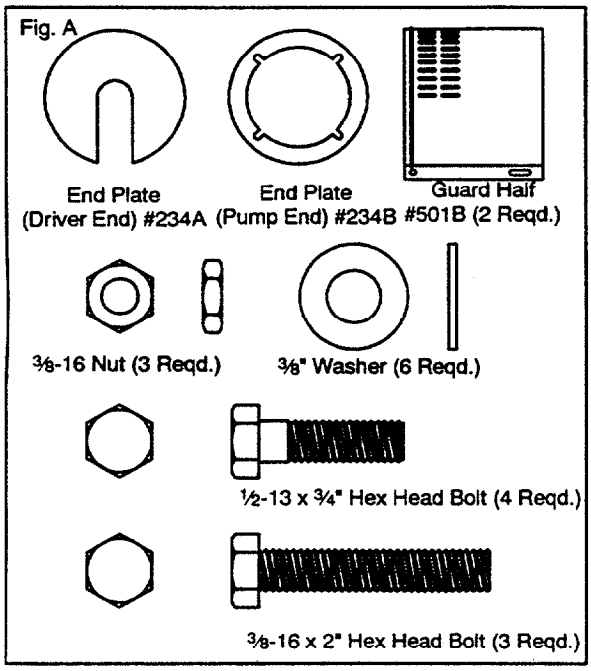
MTX
Grease Lube

APPENDIX II

Installation Instructions for Goulds ANSI B15.1 Coupling Guards

⚠ WARNING

Before assembly or disassembly of the coupling guard is performed the motor must be de-energized, the motor controller/starter put in a locked-out position and a caution tag placed at the starter indicating the disconnect. Replace coupling guard before resuming normal operation of the pump. Goulds Pumps, Inc. assumes no liability for avoiding this practice.



Simplicity of design allows complete assembly of the coupling guard, including the end plate (pump end), in about fifteen minutes. If the end plate is already in place, assembly can be accomplished in about five minutes.

Assembly:

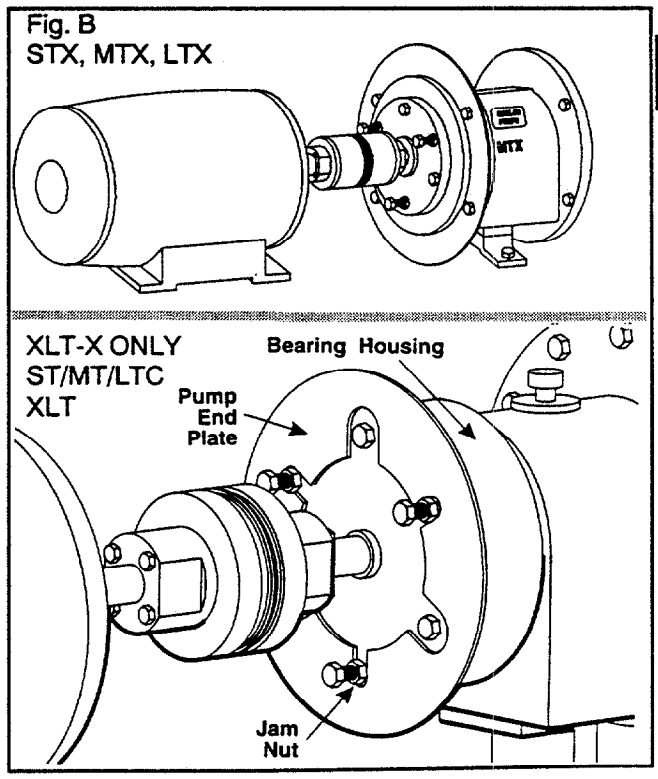
NOTE: If end plate (pump end) is already installed, make any necessary coupling adjustments and then proceed to Step 2.

1. **XLT-X ONLY** Align the end plate (pump end) to the pump bearing housing so that the large slots on the end plate clear the bearing housing tap bolts and the small slots are aligned to the impeller adjusting bolts. Attach the end plate to the bearing housing using the jam nuts on the impeller adjusting bolts as shown in Fig. B.

   After the end plate is attached to the bearing housing, the impeller clearance must be checked and reset as explained in the Goulds operations and maintenance manual for your pump.

   STX, MTX, LTX - Align end plate (pump end) to the Bearing Frame. (No impeller adjustment required)

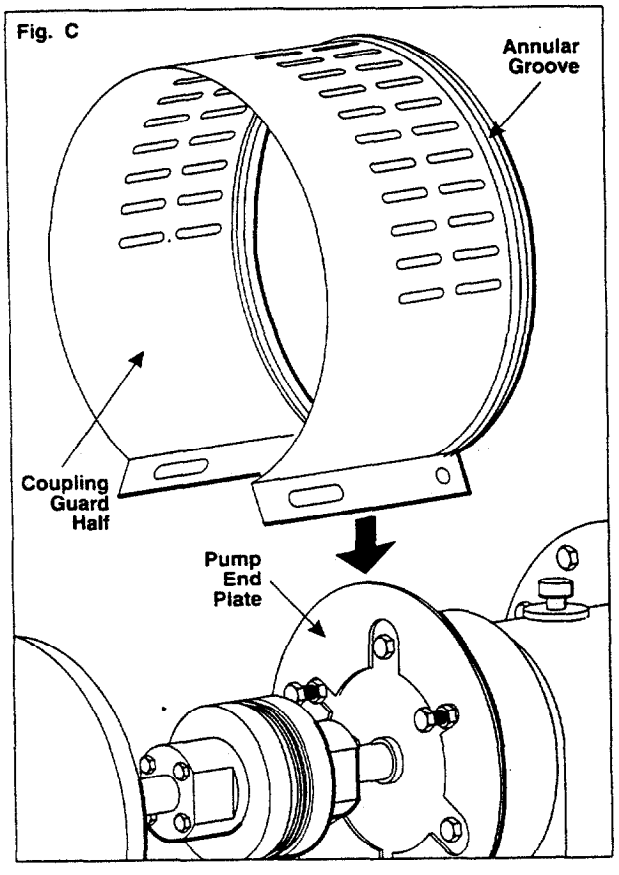
NOTE: Coupling adjustments should be completed before proceeding with coupling guard assembly.



7

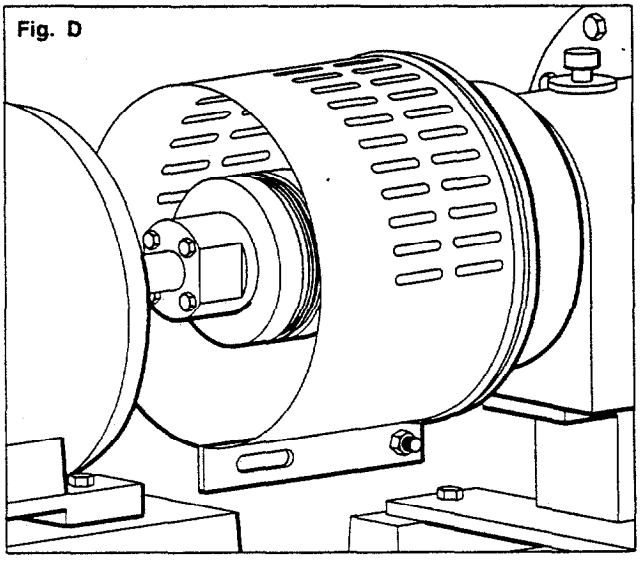
2. Spread bottom of coupling guard half (pump end) slightly and place over pump end plate as shown in Fig. C. The annular groove in the guard half is located around the end plate. See detail drawing, Fig. E.

Fig. C

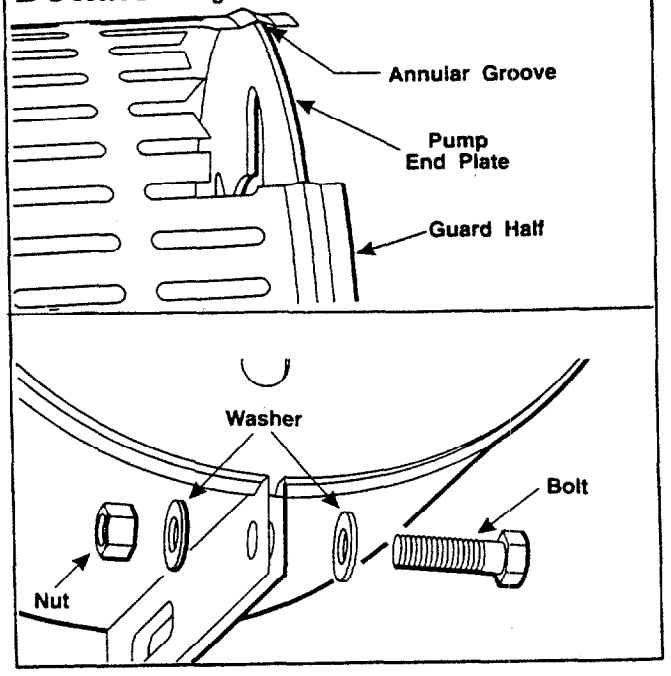


3. After the coupling guard half (pump end) is located around the end plate, secure it with a bolt, nut and two (2) washers through the round hole at the front end of the guard half as shown in Fig. D. Tighten securely. See detail drawing, Fig. E.

Fig. D

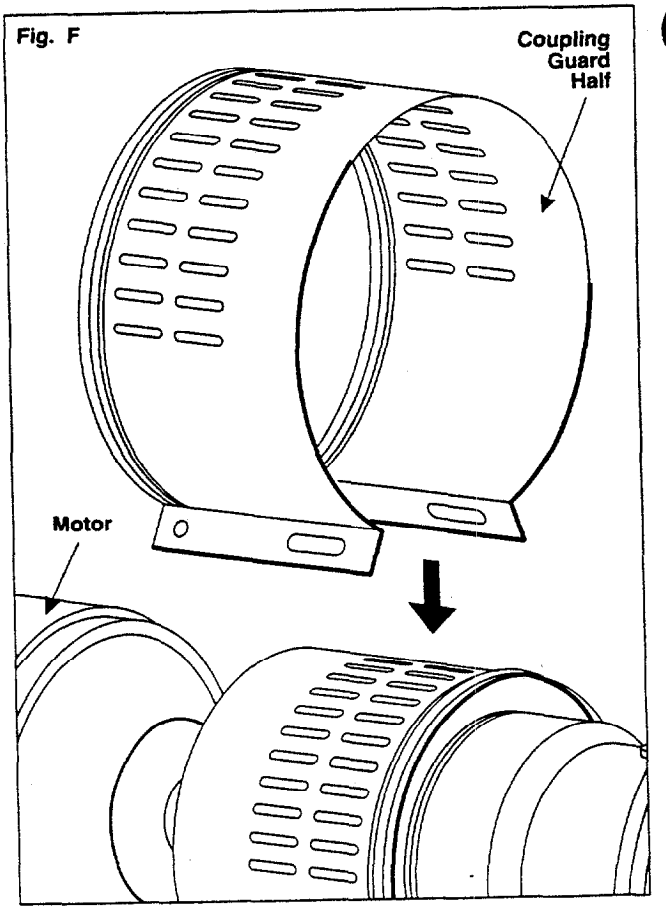


Details: Fig. E



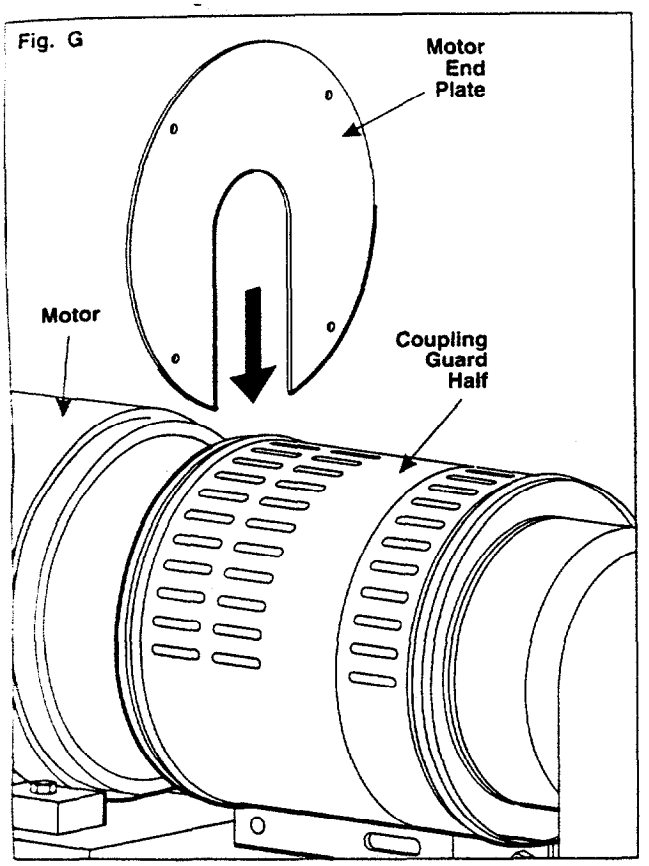
4. Spread bottom of coupling guard half (driver end) slightly and place over coupling guard half (pump end) so that annular groove in coupling guard half (driver end) faces the motor as shown in Fig. F.

Fig. F



5. Place end plate (driver end) over motor shaft as shown in Fig. G. Locate the end plate in the annular groove at the rear of the coupling guard half (driver end) and secure with a bolt, nut, and two (2) washers through the round hole at the rear of the guard half. Finger tighten only.

Fig. G

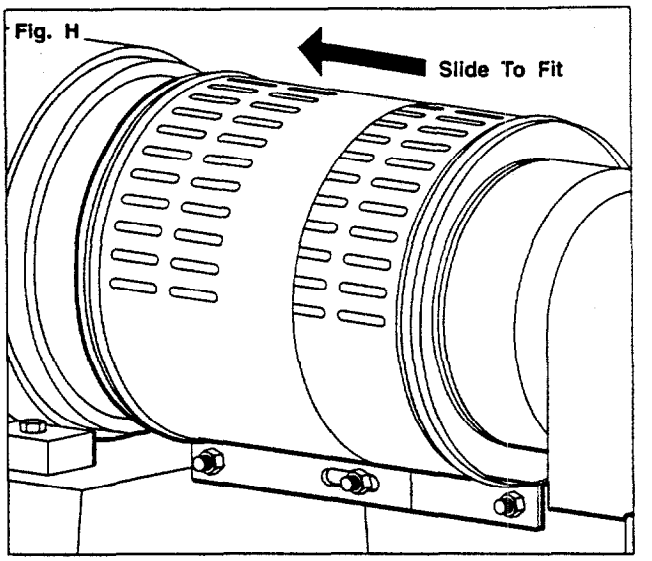


6. Adjust length of coupling guard to completely cover shafts and coupling as shown in Fig. H by sliding coupling guard half (driver end) towards motor. After adjusting guard length, secure with bolt, nut and two (2) washers through the slotted holes at the center of the guard and tighten. Check all nuts on the guard assembly for tightness.

⚠ WARNING

Before assembly or disassembly of the coupling guard is performed the motor must be de-energized, the motor controller/starter put in a locked-out position and a caution tag placed at the starter indicating the disconnect. Replace coupling guard before resuming normal operation if the pump. Goulds Pumps, Inc. assumes no liability for avoiding this practice.

Fig. H



Disassembly

The coupling guard must be removed for certain maintenance and adjustments to the pump, such as adjustment of the coupling, impeller clearance adjustment, etc. The coupling guard should be replaced after maintenance is completed.

DO NOT resume normal pump operation with the coupling guard removed.

NOTE: Refer to illustrations for assembly in reverse order.

1. Remove nut, bolt, and washers from center slotted hole in the coupling guard. Slide motor end coupling guard half towards pump. Fig. H.
2. Remove nut, bolt, and washers from coupling guard half (driver end), and remove end plate. Fig. G.
3. Spread bottom of coupling guard half slightly and lift off. Fig. F.
4. Remove remaining nut, bolt, and washers from coupling guard half (pump end). Spread bottom of coupling guard half slightly and lift off. Fig. C.

This completes disassembly of the coupling guard.

NOTE: It is not necessary to remove the end plate (pump end) from the pump bearing housing. The bearing housing tap bolts are accessible without removing the end plate in case maintenance of internal pump parts is necessary. Before removing the pump bearing housing, refer to the Goulds operations and maintenance manual for your particular pump.

APPENDIX III

MODEL 3196 RECOMMENDED MINIMUM FLOW (GPM @ MAXIMUM DIAMETER)

Size	2 Pole 60 Hz 3560 RPM	2 Pole 50 Hz 2900 RPM	4 Pole 60 Hz 1780 RPM	4 Pole 50 Hz 1470 RPM	6 Pole 60 Hz 1180 RPM	6 Pole 50 Hz 960 RPM	8 Pole 60 Hz 885 RPM
1 x 1½ - 6 STX	10	5	3	1			
1½ x 3 - 6 STX	20	9	5	2			
2 x 3 - 6 STX	40	26	9	3			
1 x 1½ - 8 STX	20	13	5	2			
1½ x 3 - 8 STX	40	23	6	2			
3 x 4 - 7 MTX	125	77	13	4			
2 x 3 - 8 MTX	60	35	9	4			
3 x 4 - 8 MTX	N/A	181	100	31	17		
3 x 4 - 8G MTX	190	104	26	11			
1 x 2 - 10 MTX	40	22	5	3	3		
1½ x 3 - 10 MTX	80	56	14	6	5		
2 x 3 - 10 MTX	200	73	19	6	3		
3 x 4 - 10 MTX	200	181	50	20	12		
3 x 4 - 10H MTX	N/A	N/A	150	76	30	11	
4 x 6 - 10 MTX	N/A	N/A	450	117	79	24	
4 x 6 - 10H MTX	N/A	N/A	400	153	85	46	
1½ x 3 - 13 MTX/LTC	180	106	45	23	11		
2 x 3 - 13 MTX/LTC	240	171	63	37	18		
3 x 4 - 13 MTX/LTC	400	333	168	104	67	31	
4 x 6 - 13 MTX	N/A	N/A	370	297	150	89	
6 x 8 - 13 XLT-X	N/A	N/A	850	480	375	197	
8 x 10 - 13 XLT-X	N/A	N/A	1200	977	570	383	
6 x 8 - 15 XLT-X	N/A	N/A	1000	726	462	277	
8 x 10 - 15 XLT-X	N/A	N/A	N/A	1400	1000	770	522
8 x 10 - 15G XLT-X	N/A	N/A	1400	1375	847	604	511
4 x 6 - 17 XLT-X	N/A	N/A	900	530	351	214	
6 x 8 - 17 XLT-X	N/A	N/A	1400	1136	778	519	
8 x 10 - 17 XLT-X	N/A	N/A	2150	1598	1148	702	676

GOULDS PUMPS, INC.
INDUSTRIAL PRODUCTS GROUP
Seneca Falls, New York 13148

Form No. EPD-166 Rev. 1/94

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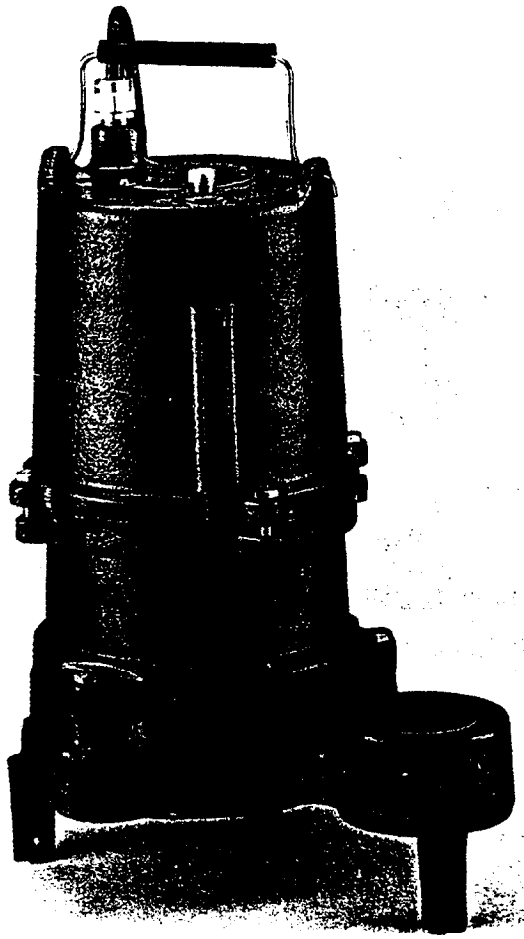
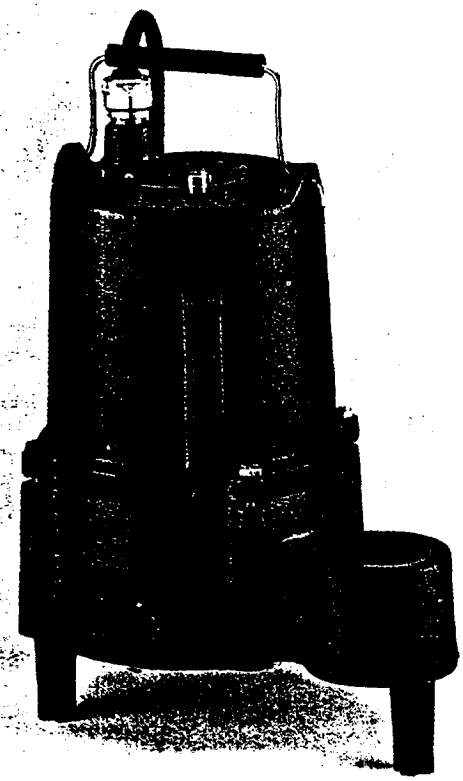
HYDROMATIC™ SHEF50/100
Submersible High Head Effluent Pumps



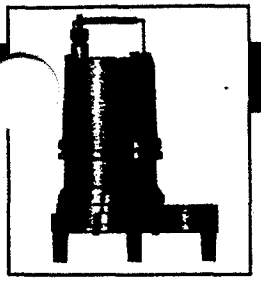
Applications:
- **Septic Tank Effluent**
- **High Head Sump**
- **Dewatering**



SHEF100 Features:
- 1 HP
- 208-230 voltage (1Ø)
  208-230/460, 575 voltage (3Ø)
- 2" Discharge
- 3/4" solids handling
- Capacities to 88 GPM
- Heads to 90 Feet
- Automatic or Manual Models

SHEF50 Features:
- 1/2 HP
- 115/208-230 dual voltage (1Ø)
  208-230/460, 575 voltage (3Ø)
- 2" Discharge
- 3/4" solids handling
- Capacities to 63 GPM.
- Heads to 63 Feet
- Automatic or Manual Models

AURORA PUMP
A UNIT OF GENERAL SIGNAL



SHEF50/100 SUBMERSIBLE EFFLUENT PUMPS

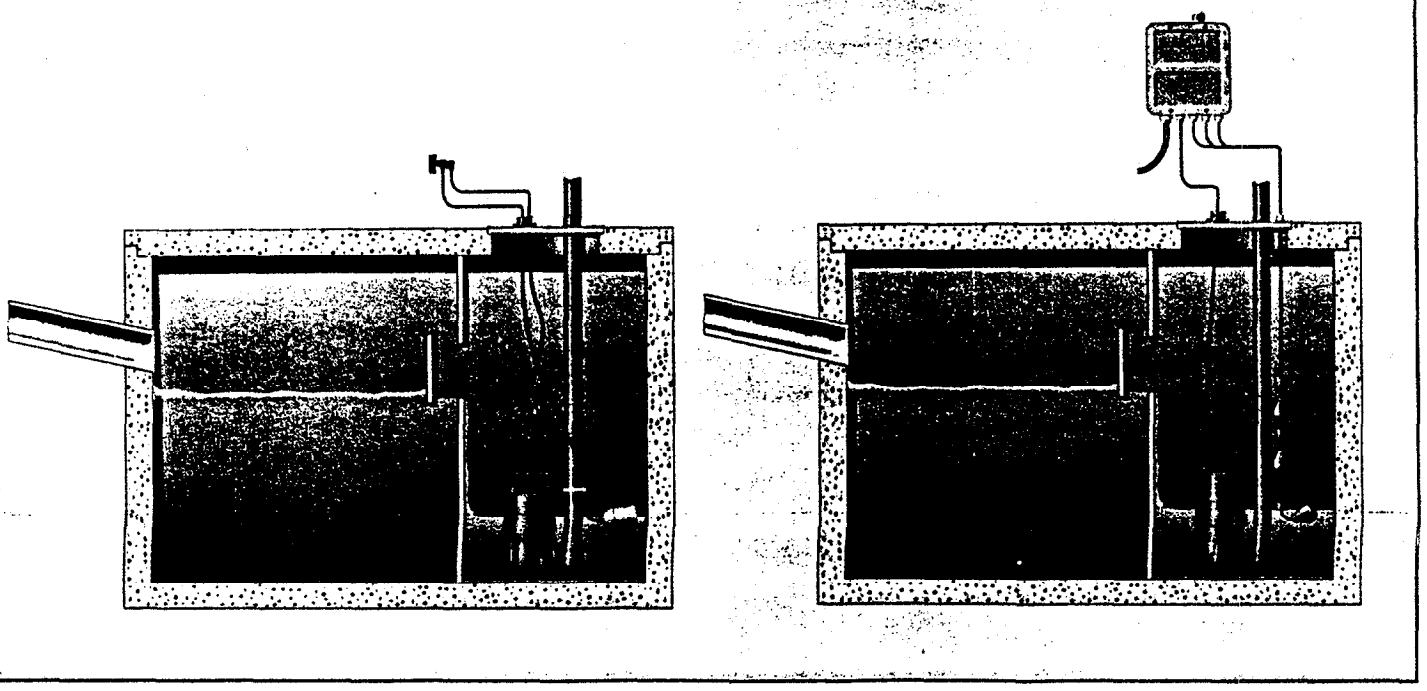
The Hydromatic SHEF50/100 submersible pumps are specifically designed to meet the demands of residential high head septic tank effluent or sump applications. The 2 inch NPT discharge pumps feature an energy-efficient 1/2 or 1 horsepower motor, automatic and manual versions, and a wide variety of voltages including dual voltage 208-230 volt single and three phase. The SHEF50 can handle capacities up to 63 gallons per minute and heads to 63 feet. The SHEF100 can handle capacities up to 88 gallons per minute and heads to 90 feet.

The SHEF50/100 features a heavy-duty cast iron construction that provides durability for a long service life, as well as dissipating heat from the motor for cooler operation. All fasteners are stainless steel for corrosion resistance. The pump's semi-open, non-clog design impeller passes 3/4" (spherical) solids and is made from a super tough engineered plastic that provides the highest level of corrosion resistance and the toughness to withstand the impact of solid materials. The impeller, molded to a bronze insert, also features pump-out vanes to preclude material from building up around the shaft and seal. The pump's unique (patent pending) non-clog design baseplate has an electrostatically applied polyester coating for corrosion resistance and provides a strainer-free inlet capable of passing two (2), 3/4" (spherical) solids simultaneously. The inlet area is raised off the bottom of the septic tank or sump basin by the pump's 2" high legs constructed of Engineered Thermoplastic material for maximum corrosion resistance.

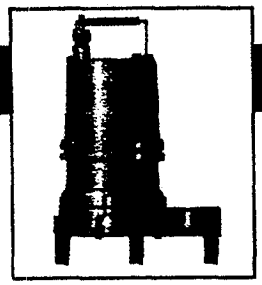
The SHEF50/100's oil filled motor provides superior cooling characteristics, allowing the motor to run cool and quiet. The oil filled design also provides permanent lubrication of the shaft bearings, minimizing maintenance and extending the service life of the pump. The oil filled motor design allows for even heat dissipation. On single phase models the windings feature a built-in thermal overload that resets automatically.

Automatic models feature an easily adjustable wide-angle float switch, incorporating a unique piggyback plug arrangement. This plug allows for simple conversion to manual operation by simply removing the switch plug and inserting the pump's motor plug into the electrical outlet. This feature provides an easy way of periodically cycling the pump to ensure it is operating properly.

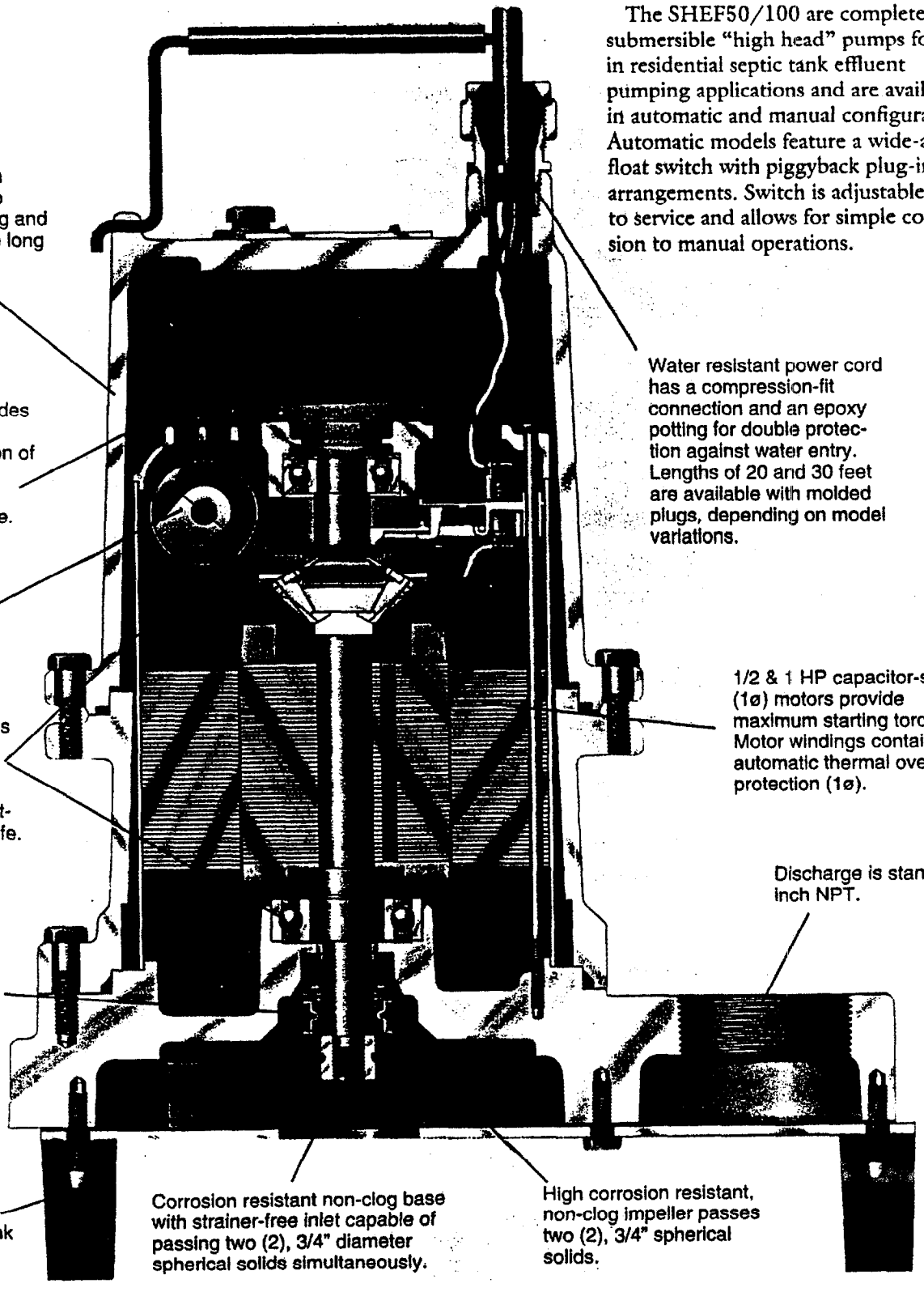
SHEF50/100 TYPICAL INSTALLATION



FEATURES/BENEFITS



The SHEF50/100 are completely submersible "high head" pumps for use in residential septic tank effluent pumping applications and are available in automatic and manual configuration. Automatic models feature a wide-angle float switch with piggyback plug-in arrangements. Switch is adjustable, easy to service and allows for simple conversion to manual operations.



High quality cast iron construction of pump volute, motor housing and seal housing provide long life.

Oil-filled motor provides superior cooling and permanent lubrication of bearings minimizing maintenance and extending service life.

Start Capacitor 1ø models only.

Upper radial- and lower thrust-bearings are heavy-duty, single-row ball bearings that are permanently lubricated for service-free life.

Mechanical shaft seal is carbon and ceramic-faced for long leakproof life.

2" High corrosion resistant legs raise pump's inlet from bottom of septic tank pump chamber.

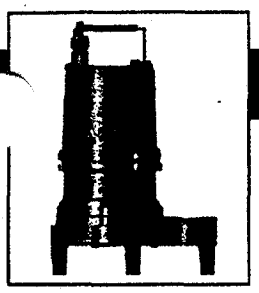
Corrosion resistant non-clog base with strainer-free inlet capable of passing two (2), 3/4" diameter spherical solids simultaneously.

High corrosion resistant, non-clog impeller passes two (2), 3/4" spherical solids.

Water resistant power cord has a compression-fit connection and an epoxy potting for double protection against water entry. Lengths of 20 and 30 feet are available with molded plugs, depending on model variations.

1/2 & 1 HP capacitor-start (1ø) motors provide maximum starting torque. Motor windings contain automatic thermal overload protection (1ø).

Discharge is standard 2 inch NPT.



ENGINEERING DETAILS - SHEF50/100

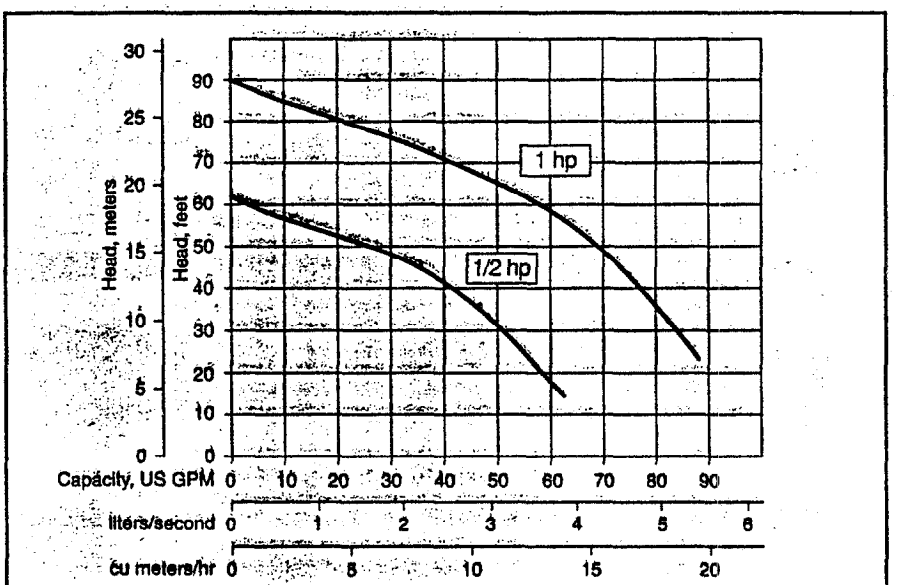
Pump Characteristics

Pump/Motor Unit	Submersible				
Manual Models (50)	M1	M2	M3	M4	M5
Automatic Models	A1	A2	-	-	-
Horsepower	1/2				
Full Load Amps	14.5	7.6/7.1	3.2/3.1	1.6	1.2
Motor Type	Capacitor Start		3 Ø		
R.P.M.	3450				
Phase	1 Ø		3 Ø		
Voltage	115	208-230	208-230	460	575
Manual Model (100)		M2	M3	M4	M5
Automatic Models		A2	-	-	-
Horsepower	1				
Full Load Amps		13.0/11.5	6.0/5.8	2.8	1.9
Motor Type	Capacitor Start		3 Ø		
RPM	3450				
Phase	1 Ø		3 Ø		
Voltage		208-230	208-230	460	575
Hertz	60				
Temperature	140° F Max Fluid Temp.				
NEMA Design	L		B		
Insulation	Class B				
Discharge Size	2" NPT Std.				
Solids Handling	3/4"				
Unit Weight	58 lbs. (50)		65 lbs. (100)		
Power Cord	115V, 14/3, SJTW-A; 230V, 1o, 16/3 SJTW-A; 3o, 16/4, STW-A, All cords 20' std. with 30' opt.				

Materials of Construction

Handle	Stainless Steel
Lubricating Oil	Dielectric Oil
Motor Housing	Cast Iron
Pump Casing	Cast Iron
Shaft	Stainless Steel
Mechanical Shaft Seal	Seal Faces: Carbon/Ceramic Seal Body: Brass Spring: Stainless Steel Bellows: Buna-N
Impeller	Engineered Thermoplastic
Upper Bearing	Single Row Ball Bearing
Lower Bearing	Single Row Ball Bearing
Bottom Plate	Polyester Coated Steel
Fasteners	Stainless Steel
Legs	Engineered Thermoplastic

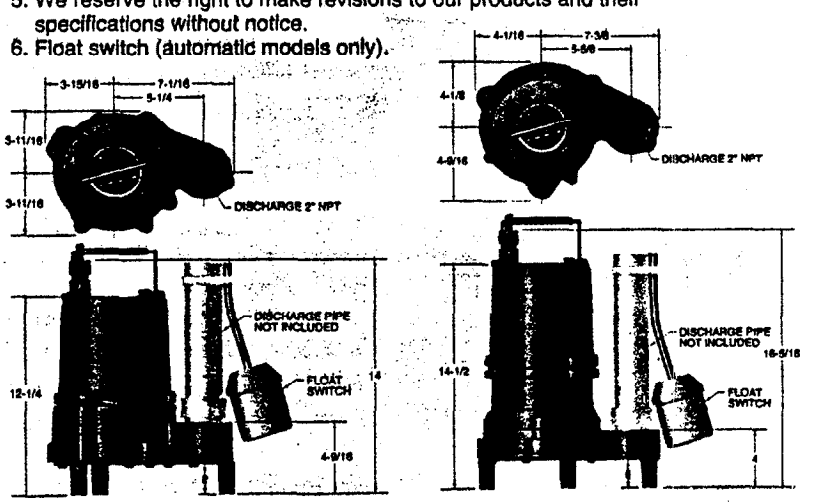
Performance Data



Total Head (feet)	13	22	40	50	55	63	70	80	90
GPM 1/2 HP	63	57	41	27	13	0	—	—	—
1 HP	—	88	77	68	63	55	42	22	0

Dimensional Data

1. All dimensions in inches.
2. Component dimensions may vary +/- 1/8 inch.
3. Not for construction purposes unless certified.
4. Dimensions and weights are approximate.
5. We reserve the right to make revisions to our products and their specifications without notice.
6. Float switch (automatic models only).



AURORA/HYDROMATIC Pumps, Inc.
1840 Baney Road, Ashland, Ohio 44805 (419)289-3042

Full or Part Circle Rotor Pop-up Sprinklers

R-70 FC/PC

Primary Application

Closed-case rotor for athletic fields, parks and large turf areas. Optimal water distribution makes the R-70 rotor ideal for use in windy applications.

Features

- Easy arc adjustment: 15° to 355° (R-70 PC)
- Powerful, water-lubricated piston drive
- Heavy-duty, industrial-grade plastic case
- Full and part circle models
- Standard, black rubber covered, interchangeable nozzles or optional purple rubber covered, interchangeable nozzles
- Superior close-in watering
- Small exposed diameter: 1 ½" (3,8 cm)
- Tall pop-up height: 3 ¼" (8,2 cm)
- Multi-function wiper seal
- Heavy-duty, stainless steel retract spring
- Unique zero-loss SAM check valve holds up to 15' (4,6 m) of elevation change
- Adjustable radius
- Constant rotation speed not affected by flow changes or pressure fluctuations
- Self-cleaning drive mechanism
- Low pressure loss through drive mechanism (maximum 5 psi; 0,3 Bars)
- Distance control diffuser screw

Operating Range

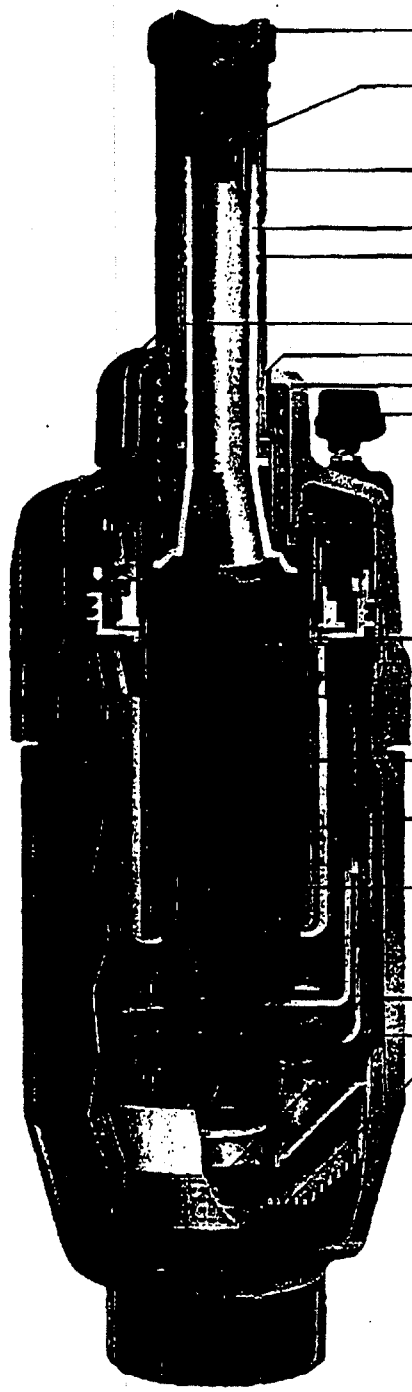
- Precipitation Rate: .53 to 1.00 inches per hour (13 to 25 mm/h) at 180°
- Spacing: 49 to 92 feet (14,9 to 28,2 m)
- Radius: 49 to 77 feet (14,9 to 23,5 m)
- Pressure: 40 to 100 psi (3 to 7 Bars)

Specifications

- 1" (26/34) female NPT or BSP threaded inlet
- SAM check valve holds up to 15' (4,6 m) of head
- Nozzle outlet trajectory is 23°
- Nozzles: 9-orange; 12-beige; 15-white; 18-blue; 21-red; 23-yellow

Dimensions

- Overall height: 11" (27,9 cm)
- Exposed top diameter: 1 ½" (3,8 cm)



Models

- R-70 FC: Full circle*
- R-70 PC: Part circle*

*Available in BSP models.

R-70 Nozzles

Nozzle	Color	Nozzle	Color
9	Orange	18	Blue
12	Beige	21	Red
15	White	23	Yellow

Changing to R-70 Rain Curtain Nozzles

Currently Using	Suggested Rain Curtain Replacement
10 - Brown	Falcon Rotor
13 - Red	9 - Orange or 12 - Beige*
14 - Orange	9 - Orange or 12 - Beige*
18 - Black	18 - Blue
20 - Yellow	18 - Blue or 21 - Red
22 - Green	21 - Red or 23 - Yellow

*See radius and flow data

RAIN BIRD

R-70 RUBBER COLLAR

Primary Application

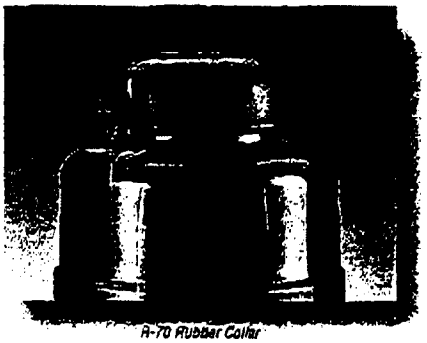
Protects from injury and damage for high-traffic applications.

Features

- *Durable, high-quality rubber collar for converting standard R-70 into rubber-covered R-70-RC*
- *Easy to Install*
- *Add RC suffix for rubber collar*

Model

- *R-70 Rubber Collar*



R-70 Rubber Collar

R-70 FC/R-70 PC
Performance

Pressure P.S.I	Nozzle	Radius ft.	Flow GPM	*Precip.■ in/h	*Precip.▲ in/h
40	9	49	8.2	0.66	0.53
	12	53	9.7	0.67	0.53
	15	55	11.9	0.76	0.61
	18	55	13.7	0.87	0.70
	21	-	-	-	-
	23	-	-	-	-
50	9	51	9.1	0.67	0.54
	12	56	10.9	0.67	0.54
	15	58	13.5	0.77	0.62
	18	58	15.5	0.89	0.71
	21	-	-	-	-
	23	-	-	-	-
60	9	52	9.9	0.71	0.57
	12	59	12.1	0.67	0.54
	15	61	14.9	0.77	0.62
	18	61	17.2	0.89	0.71
	21	61	18.4	0.95	0.76
	23	68	22.9	0.95	0.76
70	9	52	10.8	0.77	0.62
	12	59	13.2	0.73	0.59
	15	62	16.2	0.81	0.65
	18	62	18.7	0.94	0.75
	21	62	20.0	1.00	0.80
	23	71	24.9	0.85	0.76
80	9	52	11.6	0.83	0.66
	12	60	14.2	0.76	0.61
	15	63	17.5	0.85	0.68
	18	64	20.2	0.95	0.76
	21	65	21.5	0.98	0.79
	23	75	26.7	0.91	0.73
90	9	-	-	-	-
	12	60	15.1	0.81	0.65
	15	63	18.6	0.90	0.72
	18	66	21.5	0.95	0.76
	21	67	22.9	0.98	0.79
	23	76	29.1	0.97	0.78
100	9	-	-	-	-
	12	-	-	-	-
	15	64	19.7	0.93	0.74
	18	67	22.9	0.98	0.76
	21	69	24.3	0.98	0.79
	23	77	29.9	0.97	0.78

Performance data derived from tests that conform with ASAE Standards: ASAE S398.1. See page 6 for complete ASAE Test Certification Statement.

R-70 FC/R-70 PC METRIC
Performance

Pressure Bars	Nozzle	Radius m	Flow m³/h	Flow l/s	Precip.■ mm/h	Precip.▲ mm/h
3,0	9	14,9	1,86	0,52	17	13
	12	16,2	2,20	0,61	17	13
	15	16,8	2,70	0,75	19	15
	18	16,8	3,11	0,86	22	18
	21	-	-	-	-	-
	23	-	-	-	-	-
3,5	9	15,5	2,07	0,57	17	14
	12	17,1	2,48	0,69	17	14
	15	17,7	3,07	0,85	20	16
	18	17,7	3,52	0,98	23	18
	21	-	-	-	-	-
	23	-	-	-	-	-
4,0	9	15,9	2,25	0,62	18	14
	12	18,0	2,76	0,76	17	14
	15	18,6	3,38	0,94	20	16
	18	18,6	3,91	1,09	23	18
	21	18,6	4,18	1,16	24	19
	23	20,7	5,20	1,44	24	19
5,0	9	15,9	2,45	0,68	20	16
	12	18,0	3,00	0,83	19	15
	15	18,9	3,68	1,02	21	17
	18	18,9	4,25	1,18	24	19
	21	18,9	4,54	1,26	25	20
	23	21,6	5,65	1,57	24	19
5,5	9	15,8	2,63	0,73	21	17
	12	18,3	3,22	0,90	19	15
	15	19,2	3,97	1,10	22	17
	18	19,5	4,59	1,27	24	19
	21	19,8	4,88	1,36	25	20
	23	22,9	6,06	1,68	23	19
6,0	9	-	-	-	-	-
	12	18,3	3,43	0,95	21	16
	15	19,2	4,22	1,17	23	18
	18	20,1	4,88	1,36	24	19
	21	20,4	5,20	1,44	25	20
	23	23,2	6,81	1,84	25	20
7,0	9	-	-	-	-	-
	12	-	-	-	-	-
	15	19,5	4,47	1,24	24	19
	18	20,4	5,18	1,44	25	20
	21	21,0	5,52	1,53	25	20
	23	23,5	6,79	1,89	25	20

*Precipitation rates are based on half circle operation
■ Square spacing based on 50% diameter of throw.
▲ Triangular spacing based on 60% diameter of throw

R-70 NON-POTABLE NOZZLE

Primary Application

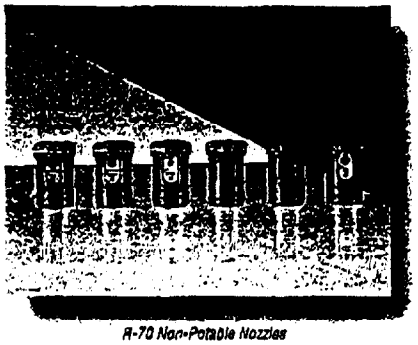
Purple rubber cover for non-potable water applications.

Features

- *Purple rubber cover with non-potable logo*
- *Easily retrofits any R-70*
- *Recommended for reclaimed water installations*
- *Specify as NP*

Model

- *R-70 NP Nozzle*



R-70 Non-Potable Nozzles

How To Specify:

R-70 PC-21-NP-RC

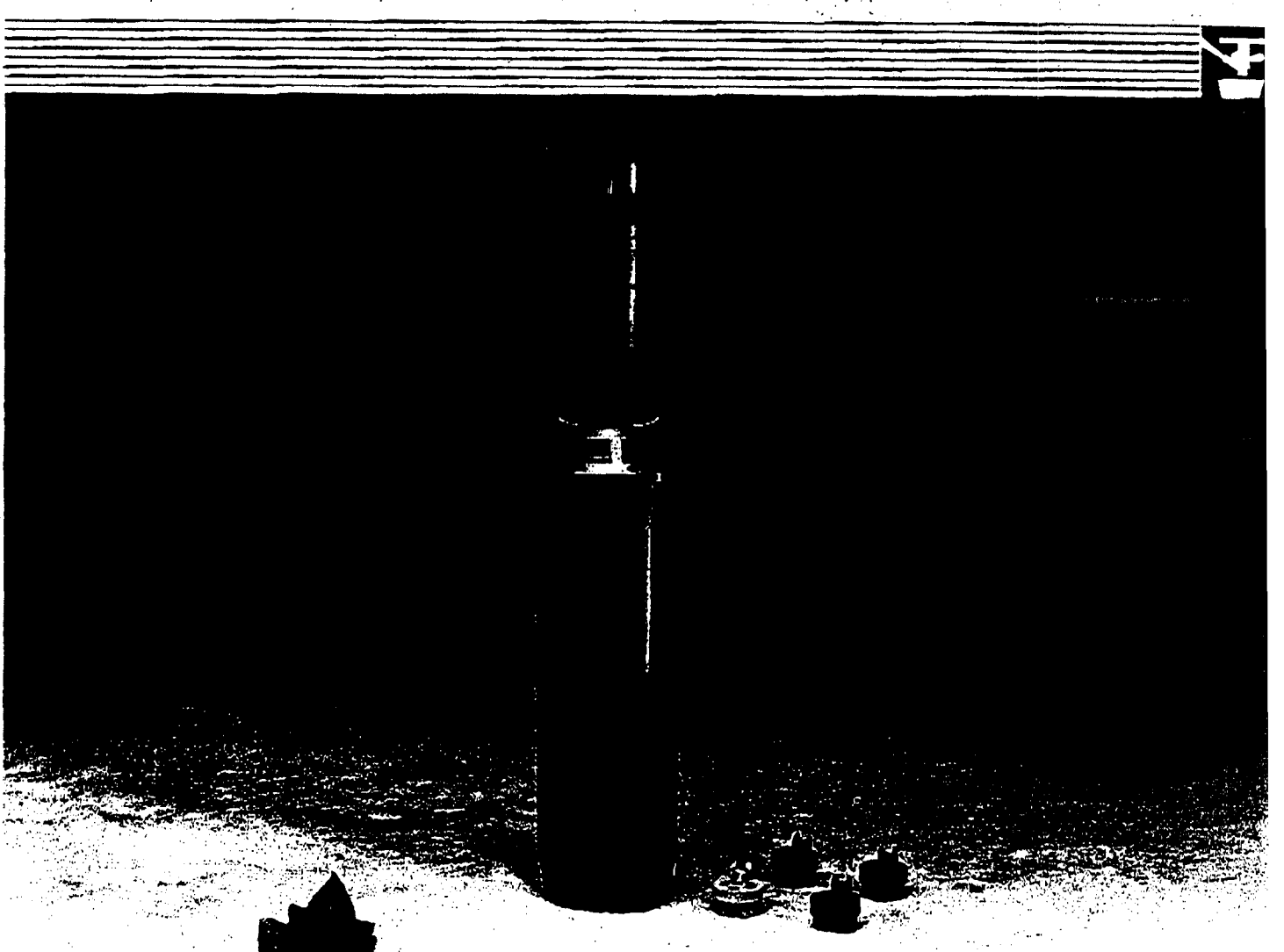
Model | Arc | Nozzle Size | Optional Features

This specifies an R-70 pop-up rotor; part circle; size 20 nozzle; optional non-potable nozzle cover; optional rubber collar.
Note: For non-U.S. applications it is necessary to specify NPT or BSP thread type.

T E C H · S P E C S

PROFESSIONAL SERIES

Falcon™ Rotor



Uncompromising Performance.

With the Falcon rotor you can have it all! Superior distribution. Reliability. And durability.

Rain Curtain™ nozzles assure maximum performance and coverage. A multi-function wiper seal keeps the stem clear of debris, providing long-term protection. Plus, heavy-duty construction makes the Falcon one of the toughest rotors in the field.

Available in full and part circle models, the versatile Falcon rotor is ideal for large turf sites such as parks, athletic fields and commercial applications.

The Falcon rotor from Rain Bird—preferred by professionals worldwide.

RAIN BIRD

FALCON™

TECH · SPECS

Falcon™ Rotor

Features

- Easy, wet or dry arc adjustment (part circle model): 40° to 360°
- Water-lubricated gear drive
- Standard rubber cover
- Seal-A-Matic™ (SAM) check device
- Full and part circle models
- Four color-coded Rain Curtain™ nozzles
- Purple rubber cover for non-potable applications (available third quarter 1993)
- Nozzles are interchangeable from the front
- Self-adjusting stator does not require replacement when changing nozzles
- Radius adjustment screw to decrease radius up to 25 percent
- Patented pressure-activated wiper seal
- 4" (10,2 cm) pop-up height

Operating Range

- Precipitation rate: .32 to .95 inches per hour (8,1 to 24,4 mm/h)
- Spacing: 38 to 74 feet (11,6 to 22,6 m)
- Radius: 38 to 62 feet (11,6 to 18,9 m)
- Pressure: 30 to 80 psi (2 to 5.5 Bars)
- Flow: 3 to 19 GPM (0,67 to 4,33 m³/h; 0,19 to 1,20 l/s)

Falcon Performance

Pressure psi	Nozzle	Radius ft.	Flow GPM
30	04	38	3.0
	08	40	5.3
	12	46	8.6
	16	50	11.1
40	04	40	3.5
	08	44	6.4
	12	50	10.2
	16	56	13.1
50	04	40	3.9
	08	44	7.4
	12	52	11.6
	16	58	14.8
60	04	40	4.4
	08	46	8.2
	12	54	12.8
	16	60	16.3
70	04	40	4.7
	08	46	8.9
	12	56	13.9
	16	62	17.8
80	04	42	5.1
	08	46	9.6
	12	56	14.9
	16	62	19.0

Falcon Performance METRIC

Pressure Bars	Nozzle	Radius m	Flow m³/h	Flow l/s
2,0	04	11,5	0,67	0,19
	08	12,0	1,19	0,33
	12	13,9	1,93	0,54
	16	15,1	2,49	0,69
2,5	04	12,1	0,76	0,21
	08	13,3	1,37	0,38
	12	14,9	2,20	0,61
	16	16,7	2,84	0,79
3,0	04	12,2	0,83	0,23
	08	13,4	1,55	0,43
	12	15,5	2,45	0,68
	16	17,4	3,14	0,87
3,5	04	12,2	0,90	0,25
	08	13,5	1,71	0,47
	12	15,9	2,68	0,74
	16	17,8	3,41	0,95
4,0	04	12,2	0,99	0,27
	08	14,0	1,84	0,51
	12	16,4	2,88	0,80
	16	18,2	3,66	1,02
4,5	04	12,2	1,04	0,29
	08	14,1	1,96	0,54
	12	16,9	3,06	0,85
	16	18,7	3,91	1,09
5,0	04	12,3	1,09	0,30
	08	14,0	2,08	0,58
	12	17,2	3,24	0,90
	16	19,0	4,15	1,15
5,5	04	12,9	1,17	0,33
	08	14,1	2,19	0,61
	12	17,0	3,40	0,94
	16	18,8	4,33	1,20

Performance data derived from tests that conform with ASAE Standards: ASAE S398.1. See 1993 Rain Bird Landscape Irrigation Products Catalog for complete ASAE Test Certification Statement.

Specifications

- 1" (26/34) female NPT or BSP threaded inlet
- SAM check device holds up to 10' (3,1 m) of head
- Nozzle outlet trajectory is 25°
- Rain Curtain nozzles: 04–black; 08–green; 12–beige; 16–brown

Dimensions

- Pop-up height: 4" (10,2 cm)
- Overall height (popped down): 8 ½" (21,6 cm)
- Exposed top diameter: 2" (5,1 cm)

Models

- Falcon FC: Full circle*
- Falcon PC: Part circle*

*Available in BSP model.

How to Specify

F4-PC-NP-16

Model	Rotation	Nozzle Size
F4: Falcon	PC: Part Circle	04 12
	FC: Full Circle	08 16

Optional Feature

NP: Purple rubber cover for non-potable applications (available third quarter 1993)

Recycled Paper.

Rain Bird. Conserving More Than Water.

RAIN BIRD.

Rain Bird Sales, Inc., Commercial Division, 2849 East Elvira Road, Tucson, AZ 85706 (602)741-6100
Rain Bird International, Inc., 145 North Grand Avenue, Glendora, CA 91740 (818)852-7100

038544

HERCULINE™ Liners and Covers

- Engineered
- Easy Installation
- Lower Job Cost

IN-LINE PLASTICS, INC.

In-Line Plastics, Inc. was established by industry leaders to provide a full range of polyethylene liner systems.

In-Line Plastics, Inc. employs personnel with decades of experience in custom-fabricating and installing polyethylene liners to any application or complexity. No challenge is too great! Call your In-Line representative today to discuss your requirements.

Geomembranes

- Co-Extruded and Mono-Layer, 6 mil.-100 mil.
- Smooth or textured.
- Only premium HDPE and LLDPE resins are used in liner manufacture. Excellent resistance to:
  - Chemicals
  - Environmental stress crack
  - Puncture & tear
  - Ultra-violet
- Stringent quality control of resin and liner during manufacture.
- Full Q.C. documentation provided.

Installation

- Experienced personnel.
- Hazardous Material trained.
- State-of-the-art seaming and testing equipment.
- Fully documented installation including:
  - Daily reports
  - Destructive and non-destructive seam test results.
  - As-built drawings.
- Committed to meet project schedules.

Pre-Fabrication

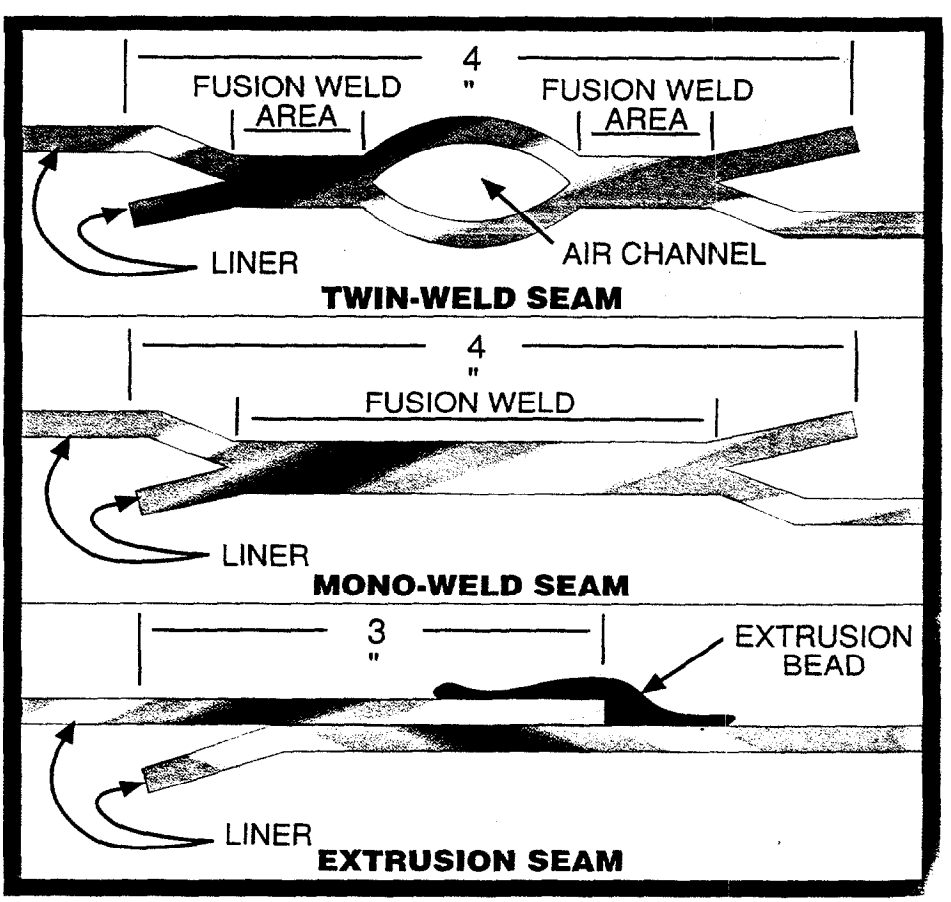
- to 3 day lead times.
- Engineered-to-fit.
- Sizes up to one acre.
- Cost effective.
- Self-installed.

Installed	Pre-Fabricated
Secondary Containment Systems	Remediation Liners and Covers
Tank Liners and Retrofits	Oilfield Liners
Lagoon Liners and Caps	Daily and Temporary Landfill Covers
Landfill Liners and Caps	Decontamination Pads
Pond Liners	Fish Pond Liners
Vapor Barriers	Cisterns and Tanks

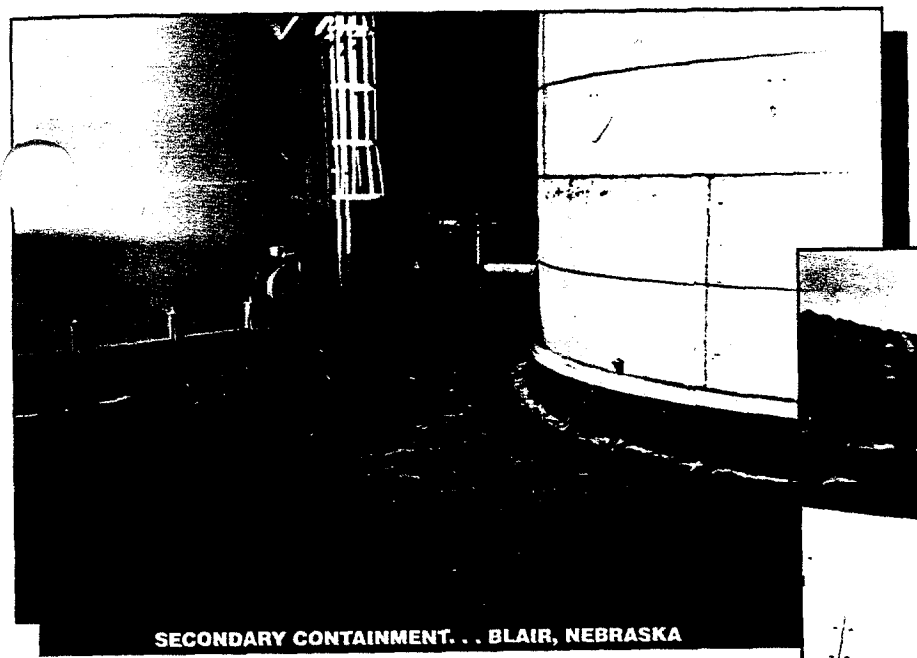
In-Line's Welding Processes

In-Line's wedge process produces continuously welded seams with total integrity and perfect closure between overlapping sections of Herculine™.

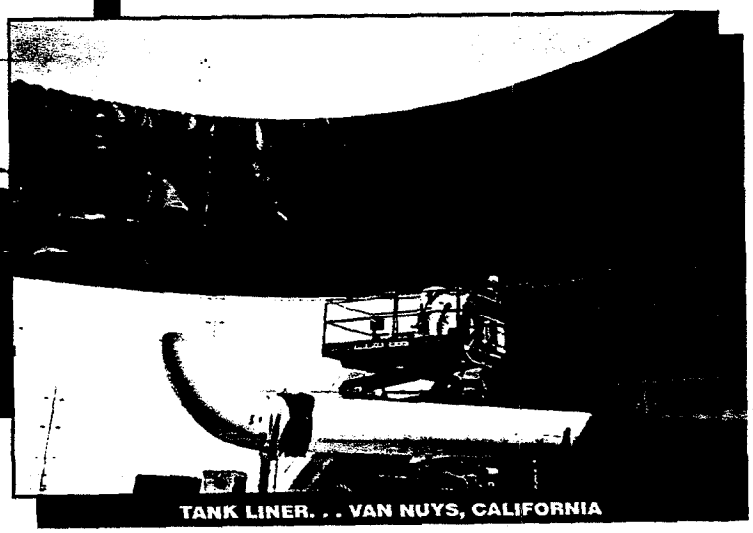
Use the twin-weld seam when pressure-testing of the joint is needed. Mono-welded joints are also available providing strength and reliability. For extrusion weld applications, use In-Line's welding rod, made of the same material as Herculine™, for total material compatibility and stronger welds.



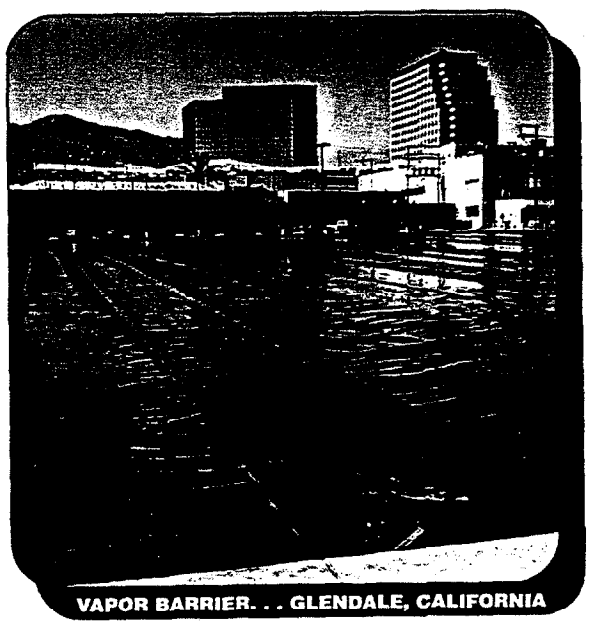
In-Line Projects



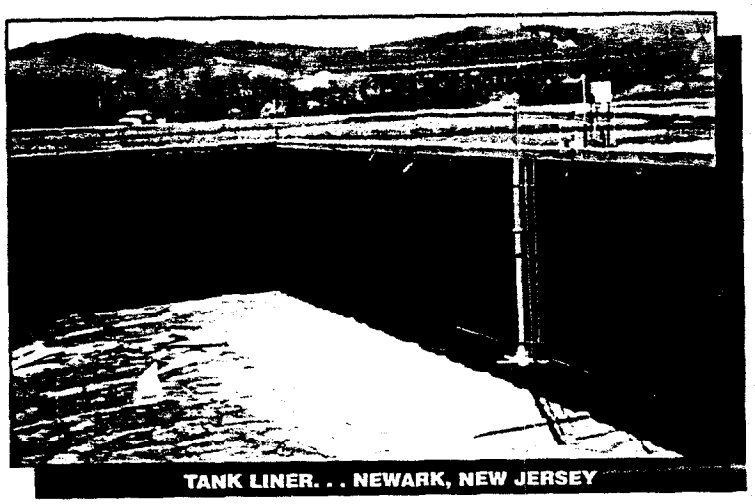
SECONDARY CONTAINMENT. . . BLAIR, NEBRASKA



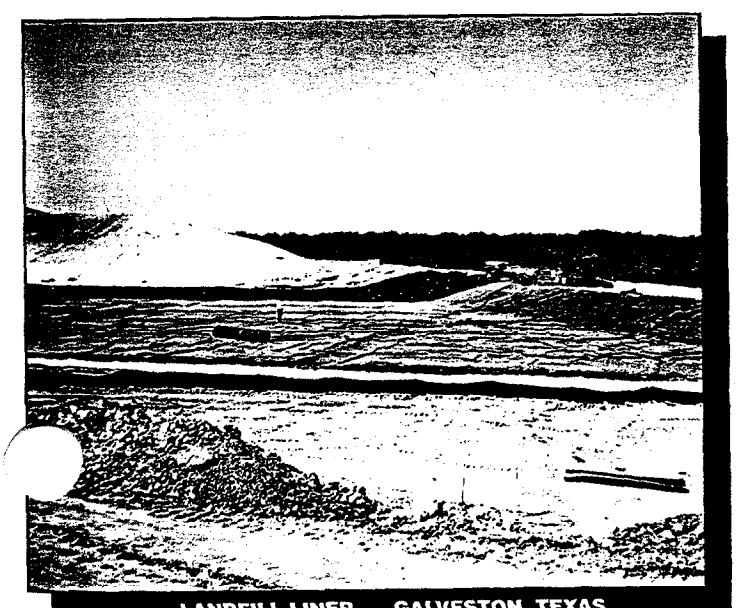
TANK LINER. . . VAN NUYS, CALIFORNIA



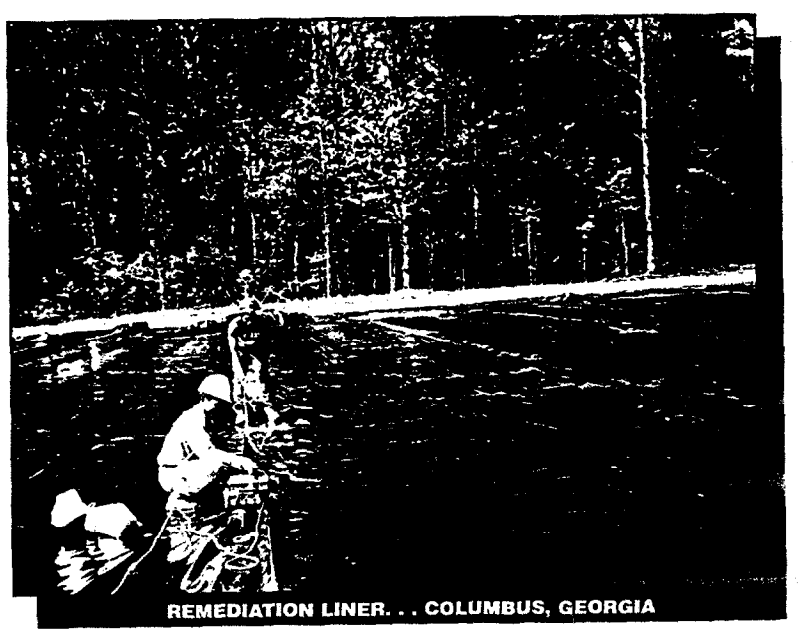
VAPOR BARRIER. . . GLENDALE, CALIFORNIA



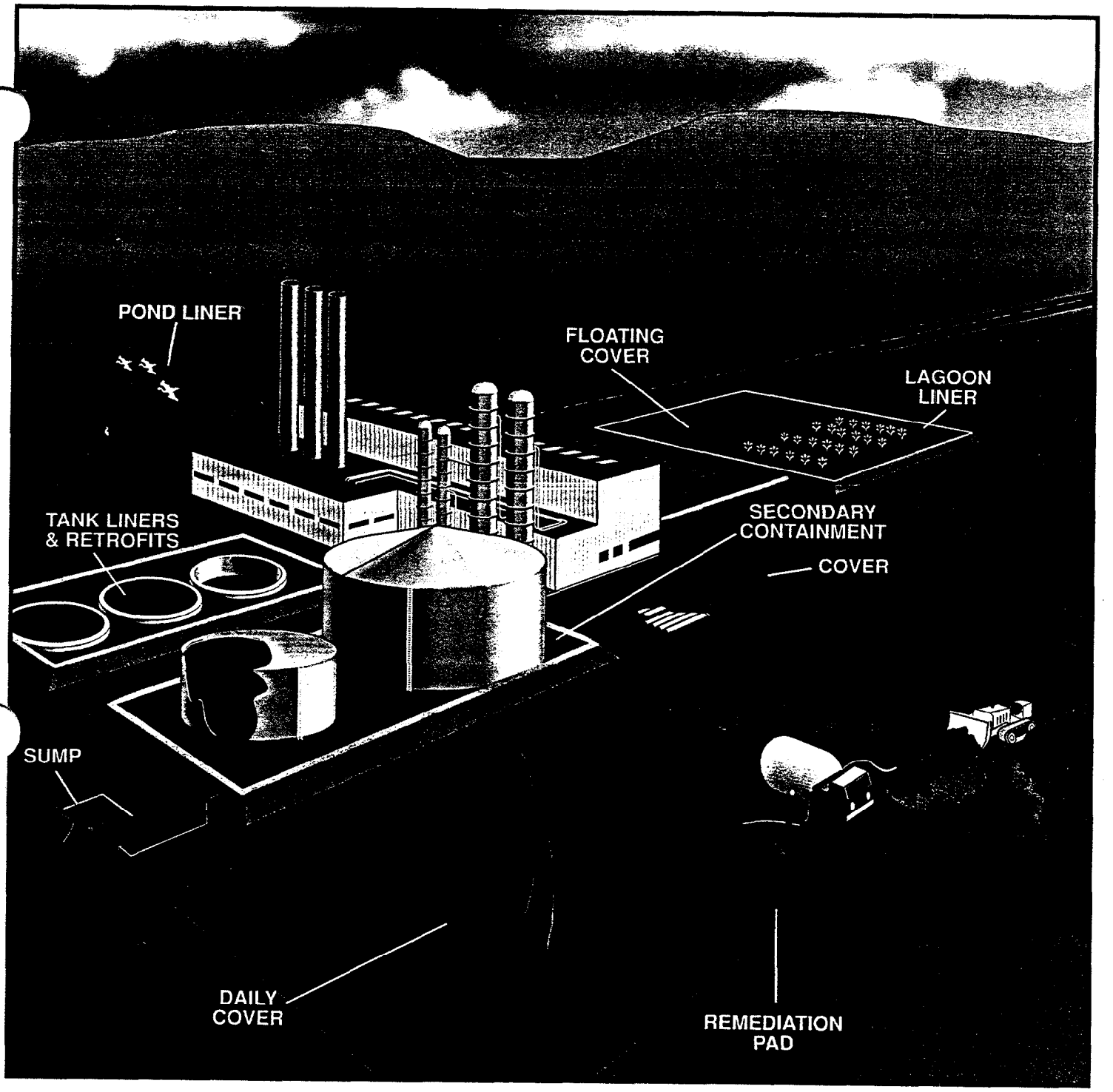
TANK LINER. . . NEWARK, NEW JERSEY



LANDFILL LINER. . . GALVESTON, TEXAS



REMEDIATION LINER. . . COLUMBUS, GEORGIA



IN-LINE PLASTICS, INC.

12247 FM 529 • Houston, Texas 77041
24-Hr. Hotline: 1-800-364-7688 • 713-849-5099
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SE HABLA ESPAÑOL

IN-LINE PLASTICS, INC.

HERCULINE SPECIFICATIONS

Premium Grade Lining Material

Herculine linear low density polyethylene is produced from high quality LLDPE resin. Herculine LLDPE has excellent chemical resistance, environmental stress crack resistance, dimensional stability, and thermal aging characteristics. Herculine LLDPE contains approximately 97.5% polymer and 2.5% carbon black, anti-oxidants and heat stabilizers and contains no additives, fillers or extenders.

PROPERTIES	TEST METHOD	MINIMUM AVERAGE ROLL VALUES			
Thickness, mils	ASTM D 751	20	30	40	60
Resin Density (g/cc)	ASTM D 1505	0.915	0.915	0.915	0.915
Melt Flow Index (g/10 minutes, max)	ASTM D1238	0.60	0.60	0.60	0.60
Tensile Properties	ASTM D638 (mod. per NSF 54)				
Tensile Strength at Yield (ppi)		32	48	64	96
Tensile Strength at Break (ppi)		85	127	170	255
Elongation at Break (percent)	2.0" Gauge Length	800	800	800	800
Elongation at Break (percent)	2.5" Gauge Length	640	640	640	640
Modulus of Elasticity (2% Secant) (psi)		30,000	30,000	30,000	30,000
Tear Strength (lbs)	ASTM D1004	11	16	22	33
Puncture Resistance (lbs)	FTMS 101 Method 2065	26	37	52	75
	ASTM D4833	34	51	68	102
Carbon Black Content (percent)	ASTM D 1603	2-3	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D 3015	A1,A2,B1	A1,A2,B1	A1,A2,B1	A1,A2,B1
Low Temperature Brittleness (°F)	ASTM D 746	<-94	<-94	<-94	<-94
Environmental Stress Crack (hrs, min.)	ASTM D1693 (10%, Igepal, 50°C)	2,000	2,000	2,000	2,000
Dimensional Stability (percent)	ASTM D 1204	±3	±3	±3	±3

Note: All values are minimum average roll except when shown as minimum or maximum. This data is provided for informational purposes only. In-Line Plastics makes no warranties as to the fitness for a specific use or merchantability of products referred to or to guarantee of satisfactory results from reliance upon contained information or recommendation and disclaims all liability for resulting loss or damage.

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IN-LINE PLASTICS, INC.

HERCULINE SPECIFICATIONS

Premium Grade Lining Material

Herculine high density polyethylene is produced from pipe grade virgin HDPE resin. Herculine HDPE has outstanding chemical resistance, mechanical properties, environmental stress crack resistance, dimensional stability and thermal aging characteristics. Herculine HDPE contains approximately 97.5% polymer and 2.5% carbon black, anti-oxidants and heat stabilizers, and contains no additives, fillers or extenders. Herculine HDPE has excellent UV resistance and is suitable for exposed conditions.

PROPERTIES	TEST METHOD	MINIMUM AVERAGE ROLL VALUES					
Thickness (mils)	ASTM D751	20	30	40	60	80	100
Density (g/cc) (Min.)	ASTM D1505	0.94	0.94	0.94	0.94	0.94	0.94
Melt Flow Index (g/10 minutes) (Max.)	ASTM D1238	0.3	0.3	0.3	0.3	0.3	0.3
Tensile Properties	ASTM D638 Type IV Dumbell, 2 ipm						
Tensile Strength at Break (lbs/in, width)		80	120	160	240	320	400
Tensile Strength at Yield (lbs/in, width)		45	70	95	140	190	240
Elongation at Break (percent), 2" gauge length		700	700	700	700	700	700
Elongation at Break (percent), 2.5" gauge length	(NSF 54 mod.)	560	560	560	560	560	560
Elongation at Yield (percent)		13	13	13	13	13	13
Modulus of Elasticity (psi)		80000	80000	80000	80000	80000	80000
Tear Resistance Initiation (lbs)	ASTM D1004 Die C	15	23	30	45	60	75
Puncture Resistance (lbs)	FTMS 101B Method 2031	88	110	175	220	350	440
	FTMS 101B Method 2065	26	40	52	80	105	130
	ASTM D4833	35	33	70	105	140	175
Carbon Black (percent)	ASTM D1603	2 to 3	2 to 3	2 to 3	2 to 3	2 to 3	2 to 3
Carbon Black Dispersion	ASTM D3015	A1,A2,B1	A1,A2,B1	A1,A2,B1	A1,A2,B1	A1,A2,B1	A1,A2,B1
Low Temperature Brittleness (°F)	ASTM D746 B	<-112	<-112	<-112	<-112	<-112	<-112
Dimensional Stability each Direction (% change max.)	ASTM D 1204 -212°F 1 hr.	± 2	± 2	± 2	± 2	± 2	± 2
Volatile Loss (max. percent)	ASTM D 1203 Meth. A	0.3	0.3	0.3	0.3	0.3	0.3
Resistance to Soil Burial (Max % change in original value)	ASTM D3083 using ASTM D638						
Tensile Strength at Break and Yield	Type IV Dumb-Bell	±10	±10	±10	±10	±10	±10
Elongation at Break and Yield	at 2 ipm	±10	±10	±10	±10	±10	±10
Ozone Resistance	ASTM D1149 7 days	No	No	No	No	No	No
	100 ppm 104°F	Cracks	Cracks	Cracks	Cracks	Cracks	Cracks
	104°F Magnification	7X	7X	7X	7X	7X	7X
Thermal Stability (% change)	ASTM D3895 130°C, 800 psi O_2	2000	2000	2000	2000	2000	2000
Environmental Stress Crack (min. hrs)	ASTM D1693 10% Igepal, 50°C	2000	2000	2000	2000	2000	2000
Water Absorption (max. % weight change)	ASTM D 570	0.1	0.1	0.1	0.1	0.1	0.1
Hydrostatic Resistance (psi)	ASTM D751 Method A Procedure 1	160	240	315	490	650	810
Coef. Linear Thermal Expansion 10^{-4}/°C ($\times 10^{-4}$ cm/cm°C) max.	ASTM D 696	2.0	2.0	2.0	2.0	2.0	2.0
Moisture Vapor Transmission (g/m^2day)	ASTM E 96	0.1	0.1	0.1	0.1	0.1	0.1

Note: All values are minimum average roll except when shown as minimum or maximum. This data is provided for informational purposes only. In-Line Plastics makes no warranties as to the fitness for a specific use or merchantability of products referred to, no guarantee of satisfactory results from reliance upon contained information or recommendation and disclaims all liability for resulting loss or damage.

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HERCUSHIELD 300

DATA SHEET

COUNT	Nominal 10 X 5 tapes/inch			
WEIGHT	4.2 oz per square yard (141 gsm) ± 10%			
TENSILE STRENGTH (Grab Method)	Warp -	135 lbs	ASTM D751 (Meth.A)	
	Weft -	95 lbs		
TEAR STRENGTH (Tongue Method)	Warp -	38 lbs	ASTM D751 (Meth.B)	
	Weft -	35 lbs		
MULLEN BURST	230 psi			

The above physical test results are representative data collected from a number of production runs. Results for an individual roll (based on at least three specimens) may vary from the average by ± 1%

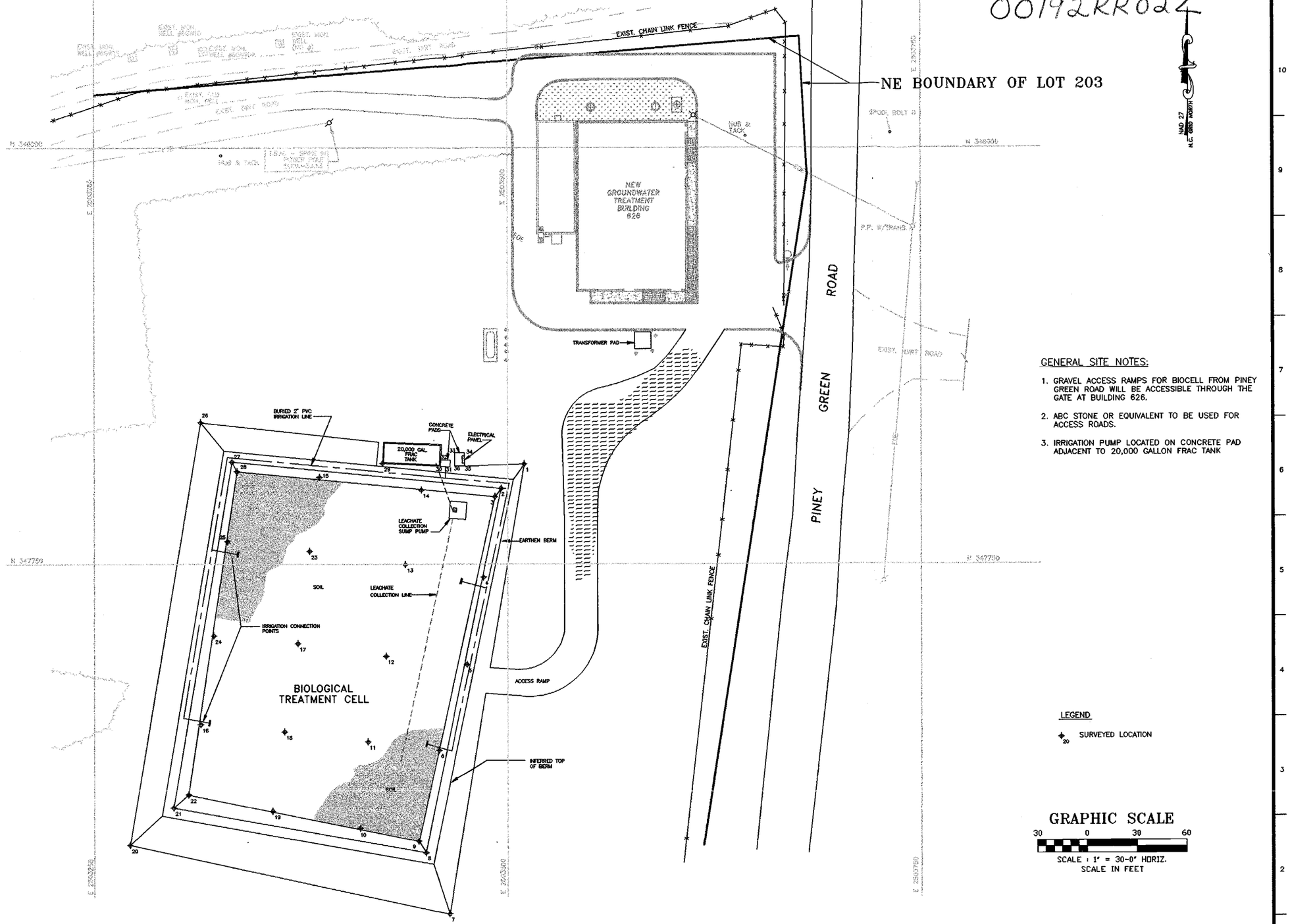
COATING THICKNESS	1.2 mil / 2.0 mil average 74 gsm average
SCRIM TYPE	Black tapes
COLOR	Black or colored coatings available as ordered
STANDARD ROLL	Single rolls with a nominal length of 1000 linear yards, on 4" I.D. core with the ends sewn closed. Actual lengths will depend on the best utilization of the input roll while eliminating coater splices. Due to the elongation of certain materials during winding, roll lengths will vary ± 1%.
MINIMUM RUNS	Special runs of standard colors - 17,000 lin yards Special runs of non-standard colors - 17,000 lin yards

Appendix B

As-Built Drawings

00192KK027

PT. NO.	NORTH	EAST	ELEV
1	347,810.10	2,503,509.91	29.7
2	347,795.45	2,503,496.15	35.1
3	347,790.48	2,503,492.32	31.8
5	347,689.59	2,503,475.39	32.4
6	347,637.85	2,503,458.27	33.0
7	347,539.27	2,503,464.71	28.5
8	347,576.37	2,503,450.16	35.4
9	347,583.31	2,503,445.87	34.5
10	347,591.18	2,503,410.64	33.7
11	347,643.10	2,503,415.27	32.7
12	347,694.61	2,503,426.24	31.5
13	347,749.73	2,503,437.83	30.9
14	347,794.44	2,503,447.49	31.1
15	347,802.16	2,503,386.23	31.4
16	347,757.63	2,503,380.20	31.4
17	347,702.22	2,503,373.16	31.8
18	347,649.18	2,503,364.95	32.7
19	347,601.41	2,503,357.78	34.2
20	347,580.99	2,503,5271.51	26.3
21	347,603.48	2,503,297.76	36.2
22	347,611.34	2,503,306.87	35.0
23	347,653.63	2,503,314.20	33.6
24	347,707.07	2,503,322.08	32.6
25	347,763.68	2,503,330.42	32.5
26	347,835.13	2,503,314.23	28.9
27	347,811.47	2,503,333.16	34.4
28	347,805.68	2,503,336.13	32.6
29	347,810.43	2,503,424.13	–
30	347,808.23	2,503,459.03	–
31	347,808.46	2,503,465.04	29.1
32	347,812.44	2,503,465.21	29.1
33	347,816.83	2,503,467.97	29.7
34	347,816.68	2,503,473.96	29.7
35	347,808.94	2,503,474.01	29.7
36	347,809.01	2,503,468.03	29.7



GENERAL SITE NOTES:

1. GRAVEL ACCESS RAMPS FOR BIOCELL FROM PINEY GREEN ROAD WILL BE ACCESSIBLE THROUGH THE GATE AT BUILDING 626.
2. ABC STONE OR EQUIVALENT TO BE USED FOR ACCESS ROADS.
3. IRRIGATION PUMP LOCATED ON CONCRETE PAD ADJACENT TO 20,000 GALLON FRAC TANK

LEGEND

20 SURVEYED LOCATION

GRAPHIC SCALE

30 0 30 60

SCALE : 1" = 30-0" HORIZ.
SCALE IN FEET

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED: _____ PROJECT MANAGER: _____ DATE: _____
APPROVED: _____ SR. PROJECT ENGINEER _____ DATE: _____
APPROVED: _____ DEPT. MANAGER _____ DATE: _____

AT FULL SCALE (IF NOT 2"-SCALE ACCORDINGLY)
CADD FILE: G-3.DWG
DRAWN: J. COLLINS
DESIGNED: G. GILLES
CHECKED: J. DUNN
CHECKED: _____

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.
	1	RECORD DRAWING	G.G.	9/13/96	J.D.

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION NORFOLK, VIRGINIA
NEESA CONTRACT N47408-92-D-3042 DELIVERY ORDER NO. 0032
OPERABLE UNIT NO. 2 MARINE CORPS BASE, CAMP LEJEUNE, N.C.

FIGURE 3
BIOLOGICAL TREATMENT CELL LAYOUT AS BUILT

DRAWING NUMBER: G-3
SHEET NUMBER: of
DATE: 7/19/95

D:\OHM\LANTDIV\LEJEUNE\3226\G-3.DWG