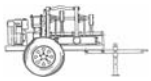
INSTALLATION, OPERATION & MAINTENANCE MANUAL FOR SERIES 490 AD SELF PRIMER PUMPS

02 MAY 2005



AMERICAN-MARSH PUMPS

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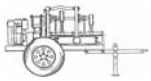


SAFETY CONSIDERATIONS

The American-Marsh AD self-primer pump has been designed and manufactured for safe operation. In order to ensure safe operation, it is very important that this manual be read in its entirety prior to installing or operating the pump. American-Marsh Pumps 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.

Remember that every pump has the potential to be dangerous, because of the following factors:

- parts are rotating at high speeds
- high pressures may be present
- high temperatures may be present
- highly corrosive and/or toxic chemicals may be present

Paying constant attention to safety is always extremely important. However, there are often situations that require special attention. These situations are indicated throughout this book by the following symbols:

⚠DANGER

DANGER - Immediate hazards which WILL result in severe personal injury or death.

⚠WARNING

WARNING – Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠CAUTION

CAUTION – Hazards or unsafe practices which COULD result in minor personal injury or product or property damage.

Maximum Lifting Speed: 15 feet/second.

If in a climate where the fluid in the casing could freeze, never leave liquid in the pump casing. Drain the casing completely. During winter months and cold weather, the liquid could freeze and damage the pump casing.

Do not run the gear casing dry.

Never operate the pump for more than a short interval with the discharge valve closed. The length of the interval depends on several factors including the nature of the fluid pumped and its temperature. Contact American-Marsh Engineering for additional support if required.

Never operate the pump with a closed suction valve.

Excessive pump noise or vibration may indicate a dangerous operating condition. The pump must be shutdown immediately.

If the liquid is hazardous, take all necessary precautions to avoid damage and injury before emptying the pump casing.

Residual liquid may be found in the pump casing, head and suction line. Take the necessary precautions if the liquid is hazardous, flammable, corrosive, poisonous, infected, etc.

Always lockout power to the driver before performing pump maintenance.

Never operate the pump without the coupling guard and all other safety devices correctly installed.

If any external leaks are found while pumping hazardous product, immediately stop operations and repair.

PUMP IDENTIFICATION

MANUFACTURER

American-Marsh Pumps
185 Progress Road
Collierville, TN 38017
United States of America

TYPE OF PUMP

The American-Marsh AD self-primer pump is a horizontal, self priming, oil lubricated, single stage centrifugal pump.

DATE OF MANUFACTURER

The date of manufacture is indicated on the pump data plate.

INSTALLATION, OPERATION & MAINTENANCE MANUAL IDENTIFICATION

Prepared: May, 2005
Edition: 02
Revision:
Date of Revision:

NAMEPLATE INFORMATION

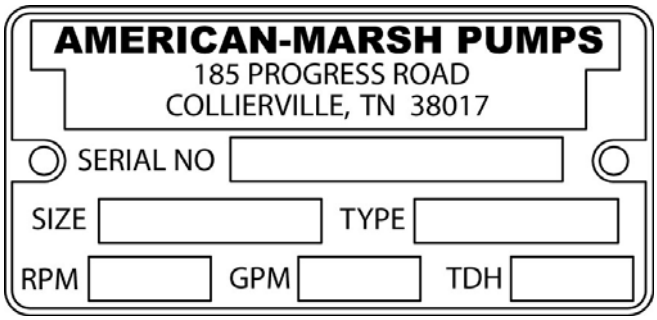


FIGURE 1 – Pump Data Plate

SERIAL NUMBER	:	Serial Number of pump unit (issued by Production Control).
SIZE	:	Size designation of pump (3x3 AD)
TYPE	:	Pump type (AD).
RPM	:	Speed of pump.
GPM	:	Rated capacity of pump.
TDH	:	Rated Total Dynamic Head of pump.

WARRANTY

American-Marsh Pumps guarantees that only high quality materials are used in the construction of our pumps and that machining and assembly are carried out to high standards.

The pumps are guaranteed against defective materials and/or faulty craftsmanship for a period of one year from the date of shipment unless specifically stated otherwise.

Replacement of parts or of the pump itself can only be carried out after careful examination of the pump by qualified personnel.

The warranty is not valid if third parties have tampered with the pump.

This warranty does not cover parts subject to deterioration or wear and tear (mechanical seals, pressure and vacuum gauges, rubber or plastic items, bearings, etc.) or damage caused by misuse or improper handling of the pump by the end user.

Parts replaced under warranty become the property of American-Marsh Pumps.

Contact the American-Marsh Pumps' factory:

American-Marsh Pumps
185 Progress Road
Collierville, TN 38017
United States Of America

Phone: **(901) 860-2300**
Fax: **(901) 860-2323**
www.american-marsh.com

GENERAL INSTRUCTIONS

The pump and motor unit must be examined upon arrival to ascertain any damage caused during shipment. If damaged immediately notify the carrier and/or the sender. Check that the goods correspond exactly to the description on the shipping documents and report any differences as soon as possible to the sender. Always quote the pump type and serial number stamped on the data plate.

The pumps must be used only for applications for which the manufacturers have specified:

- **The construction materials**
- **The operating conditions (flow, pressure, temperature, etc.)**
- **The field of application**

In case of doubt, contact the manufacturer.

HANDLING AND TRANSPORT

METHOD OF TRANSPORT

The pump must be transported in the horizontal position

INSTALLATION

During installation and maintenance, all components must be handled and transported securely by using suitable slings. Handling must be carried out by specialized personnel to avoid damage to the pump and persons. The lifting rings attached to various components should be used exclusively to lift the components for which they have been supplied.

⚠CAUTION

Maximum lifting speed: 15 feet/second

STORAGE

SHORT-TERM STORAGE

Normal packaging is designed to protect the pump during shipment and for dry, indoor storage for up to two months or less. The procedure followed for this short-term storage is summarized below:
Standard Protection for Shipment :

a. Loose unmounted items, including, but not limited to, oilers, packing, coupling spacers, stilts, and mechanical seals are packaged in a water proof plastic bag and placed under the coupling guard. Larger items are cartoned and metal banded to the base plate. For pumps not mounted on a base plate, the bag and/or carton is placed inside the shipping carton. All parts bags and cartons are identified with the American-Marsh sales order number, the customer purchase order number, and the pump item number (if applicable).
b. Inner surfaces of the bearing housing, shaft (area through bearing housing), and bearings are coated with Cortec VCI-329 rust inhibitor, or equal.
Note: **Bearing housings are not filled with oil prior to shipment.**
c. After a performance test, if required, the pump is tipped on the suction flange for drainage (some residual water may remain in the casing). Then, internal surfaces of ferrous casings, covers, flange faces, and the impeller surface are

sprayed with Calgon Vestal Labs RP-743m, or equal. Exposed shafts are taped with Polywrap.

d. Flange faces are protected with plastic covers secured with plastic drive bolts. 3/16 in (7.8 mm) steel or 1/4 in (6.3 mm) wood covers with rubber gaskets, steel bolts, and nuts are available at extra cost.
e. All assemblies are bolted to a wood skid which confines the assembly within the perimeter of the skid.
f. Assemblies with special paint are protected with a plastic wrap.
g. All assemblies having external piping (seal flush and cooling water plans), etc. are packaged and braced to withstand normal handling during shipment. In some cases components may be disassembled for shipment. The pump must be stored in a covered, dry location.

LONG-TERM STORAGE

Long-term storage is defined as more than two months, but less than 12 months. The procedure American-Marsh follows for long-term storage of pumps is given below. These procedures are in addition to the short-term procedure.

Solid wood skids are utilized. Holes are drilled in the skid to accommodate the anchor bolt holes in the base plate, or the casing and bearing housing feet holes on assemblies less base plate. Tackwrap sheeting is then placed on top of the skid and the pump assembly is placed on top of the Tackwrap. Metal bolts with washers and rubber bushings are inserted through the skid, the Tackwrap, and the assembly from the bottom of the skid and are then secured with hex nuts. When the nuts are "snugged" down to the top of the base plate or casing and bearing housing feet, the rubber bushing is expanded, sealing the hole from the atmosphere. Desiccant bags are placed on the Tackwrap. The Tackwrap is drawn up around the assembly and hermetically (heat) sealed across the top. The assembly is completely sealed from the atmosphere and the desiccant will absorb any entrapped moisture. A solid wood box is then used to cover the assembly to provide protection from the elements and handling. This packaging will provide protection up to twelve months without damage to mechanical seals, bearings, lip seals, etc. due to humidity, salt laden air, dust, etc. After unpacking, protection will be the responsibility of the user. Addition of oil to the bearing housing will remove the inhibitor. If units are to be idle for extended periods after addition of lubricants, inhibitor oils and greases should be used.

Every three months, the shaft should be rotated approximately 10 revolutions.

INSTALLATION & ALIGNMENT

FACTORY PRELIMINARY ALIGNMENT PROCEDURE

The purpose of factory alignment is to ensure that the user will have full utilization of the clearance in the motor holes for final job-site alignment. To achieve this, the factory alignment procedure specifies that the pump be aligned in the horizontal plane to the motor, with the motor foot bolts centered in the motor holes. This procedure ensures that there is sufficient clearance in the motor holes for the customer to field align the motor to the pump, to zero tolerance. This philosophy requires that the customer be able to place the base in the same condition as the factory. Thus the factory alignment will be done with the base sitting in an unrestrained condition on a flat and level surface. This standard also emphasizes the need to ensure the shaft spacing is adequate to accept the specified coupling spacer. The factory alignment procedure is summarized below:

1. The base plate is placed on a flat and level work bench in a free and unstressed position.
2. The base plate is leveled as necessary. Leveling is accomplished by placing shims under the rails (or, feet) of the base at the appropriate anchor bolt hole locations. Levelness is checked in both the longitudinal and lateral directions.
3. The motor and appropriate motor mounting hardware is placed on the base plate and the motor is checked for any planar soft-foot condition. If any is present it is eliminated by shimming.
4. The motor feet holes are centered around the motor mounting fasteners.
5. The motor is fastened in place by tightening the nuts on two diagonal motor mounting studs.
6. The pump is put onto the base plate and leveled. The foot piece under the bearing housing is adjustable. It is used to level the pump, if necessary. If an adjustment is necessary, we add or delete shims between the foot piece and the bearing housing.
7. The spacer coupling gap is verified.
8. The parallel and angular *vertical* alignment is made by shimming under the motor.
9. All four motor feet are tightened down.
10. The pump and motor shafts are then aligned *horizontally*, both parallel and angular, by *moving the pump* to the fixed motor. The pump feet are tightened down.

11. Both horizontal and vertical alignment are again final checked as is the coupling spacer gap.

RECOMMENDED PROCEDURE FOR BASE PLATE INSTALLATION & FINAL FIELD ALIGNMENT

NEW GROUTED BASE PLATES

1. The pump foundation should be located as close to the source of the fluid to be pumped as practical. There should be adequate space for workers to install, operate, and maintain the pump. The foundation should be sufficient to absorb any vibration and should provide a rigid support for the pump and motor. Recommended mass of a concrete foundation should be three times that of the pump, motor and base. Note that foundation bolts are imbedded in the concrete inside a sleeve to allow some movement of the bolt.
2. Level the pump base plate assembly. If the base plate has machined coplanar mounting surfaces, these machined surfaces are to be referenced when leveling the base plate. This may require that the pump and motor be removed from the base plate in order to reference the machined faces. If the base plate is without machined coplanar mounting surfaces, the pump and motor are to be left on the base plate. The proper surfaces to reference when leveling the pump base plate assembly are the pump suction and discharge flanges. DO NOT stress the base plate. Do not bolt the suction or discharge flanges of the pump to the piping until the base plate foundation is completely installed. If equipped, use leveling jackscrews to level the base plate. If jackscrews are not provided, shims and wedges should be used (see figure 2). Check for levelness in both the longitudinal and lateral directions. Shims should be placed at all base anchor bolt locations, and in the middle edge of the base if the base is more than five feet long. Do not rely on the bottom of the base plate to be flat. Standard base plate bottoms are not machined, and it is not likely that the field mounting surface is flat.

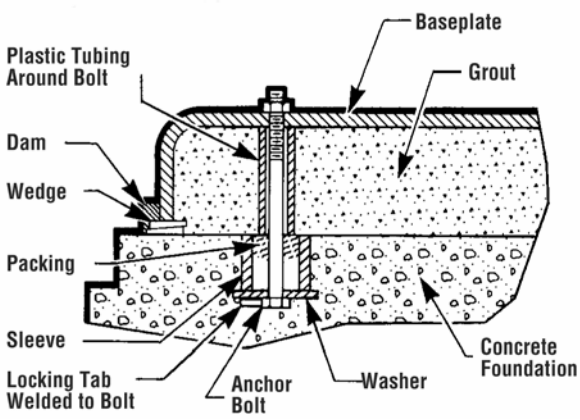


FIGURE 2 – Base Plate Foundation

3. After leveling the base plate, tighten the anchor bolts. If shims were used, make sure that the base plate was shimmed near each anchor bolt before tightening. Failure to do this may result in a twist of the base plate, which could make it impossible to obtain final alignment. Check the level of the base plate to make sure that tightening the anchor bolts did not disturb the level of the base plate. If the anchor bolts did change the level, adjust the jackscrews or shims as needed to level the base plate. Continue adjusting the jackscrews or shims and tightening the anchor bolts until the base plate is level.
4. Check initial alignment. If the pump and motor were removed from the base plate proceed with step 5 first, then the pump and motor should be reinstalled onto the base plate using American-Marsh's Factory Preliminary Alignment Procedure, and then continue with the following. As described above, pumps are given a preliminary alignment at the factory. This preliminary alignment is done in a way that ensures that, if the installer duplicates the factory conditions, there will be sufficient clearance between the motor hold down bolts and motor foot holes to move the motor into final alignment. If the pump and motor were properly reinstalled to the base plate or if they were not removed from the base plate and there has been no transit damage, and also if the above steps where done properly, the pump and driver should be within 0.015 in (0.38 mm) FIM (Full Indicator Movement) parallel, and 0.0025 in/in (0.0025 mm/mm) FIM angular. If this is not the case first check to see if the driver mounting fasteners are centered in the driver feet holes. If not,

recenter the fasteners and perform a preliminary alignment to the above tolerances by shimming under the motor for vertical alignment, and by moving the pump for horizontal alignment.

5. **Grout the base plate.** A non-shrinking grout should be used. Make sure that the grout fills the area under the base plate. After the grout has cured, check for voids and repair them. Jackscrews, shims and wedges should be removed from under the base plate at this time. If they were to be left in place, they could rust, swell, and cause distortion in the base plate.
6. Run piping to the suction and discharge of the pump. There should be no piping loads transmitted to the pump after connection is made. Recheck the alignment to verify that there are no significant loads.
7. Perform final alignment. Check for soft-foot under the driver. An indicator placed on the coupling, reading in the vertical direction, should not indicate more than 0.002 in (0.05 mm) movement when any driver fastener is loosened. Align the driver first in the vertical direction by shimming underneath its feet. When satisfactory alignment is obtained the number of shims in the pack should be minimized. It is recommended that no more than five shims be used under any foot. Final horizontal alignment is made by moving the driver. Maximum pump reliability is obtained by having near perfect alignment. American-Marsh recommends no more than 0.002 in (0.05mm) parallel, and 0.0005 in/in (0.0005 mm/mm) angular misalignment.
8. Operate the pump for at least an hour or until it reaches final operating temperature. Shut the pump down and recheck alignment while the pump is hot. Piping thermal expansion may change the alignment. Realign pump as necessary.

EXISTING GROUTED BASE PLATES

When a pump is being installed on an existing grouted base plate, the procedure is somewhat different from the previous section “New Grouted Base Plates.”

1. Mount the pump on the existing base plate.
2. Level the pump by putting a level on the discharge flange. If not level, add or delete shims between the foot piece and the bearing housing.
3. Check initial alignment. (Step 4 above)
4. Run piping to the suction and discharge flanges of the pump. (Step 6 above)
5. Perform final alignment. (Step 7 above)
6. Recheck alignment after pump is hot. (Step 8 above)

All piping must be independently supported, accurately aligned and preferably connected to the pump by a short length of flexible piping. The pump should not have to support the weight of the pipe or compensate for misalignment. It should be possible to install suction and discharge bolts through mating flanges without pulling or prying either of the flanges. All piping must be tight. Pumps may air-bind if air is allowed to leak into the piping. If the pump flange(s) have tapped holes, select flange fasteners with thread engagement at least equal to the fastener diameter but that do not bottom out in the tapped holes before the joint is tight.

PIPING CONNECTION – SUCTION & DISCHARGE

All piping must be independently supported, accurately aligned and preferably connected to the pump by a short length of flexible piping. The pump should not have to support the weight of the pipe or compensate for misalignment. It should be possible to install suction and discharge bolts through mating flanges without pulling or prying either of the flanges. All piping must be tight. Pumps may air-bind if air is allowed to leak into the piping. If the pump flange(s) have tapped holes, select flange fasteners with thread engagement at least equal to the fastener diameter but that do not bottom out in the tapped holes before the joint is tight.

⚠WARNING

Piping Forces: Take care during installation and operation to minimize pipe forces and/or moments on the pump casing.

SUCTION PIPING

To avoid NPSH and suction problems, suction pipe sizes must be at least as large as the pump suction connection. **Never** use pipe or fittings on the suction that are smaller in diameter than the pump suction size. Figure 3 illustrates the ideal piping configuration with a minimum of 10 pipe diameters between the source and the pump suction. In most cases, horizontal reducers should be eccentric and mounted with the flat side up as shown in figure 3 with a maximum of one pipe size reduction. Never mount eccentric reducers with the flat side down. Horizontally mounted concentric reducers should not be used if there is any possibility of entrained air in the process fluid. Vertically mounted concentric reducers are acceptable. In applications where the fluid is completely deaerated and free of any vapor or

suspended solids, concentric reducers are preferable to eccentric reducers.

Avoid the use of throttling valves and strainers in the suction line. Start up strainers must be removed shortly after start up. When the pump is installed below the source of supply, a valve should be installed in the suction line to isolate the pump and to permit pump inspection and maintenance. However, never place a valve directly on the suction nozzle of the pump.

Refer to the American-Marsh Pump Engineering Manual and the Centrifugal Pump IOM Section of the Hydraulic Institute Standards for additional recommendations on suction piping.

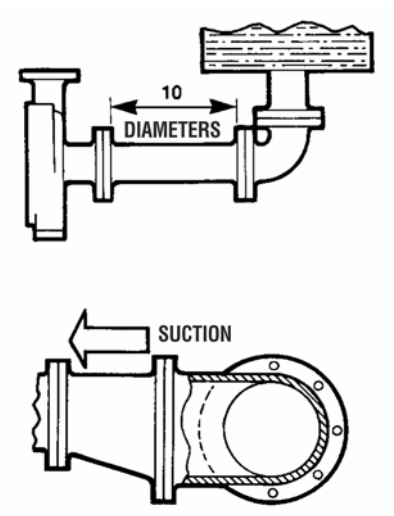


FIGURE 3 – Good Piping Practices

DISCHARGE PIPING

Install a valve in the discharge line. This valve is required for regulating flow and/or to isolate the pump for inspection and maintenance.

⚠WARNING

When fluid velocity in the pipe is high, for example, 10 ft/s (3 m/s) or higher, a rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

PUMP AND SHAFT ALIGNMENT CHECK

After connecting piping, rotate the pump drive shaft clockwise (view from motor end) by hand several complete revolutions to be sure there is no binding and that all parts are free. Recheck shaft alignment. If piping caused unit to be out of alignment, correct piping to relieve strain on the pump.

LUBRICATION

There are four points of lubrication maintenance on the pump and gear case that require attention; (refer to engine instructions for care of engine) the eccentric (J19), the eccentric shaft (J76), the intermediate shaft (J31) and the gear case (J59). Parts J19, J76 and J31 are lubricated by zerk fittings. These should have daily attention using a good grade of lithium-based grease. The gear case (J59) is sealed oil tight for the gears to run in a bath of oil. Pour in one pint of 80/90 gear lube oil through filler hole in top of case . Check oil weekly and replenish when necessary. On the older models without an oil seal around the main drive shaft, the gears should be lubricated once or twice a day through the hole in the top of the gear case with 80/90 gear lube oil. Ample lubrication with clean grease and oil prolongs the service to be had from any machine. Remember the old proverb: "Oil is cheaper than repairs."

COUPLING

The coupling should be installed as advised by the coupling manufacturer. Pumps are shipped without the spacer installed. If the spacer has been installed to facilitate alignment, then it must be removed prior to checking rotation. Remove protective material from the coupling and any exposed portions of the shaft before installing the coupling.

PUMP OPERATION

ROTATION CHECK

All AD pumps are multi-directional as viewed from the motor end.

PRE START-UP CHECKS

Prior to starting the pump it is essential that the following checks are made. These checks are all described in detail in the Maintenance Section of this booklet.

- Pump and Motor properly secured to the base plate
- All fasteners tightened to the correct torques
- Coupling guard in place and not rubbing
- Bearing lubrication
- Pump instrumentation is operational
- Pump freely rotates

As a final step in preparation for operation, it is important to rotate the shaft by hand to be certain that all rotating parts move freely, and that there are no foreign objects in the pump.

ENSURING PROPER $NPSH_A$

Net Positive Suction Head – Available ($NPSH_A$) is the measure of the energy in a liquid above the vapor pressure. It is used to determine the likelihood that a fluid will vaporize in the pump. It is critical because a centrifugal pump is designed to pump a liquid, not a vapor. Vaporization in a pump will result in damage to the pump, deterioration of the Total Differential Head (TDH), and possibly a complete stopping of pumping. Net Positive Suction Head – Required ($NPSH_R$) is the decrease of fluid energy between the inlet of the pump, and the point of lowest pressure in the pump. This decrease occurs because of friction losses and fluid accelerations in the inlet region of the pump, and particularly accelerations as the fluid enters the impeller vanes. The value for $NPSH_R$ for the specific pump purchased is given in the pump data sheet, and on the pump performance curve.

For a pump to operate properly the $NPSH_A$ must be greater than the $NPSH_R$. Good practice dictates that this margin should be at least 5 ft (1.5 m) or 20%, whichever is greater.

⚠CAUTION

Ensuring that $NPSH_A$ is larger than $NPSH_R$ by the suggested margin will greatly enhance pump performance and reliability. It will also reduce the likelihood of cavitation, which can severely damage the pump.

STARTING THE PUMP AND ADJUSTING FLOW

1. Open the suction valve to full open position. It is very important to leave the suction valve open while the pump is operating. Any throttling or adjusting of flow must be done through the discharge valve. Partially closing the suction valve can create serious NPSH and pump performance problems.

⚠DANGER

Never operate pump with both the suction and discharge valves closed. This could cause an explosion.

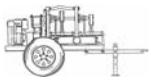
2. All cooling, heating, and flush lines must be started and regulated.
3. Start the driver (typically, the electric motor).

⚠DANGER

It is important that the discharge valve be opened within a short interval after starting the driver. Failure to do this could cause a dangerous build up of heat, and possibly an explosion.

OPERATION IN SUB-FREEZING CONDITIONS

When using the pump in sub-freezing conditions where the pump is periodically idle, the pump should be properly drained or protected with thermal devices which will keep the liquid in the pump from freezing.



SHUTDOWN CONSIDERATIONS

When the pump is being shutdown, the procedure should be the reverse of the start-up procedure. Remember, closing the suction valve while the pump is running is a safety hazard and could seriously damage the pump and other equipment.

TROUBLESHOOTING

The following is a guide to troubleshooting problems with American-Marsh pumps. Common problems are analyzed and solutions are offered. Obviously, it is impossible to cover every possible scenario. If a problem exists that is not covered by one of the examples, then contact a local American-Marsh Sales Engineer or Distributor/Representative for assistance.

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Problem #1 **Pump not reaching design flow rate.**	1.1 Insufficient $NPSH_A$. (Noise may not be present)	Recalculate NPSH available. It must be greater than the NPSH required by pump at desired flow. If not, redesign suction piping, holding number of elbows and number of planes to a minimum to avoid adverse flow rotation as it approaches the impeller.
	1.2 System head greater than anticipated.	Reduce system head by increasing pipe size and/ than or reducing number of fittings.
	1.3 Entrained air. Air leak from atmosphere on suction side.	1. Check suction line gaskets and threads for tightness. 2. If vortex formation is observed in suction tank, install vortex breaker. 3. Check for minimum submergence.
	1.4 Entrained gas from process.	Process generated gases may require larger pumps.
	1.5 Speed too low.	Check motor speed against design speed.
	1.6 Impeller too small.	Replace with proper diameter impeller. NOTE: Increasing impeller diameter may require use of a larger motor.
	1.7 Impeller clearance too large.	Reset impeller clearance.
	1.8 Plugged impeller, suction line or casing which may be due to a product or large solids.	1. Reduce length of fiber when possible. 2. Reduce solids in the process fluid when possible. 3. Consider larger pump.
	1.9 Wet end parts (casing cover, impeller) worn, corroded or missing.	Replace part or parts.
Problem #2.0 Pump not reaching design head (TDH).	2.1 Refer to possible causes under Problem #1.0.	Refer to remedies listed under Problem #1.0 and #3.0.
Problem #3.0 No discharge or flow	3.1 Not properly primed.	Repeat priming operation, recheck instructions.
	3.3 Entrained air. Air leak from atmosphere on suction side.	Refer to recommended remedy under Problem #1.0, Item #1.3.
	3.4 Plugged impeller, suction line or casing which may be due to a fibrous product or large solids.	Refer to recommended remedy under Problem #1.0, Item #1.9.
	3.5 Damaged pump shaft, check valves, diaphragm.	Replace damaged parts.

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Problem #4.0 Pump operates for short period, then loses prime.	4.1 Insufficient NPSH.	Refer to recommended remedy under Problem #1.0, Item #1.1.
	4.2 Entrained air. Air leak from atmosphere on suction side.	Refer to recommended remedy under Problem #1.0, Item #1.3.
Problem #5.0 Excessive noise from wet end.	5.1 Cavitation - insufficient NPSH available.	Refer to recommended remedy under Problem #1.0, Item #1.1.
	5.2 Abnormal fluid rotation due to complex suction piping.	Redesign suction piping, holder number of elbows and number of planes to a minimum to avoid adverse fluid rotation as it approaches the impeller.
Problem #6.0 Excessive noise from power end.	6.1 Bearing contamination appearing on the raceways as scoring, pitting, scratching, or rusting caused by adverse environment and entrance of abrasive contaminants from atmosphere.	1. Work with clean tools in clean surroundings. 2. Remove all outside dirt from housing before exposing bearings. 3. Handle with clean dry hands. 4. Treat a used bearing as carefully as a new one. 5. Use clean solvent and flushing oil. 6. Protect disassembled bearing from dirt and moisture. 7. Keep bearings wrapped in paper or clean cloth while not in use. 8. Clean inside of housing before replacing bearings. 9. Check oil seals and replace as required. 10. Check all plugs and tapped openings to make sure that they are tight.
	6.2 Brinelling of bearing identified by indentation on the ball races, usually caused by incorrectly applied forces in assembling the bearing or by shock loading such as hitting the bearing or drive shaft with a hammer.	When mounting the bearing on the drive shaft use a proper size ring and apply the pressure against the inner ring only. Be sure when mounting a bearing to apply the mounting pressure slowly and evenly.

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Cont. Problem #6.0 Excessive noise from power end.	6.3 False brinelling of bearing identified again by either axial or circumferential indentations usually caused by vibration of the balls between the races in a stationary bearing.	1. Correct the source of vibration. 2. Where bearings are oil lubricated and employed in units that may be out of service for extended periods, the drive shaft should be turned over periodically to re-lubricate all bearing surfaces at intervals of one-to three months.
	6.4 Thrust overload on bearing identified by flaking ball path on one side of the outer race or in the case of maximum capacity bearings, may appear as a spalling of the races in the vicinity of the loading slot.	1. Follow correct mounting procedures for bearings.
	6.5 Misalignment identified by fracture of ball retainer or a wide ball path on the inner race and a narrower cocked ball path on the outer race. Misalignment is caused by poor mounting practices or defective drive shaft. For example bearing not square with the centerline or possibly a bent shaft due to improper handling.	Handle parts carefully and follow recommended mounting procedures. Check all parts for proper fit and alignment.
	6.6 Bearing damaged by electric arcing identified as electro-etching of both inner and outer ring as a pitting or cratering. Electrical arcing is caused by a static electrical charge eminating from belt drives, electrical leakage or short circuiting.	1. Where current shunting through the bearing cannot be corrected, a shunt in the form of a slip ring assembly should be incorporated. 2. Check all wiring, insulation and rotor windings to be sure that they are sound and all connections are properly made. 3. Where pumps are belt driven, consider the elimination of static charges by proper grounding or consider belt material that is less generative.

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Cont.: **Problem #6.0** Excessive noise from power end.	6.7 Bearing damage due to improper lubrication, identified by one or more of the following: 1. Abnormal bearing temperature rise. 2. A stiff cracked grease appearance. 3. A brown or bluish discoloration of the bearing races.	1. Be sure the lubricant is clean. 2. Be sure proper amount of lubricant is used. The oil level eye supplied with SP pumps will maintain the proper oil level if it is installed and operating properly. 3. Be sure the proper grade of lubricant is used.
	6.8 Damage to gears within gear housing.	1. Tear down and inspect all four reduction gears and stub shafts.

MAINTENANCE

PREVENTIVE MAINTENANCE

The following sections of this manual give instructions on how to perform a complete maintenance overhaul. However, it is also important to periodically repeat the "Pre start-up checks" listed on page 11. These checks will help extend pump life as well as the length of time between major overhauls.

NEED FOR MAINTENANCE RECORDS

A procedure for keeping accurate maintenance records is a critical part of any program to improve pump reliability. There are many variables that can contribute to pump failures. Often long term and repetitive problems can only be solved by analyzing these variables through pump maintenance records.

NEED FOR CLEANLINESS

One of the major causes of pump failure is the presence of contaminants in the bearing housing. This contamination can be in the form of moisture, dust, dirt and other solid particles such as metal chips. Contamination can also be harmful to the mechanical seal as well as other parts of the pumps. Some guidelines are listed below.

After draining the oil from the bearing housing, periodically send it out for analysis. If it is contaminated, determine the cause and correct. The work area should be clean and free from dust, dirt, oil, grease, etc. Hands and gloves should be clean. Only clean towels, rags, and tools should be used.

⚠DANGER

Lock out power to driver to prevent personal injury.

INSPECTION AND CHECKS

Check from time to time that the pump is working properly. Use the instruments mounted in the system (pressure gauges, vacuum gauges, ammeter, etc) to see that the pump continues to meet its duty.

Periodic maintenance of the parts subject to wear, in particular, the impeller and wear plate, is recommended. Check from time to time that the pump is working properly. Use the instruments mounted in the system (pressure gauges, vacuum gauges, ammeter, etc) to see that the pump continues to meet its duty.

Periodic maintenance of the parts subject to wear, in particular, the impeller and wear plate, is recommended.

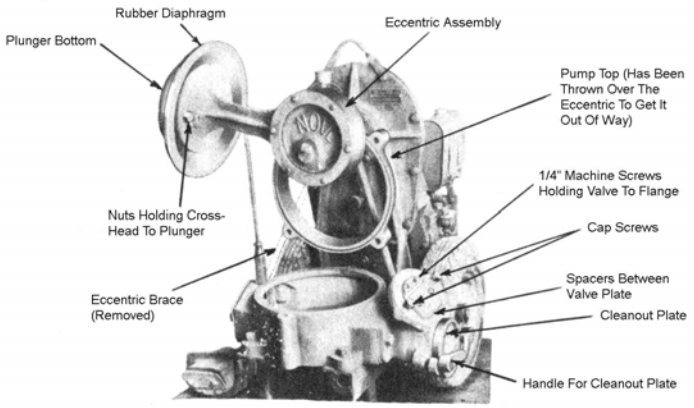


FIGURE 4 – Fluid End Parts

REPLACING THE DIAPHRAGM

The pump is so designed as to make replacement of the diaphragm an easy job. Refer to Figure 5 for diaphragm replacement. Remove the eccentric brace (J25) on the suction side of the pump. Remove the four capscrews (D14A & D25) holding down the pump top (D2). With the eccentric (J19) at **UPPER DEAD CENTER**, swing the crosshead (D5) out. Remove the two nuts (D14 & J42) which clamp the crosshead (D5) to the plunger bottom casing (D4). Swing the top (D2) over the crosshead (D5). Remove the old diaphragm (D20) and plunger bottom (D4). Bring the pump top (D2) down to position on the diaphragm (D20), with the eccentric (J19) at **LOWER DEAD CENTER**, making certain the diaphragm (D20) is centered on the pump base (D1). Replace the eccentric brace (J25) and the four bolts (D14A & D25) of the pump top (D2) drawing down evenly all around the pump. The pump is now ready for service.

REPLACING THE WEAR PLATE

Unscrew the nuts (52) and remove the pump casing (1), taking care not to damage the casing gasket (43). Unscrew the wear plate screws (57). Remove and replace the wear plate (02). If necessary, replace the casing gasket (43). To reassemble, proceed in reverse order. Check that the distance between the impeller (03) and the front wear plate is as described in Impeller Adjustment below.

CHECK VALVE INSPECTION & REPLACEMENT

To inspect or change the check valves start by removing the cleanout cover (P158) by removing the two handles (D53), no wrench is required. This will permit removal of trash and grit from the valve faces (D22). The check valve assembly consists of the valve (D22), valve rubber retainer (D12), large valve weight (D10), small valve weight (P162), spacers (V11) and machine screws (D16). The angle of the check valve and the valve weights ensure that it seats properly. Cap screws (D15) hold the valve assembly together against the spacers (V11) to prevent valve pinching.

To change one or both of the check valves, remove the four caps screws (D14 & D25) on the suction and/or the discharge side. The valve is fastened to the suction (D9) and/or discharge (P173) ports by two ¼" machine screws (D16). In assembling the new valve (D22), first insert the spacers (V11) in the screw holes to prevent pinching the valve (D22) out of shape. When replacing the suction (D9) and/or discharge (P173) port, be sure the gasket(s) (D23 or D23A) is/are in place.

REPLACING THE ECCENTRIC

The eccentric (J19) which is keyed (J20) to the eccentric shaft (J76) transmits the power from the gears to the crosshead (D5). The eccentric (J19) is bushed with a split bushing (J74) which is greased by a zerk fitting (J63). This split bushing (J74) floats in the crosshead (D5) and on the eccentric (J19) and is held in place by side plates (J205). To disassemble the eccentric (J19) remove the eccentric key (J20) and the six bolts (D6) that extend through the entire assembly. Gaskets (J222) make the assembly grease tight. Two bronze bushings (J74) are pressed into either end of the eccentric support (J60) with space between providing a pocket for grease supplied by the zerk fitting (J63).

The eccentric support (J60) can be removed from the gear case (J59) by removing the four cap screws (J62). The eccentric braces (J25) fasten to the eccentric support (J60) with nut and washer (J24). Two half nuts and washers (J23) provide support under the eccentric support (J60).

GEAR CASE

The engine power is transmitted from the engine to the pump eccentric (J19) by a chain of gears enclosed in the gear case (J59), which is sealed oil tight by use of a paper gasket (J141) and eleven cap screws (J171) with lock washers. The gears run in a bath of oil. The level cock (J174) indicates level at which the oil should be maintained. See figure 5.

If the gear case (J59) is to be disassembled, it will be necessary to remove the pump and eccentric assembly from the base. The pump is removed by taking out the four anchor bolts holding the pump bottom (D1) to the base frame (SPC97). To remove the eccentric assembly, see **Replacing The Eccentric** section above.

Remove the gear cover (J54) by removing the eleven cap screws (J171) holding the gear case cover (J54) to the gear case (J59). This will expose the complete gear assembly.

The intermediate shaft (J31) is held in the gear case by an Allen head set screw (J175). The intermediate gear (J27) is assembled on the hub of the pinion gear (J16) and held in place by two threaded pins (J115). These pins are screwed into holes that are drilled and tapped halfway in the pinion hub (J16) and halfway in the intermediate gear (J27). The pins (J115) are then milled flush with the intermediate gear (J27).

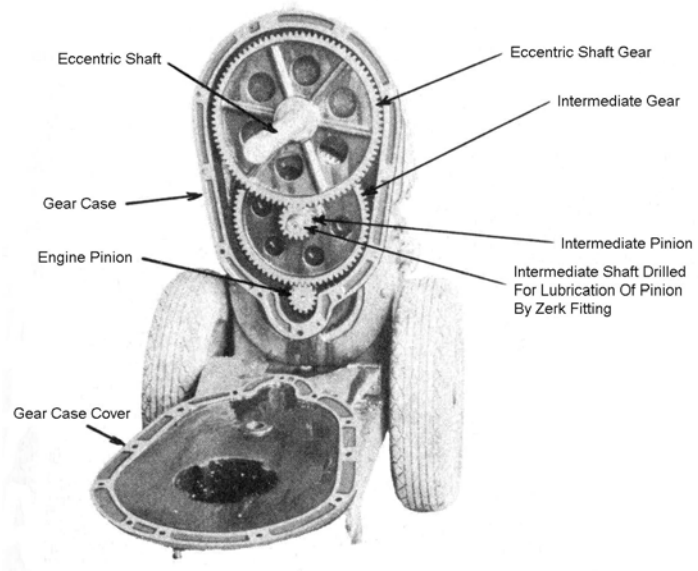


FIGURE 5 – Gear Reduction Housing

Two bronze bushings (J29) are pressed, one into each end of the pinion (J16). The space between the bronze bushings (J29) provides room for the grease lubrication via the zerk fitting (J63). The zerk fitting (J63) is threaded into the end of the intermediate shaft (J31) where a drilled hole directs the grease to the appropriate location.

The eccentric shaft (J76) is keyed into the eccentric gear (J27C) by the use of two threaded pins (J115) in the same manner as the intermediate shaft (J31) as above.

The adapter ring (V2) is held to the engine flywheel housing by eight cap screws (J172) and one additional cap screw (J173).

The engine pinion (J5) is keyed to the engine shaft with a Gib key (J6) and a lip seal (C108) prevents oil from leaking out of the pump gear case (J59).

BASE AND TRUCK ASSEMBLY

The base assembly (SPC97) is an all welded unit with front foot or support welded in place. The axle is placed through holes drilled in the angle frame and is welded in place rigidly. Pads and supports are welded to the top of the frame to bolt the engine, gear case (J59) and the pump bottom (D1) rigidly in place. The handle is curved, tubular steel, which is drilled at each end to accept cap screws (SPC113), which hold it tight to the frame (SPC97).

Pneumatic or steel wheels (TR1) are held in place with two large cotter pins (TR16) and washers (TR15), one on either side.

SPARE PARTS

RECOMMENDED SPARE PARTS – STANDARD AD PUMP

The decision on what spare parts to stock varies greatly depending on many factors such as the criticality of the application, the time required to buy and receive new spares, the erosive/corrosive nature of the application, and the cost of the spare part. Figures 6, 7, 8 & 9 give the parts list for a typical AD pump. Please refer to the "American-Marsh Pump Parts Catalog" for more information. Prior to resizing impellers in high chrome iron and nickel, please consult your local American-Marsh sales representative.

HOW TO ORDER SPARE PARTS

Spare parts can be ordered from the local American-Marsh Sales Engineer, or from the American-Marsh Distributor or Representative. The pump size and type can be found on the name plate on the bearing housing. See Figure 1. Please provide the item number, description, and alloy for the part(s) to be ordered.

To make parts ordering easy, American-Marsh has created a catalog titled "American-Marsh Pump Parts Catalog." A copy of this book can be obtained from the local American-Marsh Sales Engineer or Distributor/Representative.

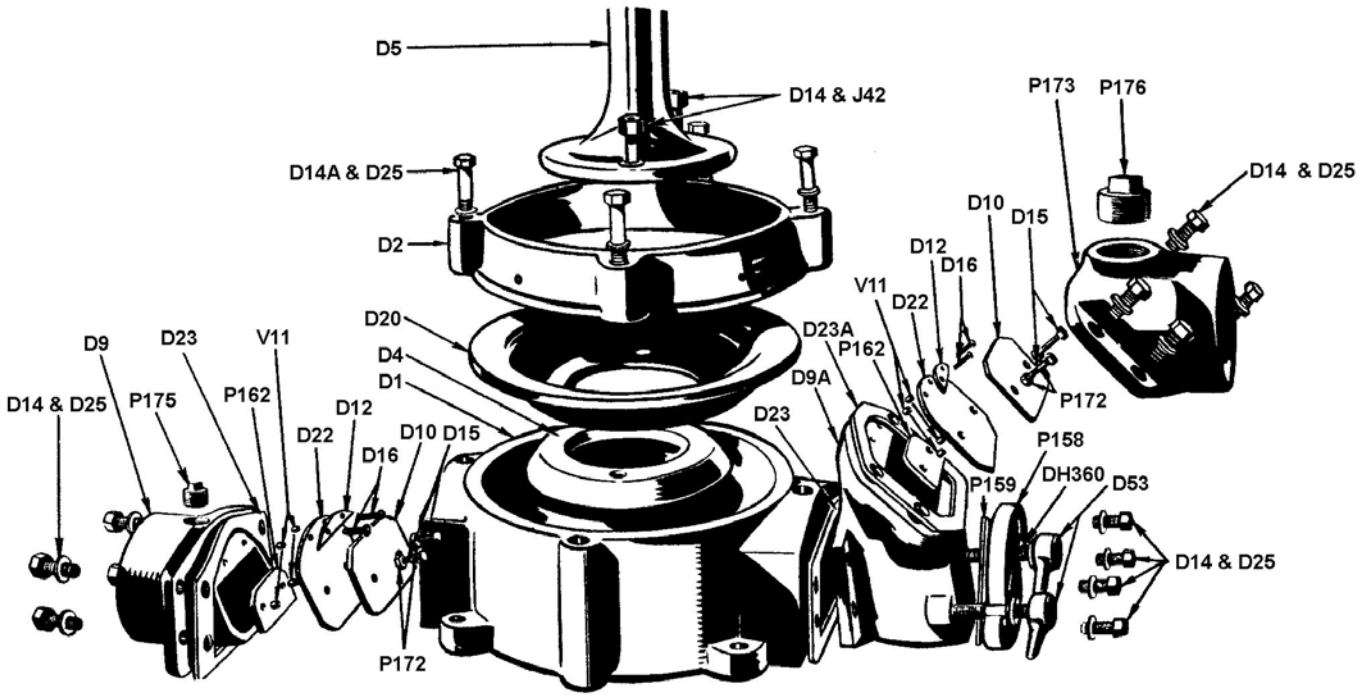


FIGURE 6 – PUMP FLUID END ASSEMBLY

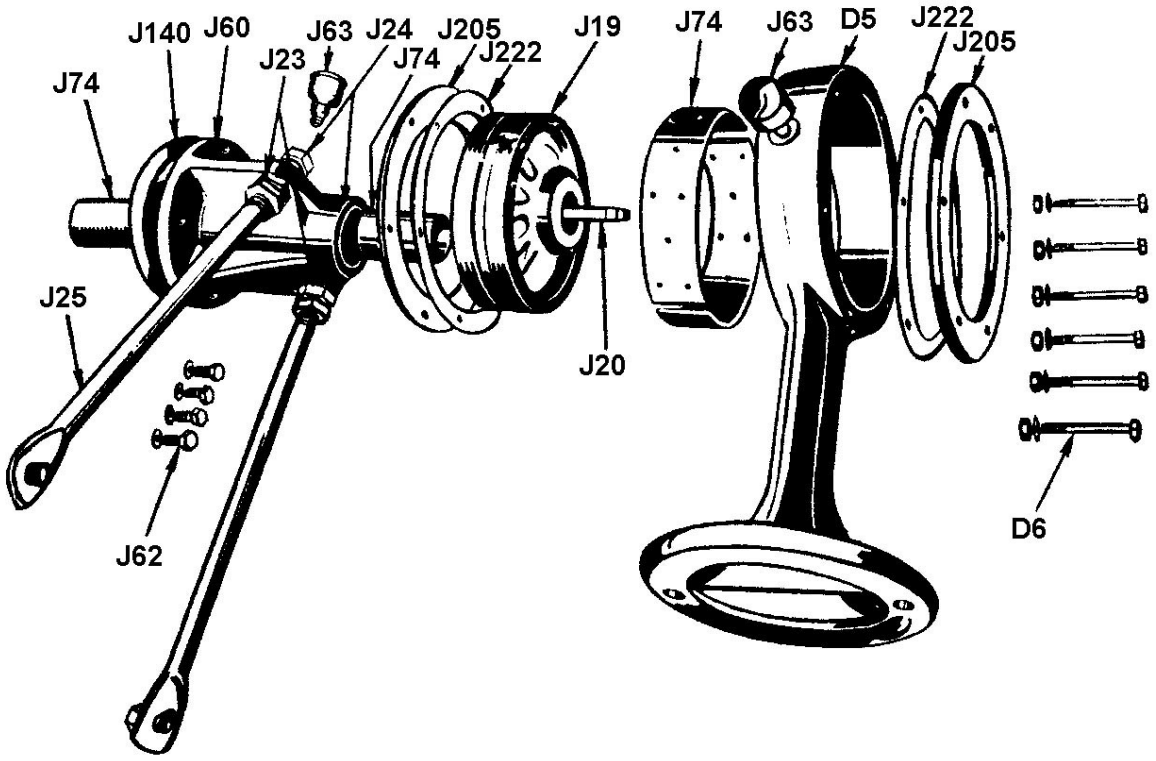


FIGURE 7 – ECCENTRIC AND ECCENTRIC SUPPORT ASSEMBLY

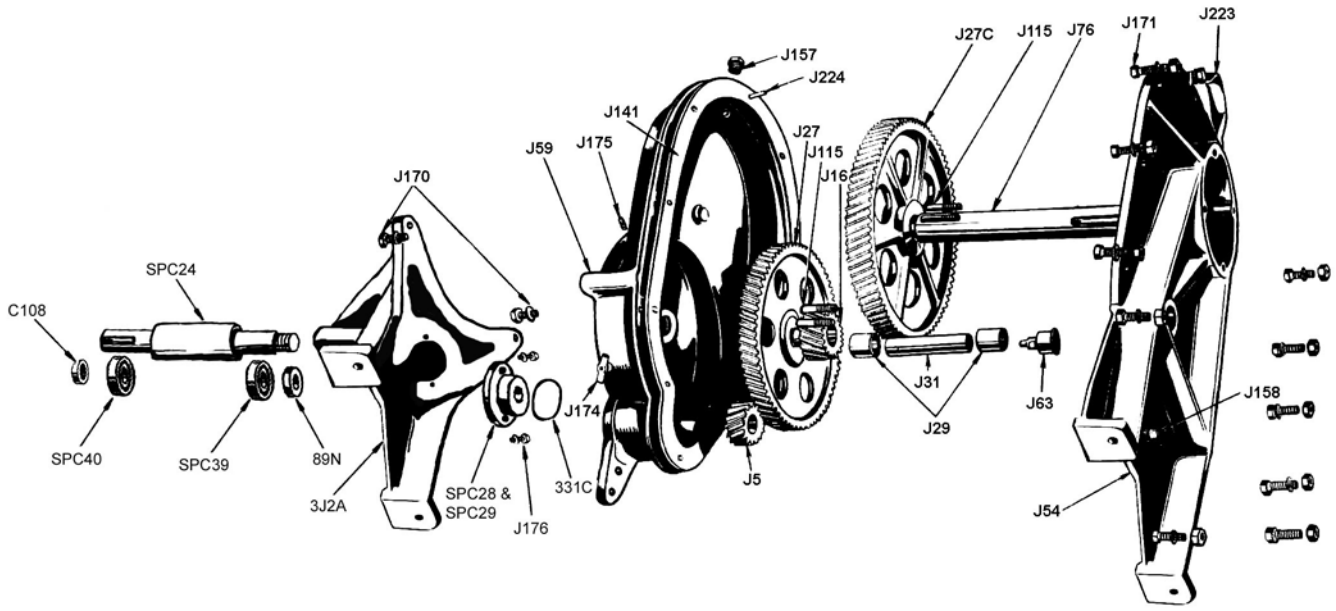


FIGURE 8 – GEAR CASE ASSEMBLY (FLEX-COUPLED)

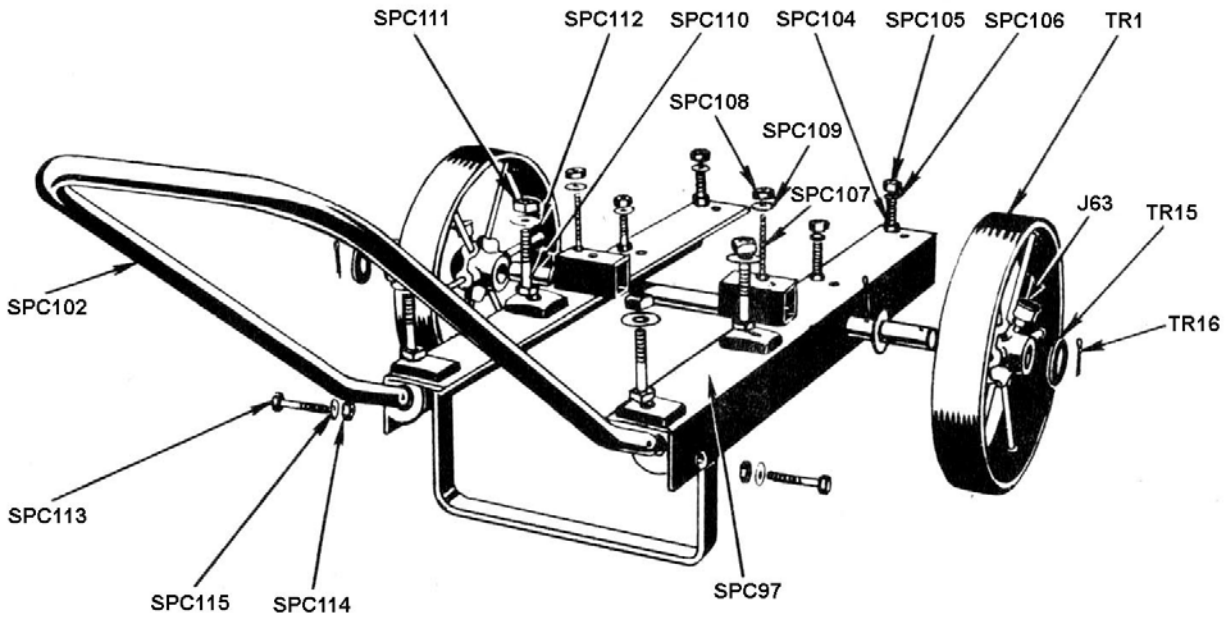


FIGURE 9 – WHEELED BASE ASSEMBLY

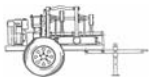
AMERICAN-MARSH PUMPS

NOVO AD Diaphragm Self-Primer Sectional Drawing

Item Number	Item Description	AD-3-1		AD-4-1		AD-3-2		AD-4-2		AD-3-B		AD-4-B	
		Symbol	Qty.	Symbol	Qty.	Symbol	Qty.	Symbol	Qty.	Symbol	Qty.	Symbol	Qty.
C108	Crankshaft Oil Seal	2J227	1	2J227	1	2J227	1	2J227	1	1C108	1	1C108	1
D1	Pump Base	3D1G	1	4D1E	1	3D1G	2	4D1E	2	3D1G	1	4D1E	1
D2	Pump Top	3D2C	1	4D2F	1	3D2C	2	4D2F	2	3D2C	1	4D2F	1
D4	Plunger Bottom	3D4D	1	3D4E	1	3D4D	2	3D4E	2	3D4D	1	3D4E	1
D5	Cross Head	3D5J	1	3D5K	1	3D5J	2	3D5K	2	3D5J	1	3D5K	1
D6	Crosshead Plate Screws	3D6	6	4D6	6	3D6	12	4D6	12	3D6	6	4D6	6
D9	Suction Flange	3D9N	1	4D9B	1	3D9H	2	4D9D	2	3D9N	1	4D9B	1
D9A	Discharge Flange	3D9L	1	4D9E	1	3D9L	2	4D9E	2	3D9L	1	4D9E	1
D10	Valve Weight (Large)	3D10B	2	4D10A	2	3D10B	4	4D10A	4	3D10B	2	4D10A	2
D12	Valve Rubber Retainer	3D12B	2	4D12	2	3D12B	4	4D12	4	3D12B	2	4D12	2
D13	½" Closed End Nut	3D13A	2	3D13A	2	3D13A	4	3D13A	4	3D13A	2	3D13A	2
D14	Cap Screw (Long)	3D14	5	3D14	12	3D14	6	3D14	16	3D14	5	3D14	12
D14A	Cap Screw (Short)	3D14C	1			3D14C	4			3D14C	1		
D14B	Cap Screw	3D14B	4	4D14A	4	3D14B	8	4D14A	8	3D14B	4	4D14A	4
D15	Valve Retainer Set Screw	3D15	2	4D15	2	3D15	4	4D15	4	3D15	2	4D15	2
D16	Valve Weight Set Screw	3D16	2	4D16	2	3D16	4	4D16	4	3D16	2	4D16	2
D20	Diaphragm	3D20	1	4D20	1	3D20	2	4D20	2	3D20	1	4D20	1
D22	Check Valve	3D22C	2	4D22	2	3D22C	4	4D22	4	3D22C	2	4D22	2
D23	Suction Flange Gasket	3D23C	2	4D23E	2	3D23C	6	4D23E	6	3D23C	2	4D23E	2
D23A	Discharge Flange Gasket	3D23D	1	4D23D	1	3D23D	2	4D23D	2	3D23D	1	4D23D	1
D24	Washer – Plain	4D24	2	4D24	2	4D24	4	4D24	4	4D24	2	4D24	2
D25	Washer – Plain	3D25	6	3D25	16	3D25	14	3D25	24	3D25	6	3D25	16
D25A	Washer – Plain	3D25A	4			3D25A	8			3D25A	4		
D53	Handle	3D53	2	3D53	2	3D53	4	3D53	4	3D53	2	3D53	2
*D55	Stud					3D55	2						
DH360	Clean Out Plate Stud	DH360	2	DH360	2	DH360	4	DH360	8	DH360	2	DH360	2
J5	Engine Pinion	2J5U	1	2J5U	1	2J5U	1	2J5U	1	3J5F	1	3J5F	1
J6	Engine Pinion Key	2J6	1	2J6	1	2J6	1	2J6	1	2J6	1	2J6	1
J16	17 Tooth Pinion	2J16D	1	2J16D	1	2J16D	1	2J16D	1	2J16D	1	2J16D	1
	Before Serial Number P-33306 Use 2J16C												
J19	Eccentric	2J19T	1	2J19V	1	2J19T	2	2J19U	2	2J19T	1	2J19U	1
J20	Eccentric Key	2J20	1	2J20	1	2J20	2	2J20	2	2J20	1	2J20	1
J23	Brace Nuts	2J23	2	2J23	2	2J23	4	2J23	4	2J23	2	2J23	2
*J23A	Suction Manifold					3J23A	1	4J23C	1				
J24	Brace Nuts	2J24	2	2J24	2	2J24	4	2J24	4	2J24	2	2J24	2
J25	Pump & Jack Brace	2J25L	2	2J25L	2	2J25L	4	2J25L	4	2J25L	2	2J25L	2
J27	70 Tooth Int. Gear	2J27G	1	2J27G	1	2J27G	1	2J27G	1	2J27G	1	2J27G	1
J27C	85 Tooth Gear	2J27H	1	2J27H	1	2J27H	1	2J27H	1	2J27H	1	2J27H	1
	Before Serial Number P-33306 Use 2J27F												
J29	Int. Shaft Bushing	2J29C	2	2J29C	1	2J29C	2	2J29C	2	2J29C	2	2J29C	2
J31	Int. Shaft	2J31G	1	2J31G	1	2J31G	1	2J31G	1	2J31G	1	2J31G	1
J42	Plunger Bottom Stud	2J42	2	2J42	2	2J42	4	2J42	4	2J42	2	2J42	2
J54	Gear Case Cover	4J54G	1	4J54G	1	4J54J	1	4J54J	1	4J54G	1	4J54G	1
J59	Gear Case	4J59J	1	4J59J	1	4J59J	1	4J59J	1	4J59J	1	4J59J	1
J60	Eccentric Shaft Support	2J60B	1	2J60B	1	2J60B	2	2J60B	2	2J60B	1	2J60B	1
J62	Eccentric Support Bolts	2J62	4	2J62	4	2J62	4	2J62	4	2J62	4	2J62	4
J63	Zerk Fitting	2J63	3	2J63	3	2J63	4	2J63	4	2J63	3	2J63	3
J74	Eccentric Bushing	2J74D	2	2J74D	2	2J74D	4	2J74D	4	2J74D	2	2J74D	2
J76	Eccentric Shaft	2J76Q	1	2J76Q	1	2J76R	1	2J76S	1	2J76Q	1	2J76Q	1
J115	5/16" x 7/8" Groove Pin	X577	4	X577	4	X577	2	X577	2	X577	4	X577	4
*J127	Crank Shaft Sleeve	2J127B	1	2J127B	1	2J127B	1						
J141	Gear Case Gasket	2J141C	1	2J141C	1	2J141C	1	2J141C	1	2J141C	1	2J141C	1
J140	Ecc. Shaft Brg. Gasket	2J140	1	2J140	1	2J140	1	2J140	1	2J140	1	2J140	1
*J150	Int. Shaft Thrust Washer	1J150B	Var.	1J150B	Var.	1J150B	Var.	1J150B	Var.	1J150B	Var.	1J150B	Var.
*J151	Thrust Washer	1J151C	1	1J151C	1	1J151C	2	1J151C	2	1J151C	1	1J151C	1
J154	Bush. For Ecc. Support	2J154	2	2J154	2	2J154	4	2J154	4	2J154	2	2J154	2
J157	Oil Fill Plug	2J157	1	2J157	1	2J157	1	2J157	1	2J157	1	2J157	1
J158	Oil Drain Plug	2J158	1	2J158	1	2J158	1	2J158	1	2J158	1	2J158	1
J170	Adapter Capscrews	2J170	3	2J170	3	2J170	3	2J170	3				
J171	Gear Cover Capscrews	2J171	11	2J171	11	2J171	11	2J171	11	2J171	11	2J171	11
J172	Motor Capscrews	2J172	8	2J172	8	2J172	8	2J172	8				
J173	Capscrew	2J173	1	2J173	1	2J173	1	2J173	1	2J173	1	2J173	1

*Not shown in sectional.

Recommended spare parts are in BOLD.



AMERICAN-MARSH PUMPS

NOVO AD Diaphragm Self-Primer Sectional Drawing

Item Number	Item Description	AD-3-1		AD-4-1		AD-3-2		AD-4-2		AD-3-B		AD-4-B	
		Symbol	Qty.	Symbol	Qty.	Symbol	Qty.	Symbol	Qty.	Symbol	Qty.	Symbol	Qty.
J174	Drain Cock	2J174	1	2J174	1	2J174	1	2J174	1	2J174	1	2J174	1
J175	Setscrew	2J175	1	2J175	1	2J175	1	2J175	1	2J175	1	2J175	1
J205	Cross Head Side Plate	2J205A	2	2J205A	2	2J205A	4	2J205A	4	2J205A	2	2J205A	2
J222	Side Plate Gasket	2J222	2	2J222	2	2J222	4	2J222	4	2J222	2	2J222	2
J223	Hoisting Sling	EF598	1	EF598	1	A4443	1	A4446	1	EF598	1	EF598	1
*J224	Dowel Pin	2J224	2	2J224	2	2J224	2	2J224	2	2J224	1	2J224	2
*J228	Support Bracket	4J228	1	4J228	1								
*J231	Governor Stop	4J231	1	4J231	1								
P158	Clean Out Plate	3P158A	1	3P158A	1	3P158A	2	3P158A	2	3P158A	1	3P158A	1
P159	Clean Out Plate Gasket	3P159A	1	3P159A	1	3P159A	2	3P159A	2	3P159A	1	3P159A	1
P162	Valve Weight (Small)	3P162B	1	4D11A	2	3P162B	4	4D11A	4	3P162B	2	4D11A	2
P172	Valve Nut	3P172	4	3P172	4	3P172	8	3P172	8	3P172	4	3P172	4
P173	Discharge Flange	3P173B	1	4P173	1	3P173D	1	4P173B	1	3P173B	1	4P173	1
P175	Suction Plug	3P175	1	3P175	1	3P175	2	3P175	2	3P175	1	3P175	1
P176	Discharge Plug	3P176	1	3P176	1	3P176	2	3P176	2	3P176	1	3P176	1
V11	Valve Spacer	3V11	8	3V11	8	3V11	16	3V11	16	3V11	8	3V11	8
V2	Adapter	2J2	1	2J2	1	2J2	1	4J2A	1				
*V63	Pinion Nut									1V63	1	1V63	1
*SPC22	Shaft Seal – Outer									2SPC22	1	2SPC22	1
*SPC22A	Shaft Seal – Inner									2SPC22A	1	2SPC22A	1
SPC24	Shaft									2SPC24	1	2SPC24	1
*SPC28	Bearing Retainer									2SPC28	1	2SPC28	1
*SPC29	Retainer Shim									2SPC29		2SPC29	
SPC39	Shaft Bearing (Outer)									2SPC39	1	2SPC39	1
SPC40	Shaft Bearing (Inner)									2SPC40	1	2SPC40	1
*SPC92	Oil Filler									1SPC92	1	1SPC92	1
SPC97	Base Assembly	B2487	1	B2517	1	B2503	1	B2515	1	A4434	1	B2480	1
*U1318	Soft Washer							NNU1318	4				
Wheeled Truck Assembly													
*SPC95	Tongue Chain Assy.	2SPC95	1	2SPC95	1								
*SPC97	Prop Assembly	2SPC97	1	2SPC97B	1	4TR182N	1	4TR182N	1				
*SPC98	Tongue Assembly	2SPC98	1	2SPC98	1	4TR111E	1	4TR111E	1				
*SPC99	Axle	2SPC99	1	2SPC99A	1	4TR107X	1	4TR107W	1				
SPC102	Handle	2SPC102	1	2SPC102	1	2SPC102	1	2SPC102	1	2SPC102	1	2SPC102	1
SPC104	Motor Capscrew	2SPC104	4	2SPC104	4	2SPC104	4	2SPC104	4	2SPC104	4	2SPC104	4
SPC105	Motor Nut	2SPC105	4	2SPC105	4	2SPC105	4	2SPC105	4	2SPC105	4	2SPC105	4
SPC106	Motor Washer	2SPC106	4	2SPC106	4	2SPC106	4	2SPC106	4	2SPC106	4	2SPC106	4
SPC107	Gear Housing Capscrew	2SPC107	2	2SPC107	2	2SPC107	2	2SPC107	2	2SPC107	2	2SPC107	2
SPC108	Gear Housing Nut	2SPC108	2	2SPC108	2	2SPC108	2	2SPC108	2	2SPC108	2	2SPC108	2
SPC109	Gear Housing Washer	2SPC109	2	2SPC109	2	2SPC109	2	2SPC109	2	2SPC109	2	2SPC109	2
SPC110	Pump Capscrew	2SPC110	4	2SPC110	4	2SPC110	4	2SPC110	4	2SPC110	4	2SPC110	4
SPC111	Pump Nut	2SPC111	4	2SPC111	4	2SPC111	4	2SPC111	4	2SPC111	4	2SPC111	4
SPC112	Pump Washer	2SPC112	4	2SPC112	4	2SPC112	4	2SPC112	4	2SPC112	4	2SPC112	4
SPC113	Handle Capscrew	2SPC113	2	2SPC113	2	2SPC113	2	2SPC113	2	2SPC113	2	2SPC113	2
SPC114	Handle Nut	2SPC114	2	2SPC114	2	2SPC114	2	2SPC114	2	2SPC114	2	2SPC114	2
SPC115	Handle Washer	2SPC115	2	2SPC115	2	2SPC115	2	2SPC115	2	2SPC115	2	2SPC115	2
*TR1	Steel Wheel	3TR1S	2	3TR1S	2	4TR1L	2	4TR1L	2	3TR1S	2	3TR1S	2
*TR15	Axle Washer	3TR15D	4	3TR15D	4	TR15	4	TR15	4	3TR15D	4	3TR15D	4
TR16	Cotter Pin	3TR16	2	3TR16	2	3TR16	2	3TR16	2	3TR16	2	3TR16	2

*Not shown in sectional.

Recommended spare parts are in BOLD.

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