

GARDNER DENVER®

3-3-600
2nd Edition
June, 1999

**DUPLEX
STEAM PUMP**

N.D.S. Drilling Supply
26041 Newton Circle
Elko, MN 55020
Phone #952-461-3400
Fax # 952-461-3403

**OPERATING AND
SERVICE MANUAL**

**Gardner
Denver**

**MAINTAIN PUMP RELIABILITY AND PERFORMANCE WITH
GENUINE GARDNER DENVER
PARTS AND SUPPORT SERVICES**

Gardner Denver® and OPI® genuine pump parts, manufactured to design tolerances, are developed for optimum dependability. Design and material innovations are the result of years of experience with hundreds of different pump applications. Reliability in materials and quality assurance are incorporated in our genuine replacement parts.

Your authorized Gardner Denver and OPI distributor offers all the backup you'll need. A worldwide network of authorized distributors provides the finest product support in the pump industry.

Your local authorized distributor maintains a large inventory of genuine parts and he is backed up for emergency

parts by direct access to the Gardner Denver Master Distribution Center (MDC) in Memphis, Tennessee.

Your authorized distributor can support your Gardner Denver and OPI pump needs with these services:

1. Trained parts specialists to assist you in selecting the correct replacement parts.
2. Repair and maintenance kits designed with the necessary parts to simplify servicing your pump.

Authorized distributor service technicians are factory-trained and skilled in pump maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair services.

For the location of your local authorized Gardner Denver and OPI distributor refer to the yellow pages of your phone directory or contact:

Distribution Center:
Gardner Denver
Master Distribution Center
5585 East Shelby Drive
Memphis, TN 38141
Phone: (901) 542-6100
Fax: (901) 542-6159

Factory:
Gardner Denver
1800 Gardner Expressway
Quincy, IL 62301
Phone: (217) 222-5400
Fax: (217) 224-7814

INSTRUCTIONS FOR ORDERING REPAIR PARTS

When ordering parts, specify Pump MODEL and SERIAL NUMBER (see nameplate on unit). The Serial Number is also stamped on top of the cylinder end of the frame (cradle area).

All orders for Parts should be placed with the nearest authorized distributor.

Where NOT specified, quantity of parts required per pump or unit is one (1); where more than one is required

per unit, quantity is indicated in parenthesis. **SPECIFY EXACTLY THE NUMBER OF PARTS REQUIRED.**

DO NOT ORDER BY SETS OR GROUPS.

To determine the Right Hand and Left Hand side of a pump, stand at the power end and look toward the fluid end. Right Hand and Left Hand are indicated in parenthesis following the part name, i.e. (RH) & (LH), when appropriate.

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INSTALLATION — The pump should be installed in a light, clean, dry place fully protected from the weather and as close to the fluid supply as possible. Ample space should be provided around the pump to facilitate inspection and adjustment with particular attention to the space required for removal and installation of piston rods.

Pump should be properly leveled and securely anchored to the foundation. In the case of large steam pumps, it is well not to bolt the steam end too tightly, allowing some "float" to take care of expansion and contraction.

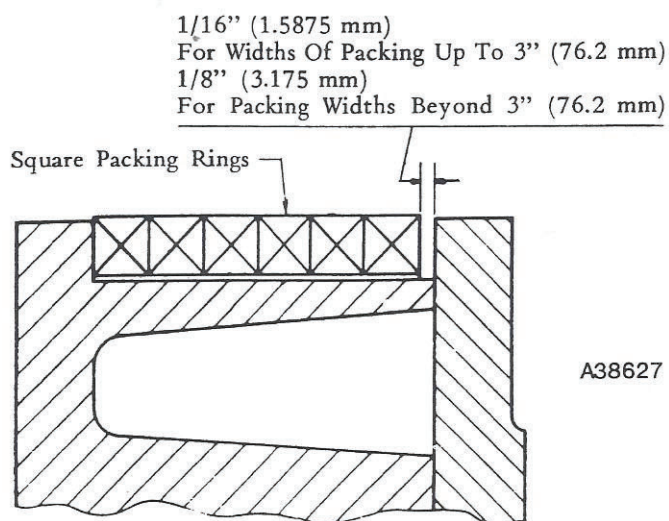
PIPING — All piping must be supported independently of the pump to insure that no strain is imposed on the pump by misalignment or improperly fitted pipe. Blow all pipes free from scale, dirt or chips with compressed air or steam.

Fluid Inlet Or Suction Piping — Inlet piping should be as direct and short as possible and should be laid out so that air pockets are eliminated. The inlet pipe size must never be smaller than the pump inlet and lines longer than 20 feet (6.096 m) must be one or two pipe sizes larger. A suction lift of 22 feet (6.71 m) (including friction) must never be exceeded. When fluid inlet temperature exceeds 160° F. (71.1° C.) (at sea level) the fluid must flow to the pump with a positive head at all times. The inlet line should be tested for leaks with 25 to 35 P.S.I. (1.758 to 2.461 kg/cm²) air pressure.

In cases where the pump must operate with a suction lift in excess of 15 feet (4.57 m) or a line over 100 feet (30.48 m) in length, the installation of a foot valve will insure quick starting and is always recommended. To protect the pump from foreign matter, an inlet strainer should be installed with a net area of four times the inlet pipe.

Fluid Discharge Piping — It is advisable to use an ample size discharge line to prevent excessive friction losses. If a gate valve is located in the discharge line, a relief valve must be installed in the line close to the pump between the pump and gate valve.

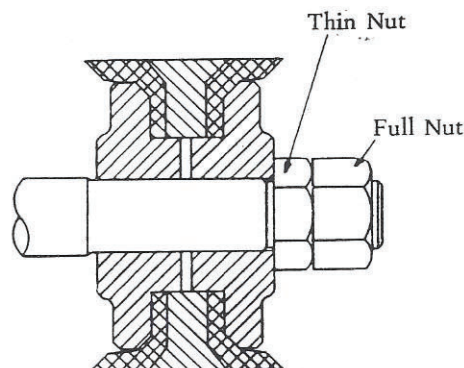
Steam Inlet And Exhaust Piping — These lines must be of ample size, never less than the size of the pump openings and provision should be made to allow for expansion. A high quality steam tight throttle valve should be installed in the inlet line as close to the pump as possible.



PACKED TYPE PISTON

FLUID PISTONS & PACKING — Four general types of fluid pistons and packings are used, depending upon operating conditions or requirements.

Low Pressure Water Or Boiler Feed Service — Iron or bronze follower type pistons with fibrous duck and rubber rings having regular or rock hard cure. Regular cure rings are recommended for fluids with temperatures of 180° F. (82.2° C.) or lower. Rock hard rings should always be used for fluids with higher temperatures to 250° F. (121.1° C.) maximum. Ring lateral clearance between the follower and piston body flange is determined by the amount of packing. Clearance should be 1/16" (1.5875 mm) for 3" (76.2 mm) width packing and under, and 1/8" (3.18 mm) for width beyond 3" (76.2 mm). The rings should be installed with the end step-cut joint gap of 1/32" (.795 mm) for 3" (76.2 mm) diameter and under, 1/16" (1.5875 mm) for 3" (76.2 mm) to 7-1/2" (190.5 mm) and 1/8" (3.18 mm) beyond 7-1/2" diameter. All regular cure and rock hard piston packing should be soaked at least eight hours in warm water before installing.



CUP TYPE PISTON

High Pressure Special Fluid Service — For high pressure water and abrasive fluids, the cup type pistons are recommended. Pistons are available in bronze, steel, iron, monel and stainless steel. Fluids such as acids and alkalis require special cup compositions and should be referred to factory for information.

Temperature	Pressure	Texture
-20 to 212° F. (-28.8 to 100° C.)	0 to 125 P.S.I. (0 to 8.79 kg/cm ²)	Soft
-20 to 300° F. (-28.8 to 148.8 °C.)	100 to 500 P.S.I. (7.03 to 35.15 kg/cm ²)	Medium
30 to 300° F. (-1.1 to 148.8 °C.)	500 to 1000 P.S.I. (35.15 to 70.31 kg/cm ²)	Hard

To assemble piston to rod proceed as follows: Mount hub to taper, fit cup snugly to hub, mount spacing plate, mount outer cup, mount follower plate and tighten nut and locknut securely. For texture of cups see table above.

Oil Or Petroleum Products Service (All Pressures) — Solid metal pistons with grooves and metal snap rings or nonmetallic rings with expanders. Piston ring grooves have the proper clearance but it is necessary to check rings for end clearance. Insert each ring in the cylinder liner and check

end clearance with a feeler gauge. Metal rings should have from .003" (.076 mm) to .004" (.102 mm) per inch (25.4 mm) of ring diameter and nonmetallic should have from .006" (.152 mm) to .008" (.203 mm) per inch (25.4 mm) of ring diameter.

"Slush-Proof" High Pressure Pistons For Abrasive Service — Steel body with replaceable synthetic rubber insert

Piston Rod And Valve Rod Stuffing Box Packing — Piston rod packing may be supplied in formed sets, molded or formed rings or in a continuous piece while valve rod packing is one continuous piece. When packing the stuffing boxes pull the glands just tight enough to keep the packing from leaking. It is considered good practice for rods to be slightly wet on out strokes when pumping clear fluids. Do not tighten glands too tight. In repacking a stuffing box all old packing should be removed and new packing used for replacement. Do not add single new ring to old set of packing.

LUBRICATION — A lubricator is recommended for all steam pumps. A mechanical lubricator is superior but on small pumps a sight feed type is permissible. Air driven pumps should be equipped with a *Gardner-Denver*[®] air line oiler.

Steam cylinders should always be lubricated with a good quality steam cylinder oil. When pump is operated with superheated steam, a special oil for superheated steam must be used. Air operated cylinders should use a good grade of motor oil. Rocker stand grease cups should be supplied with NLGI Grade No. 2 multi-purpose grease. Open type valve motion parts with oil holes should be supplied each day with oil by means of a spring type oil can.

The quantity of steam cylinder lubrication required is governed by so many factors, such as use of exhaust steam for processing, condition of inlet steam (whether saturated or superheated), steam pressures, etc., that it is recommended that a representative of a reputable lubrication vendor be consulted.

It is not recommended that steam pumps, particularly those with slide valves, be operated without cylinder lubrication. If operation without lubrication is absolutely essential, always use a piston valve steam end, but excessive wear of parts will be experienced.

STARTING THE PUMP —



DANGER

Before starting a pump, these points should be checked:

(Also see page 4)

1. Open steam exhaust line valve (if one is used).
2. If suction and discharge fluid lines have valves in the lines they must be opened.
3. Open all steam cylinder drain cocks.
4. Check lubrication points including lubricator.
5. If fluid end is not filled from previous operation, open priming cock in fluid discharge cap or remove the priming plugs in the fluid discharge passage.
6. Check fluid end drains and make sure all plugs or cocks are tight.
7. Crack the steam throttle valve and permit the steam end to warm up.

The pump may short stroke and run erratically until the fluid cylinders are filled. As soon as the pump primes close the fluid priming cocks or openings and when all condensate is out of the steam cylinder, close the drain cocks.

It is advisable to check the stuffing boxes, lubricator and pressure gauge upon reaching recommended operating speed.

OPERATING SPEEDS — While the viscosity, temperature and pressures of the fluid to be handled govern to a great extent the speed at which the pump should be operated, the table below shows operating speeds of steam pumps under average conditions.

LOCATING PUMP TROUBLES — Failure To Deliver Required Volume —

- a. Pump not primed
- b. Insufficient speed
- c. Fluid liner worn
- d. Suction lift too high
- e. Air leaks in suction or stuffing boxes
- f. Foot valve too small or clogged
- g. Suction pipe not immersed deep enough
- h. Fluid piston packing worn
- i. Fluid valves worn

Failure To Create Rated Pressure —

- a. Low steam pressure
- b. High back pressure
- c. Piston rings in steam end worn
- d. Piston rings in fluid end binding

Stroke Of Pump	General Service				Boiler Feed Service	
	Normal		Maximum		Cycles Per Minute	Strokes Per Minute Of Each Piston
	Cycles Per Minute	Strokes Per Minute Of Each Piston	Cycles Per Minute	Strokes Per Minute Of Each Piston		
3" (76.2 mm)	50	100	100	200	36	72
4" (101.6 mm)	50	100	100	200	33	66
5" (127 mm)	45	90	90	180	29	58
6" (152.4 mm)	45	90	90	180	26	52
10" (254.0 mm)	30	60	60	120	23	46

- a. Piston diameters not properly proportioned.
- f. Pistons improperly packed
- g. Valves not holding.
- h. Leakage past fluid piston rings.
- i. Leakage past liner packing.
- k. Liners worn.

Pump Loses Capacity After Starting —

- a. Leaky suction line.
- b. Suction lift too great
- c. Entrained vapors in fluid

Pump Vibrates —

- a. Fluid pistons improperly packed
- b. Foundation not sufficiently rigid
- c. Fluid piston packed too tight
- d. Fluid valves improperly seated

Pump Tends To Short Stroke —

- a. Steam and fluid packing too tight
- b. Improper adjustment
- c. Fluid cylinder liner worn out of true.
- d. Piston rods worn out of true.

Pump Erratic In Operation —

- a. Vapor trapped in fluid end
- b. Suction lift too great
- c. Pump operating beyond rating

ROUTINE MAINTENANCE — Daily Care — The steam pump can be expected to give long and trouble-free operation if kept clean, well lubricated and with attention given to packing leakage, unsteady operation and abnormal conditions.

If removed for inspection, valves and seats must be returned to their original location to avoid leakage.

SERVICE INSTRUCTIONS — Due to the extreme simplicity of construction of steam pumps, no complicated service problems are encountered. Parts are few and the relation of each to the other is readily apparent. Special instructions concerning packing and steam valve settings are contained in this manual and aside from normal maintenance no special instructions are required.

WARNING

When handling the steam and fluid end piston rods when making replacement or adjustment, care must be exercised not to damage or nick the highly polished finish where the rods travel through the stuffing boxes.

CEMENT OR GROUT PUMPS — Special attention must be given the fluid ends of pumps handling material such as fluid cement, grout, etc., which harden when dormant. All fluid passages must be completely cleaned of the material and thoroughly flushed with clean water.

It is advisable, if any doubt exists concerning the complete removal of such material, to remove valve covers and cylinder heads for complete examination and cleaning.

Provision has been made in the popular sizes of grout fluid ends to install large size pipe plugs for ready inspection of the suction passages and to permit easy flushing of foreign

material

In the majority of cases these pumps are used out-of-doors and special precautions must always be taken to drain both fluid and steam or air ends at the conclusion of operations each day during freezing weather and whenever the pump is to be idle or stored for any appreciable length of time.

ORDERING OF REPAIR PARTS — Repair parts lists with sectional views are available for any *Gardner-Denver®* steam pump and may be secured from Cooper Petroleum Equipment Division, Quincy, Illinois, or any of the branch or foreign offices.

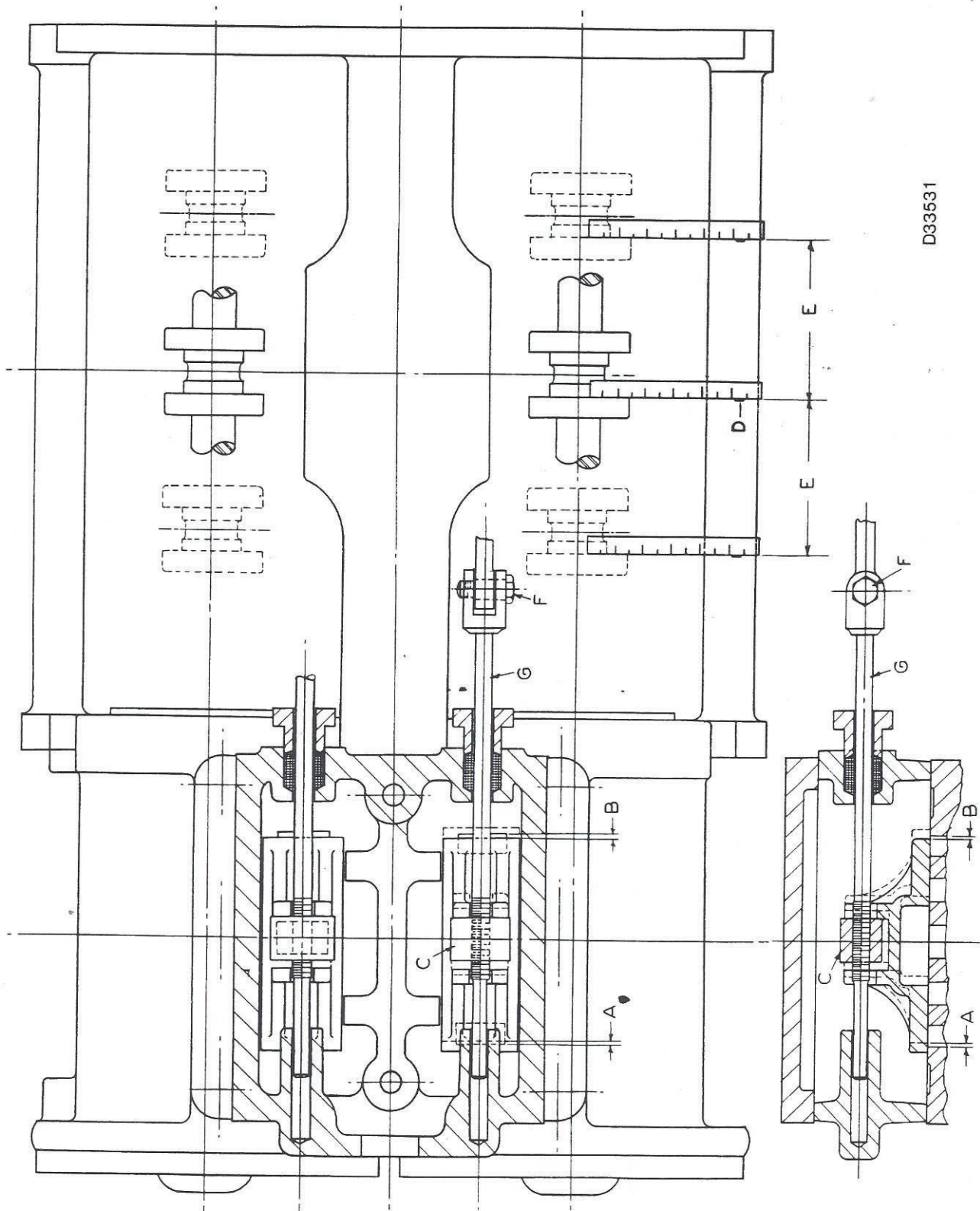
When ordering parts list of repairs always give size and serial number of pump. Small pumps have the serial number stamped on a raised pad on the steam chest cover. Large pumps have the serial number stamped on a raised pad located at the front of the steam cylinder at the point where the cylinder head is attached. If the serial number is not available, obtain several photographic views, including part numbers on principal castings, which should furnish us clues as to the identity of the pump.

STEAM SLIDE VALVE SETTING — To set the steam valve on any *Gardner-Denver®* slide valve steam pump the following procedure should be followed:

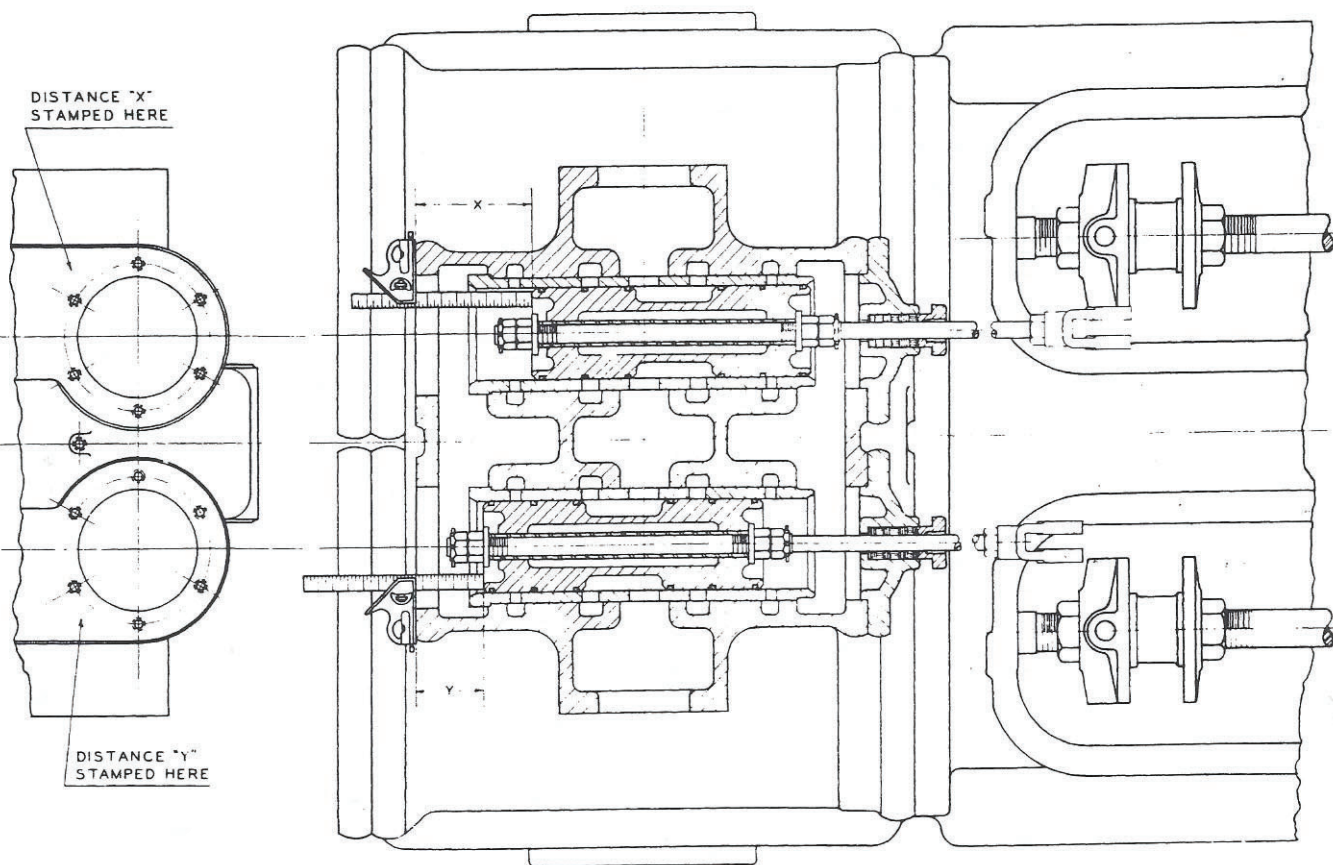
1. Bar the piston rod toward the steam cylinder until the piston strikes the cylinder head. Lay a straight edge against the crosshead face and over the frame. Mark the frame with a chisel where the straight edge crosses the bead of the frame.
2. Bar the piston to the other end of the cylinder until the piston strikes the cylinder head and with the straight edge mark the frame in a similar place. Be sure the straight edge is placed against the same face of the crosshead.
3. Divide the distance between these two marks (E) and mark the frame at the midpoint as shown at D. Now bar the piston rod toward this middle mark and when the straight edge is placed against the same face on the crosshead and registers with the middle or center mark D, the piston is in midtravel. Set both piston rods in midtravel and leave them in this position for subsequent operations.
4. Remove steam chest cover.
5. Push slide valve as far as it will go to either end of its travel. Note amount of port opening at the other end of valve as shown at A.
6. Push valve to the other end of its travel and note port opening at other end of valve as at B. These two port openings should be the same. Move valve driving block C on its thread to correct any difference in the port openings A and B. Remove screw F and turn valve rod G in or out of block C to make A and B equal. See illustration D33531.
7. Do this for both valves. Be sure not to move the pistons during these operations.
8. Push one valve as far as it will go in either direction and replace chest cover. Pump is ready to use.

Special Care Of Pump In Storage — Piston Rod, Valve

D33531



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D24903

Rod and Piston Packing must never be installed until just before the pump is put into service. Permitting packing to remain in an idle pump for a long period of time will tend to create rusting and pitting of the liner bore and the piston rods.

STEAM PISTON VALVE SETTING — To set the steam valve on any *Gardner-Denver*® piston valve steam pump the following procedure should be followed:

1. Bar the piston rod toward the steam cylinder until the piston strikes the cylinder head. Lay a straight edge against the crosshead face and over the frame. Mark the frame with a chisel where the straight edge crosses the bead of the frame.
2. Bar the piston to the other end of the cylinder until the piston strikes the cylinder head and with the straight edge mark the frame in a similar place. Be sure the straight edge is placed against the same face on the crosshead.
3. Divide the distance between these two marks and mark the frame at the midpoint. Now bar the piston rod toward this middle mark and when the same straight edge is placed against the same face on the crosshead and registers with the middle or center mark the piston is in midtravel. The piston rod should be left in this position during the remainder of the operations.
4. Remove both valve chest covers from the valve chest over the opposite cylinder and measure the distance from the edge of the port to the end of the valve.

This is done by pushing the valve as far as it will go from one end. Check the distance between the end of the valve and the port (this should be about 1/16" [1.5875 mm]). Then go to the other end of the chest and push the valve as far as it will go and the distance the valve uncovers the port should be the same as that at the first end. Lengthen or shorten the valve rod to equalize these measurements.

All *Gardner-Denver*® piston valve steam pumps manufactured after January 1, 1939, are marked at the factory to show the correct valve setting.

The valve setting may, therefore, be checked without going thru the above routine.

Either on the valve chest face or on a small raised pad on each valve chest is a stamped figure. This figure is the distance from the face of the valve chest to the valve when the valve is pushed away as far as it will go when the piston which actuates the valve (which is the piston in the opposite cylinder) is against the outer cylinder head.

Therefore, to check the valve setting on *Gardner-Denver*® pumps where these marks can be seen:

1. Bar both crossheads toward the steam end until the pistons hit the cylinder heads.
2. Remove outer covers from the valve chests and push the valves in as far as they will go.
3. Measure the distance from the end of the piston valve

to the face of the valve chest. This distance should be the same as the figure marked on the face of the valve chest.

4. If this measurement does not equal the stamped figure, adjust by screwing the valve rod into or out of the fork.
5. It should be noted the measurements for the two valves are different.

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TORQUES

	FYFS ft-lbs	FYFS kg-m	FDFS ft-lbs	FDFS kg-m	FCFS ft-lbs	FCFS kg-m
Fluid Cylinder to Steam End Connecting Stud Nuts	210	29.0	590	81.6	590	81.6
Fluid Cylinder Head Stud Nut	---	---	---	---	590	81.6
Fluid Cylinder Liner Set Screw	25	3.5	25	3.5	25	3.5
Suction Manifold to Fluid Cylinder	---	---	---	---	260	36.0
Discharge Manifold to Fluid Cylinder	---	---	---	---	260	36.0
Suction Manifold Flange Nut	260	36.0	260	36.0	260	36.0
Discharge Manifold Flange Nut	260	36.0	---	---	800	110.6
Fluid End Piston Rod Nut (Slush-Proof Rod)	525	72.6	525	72.6	525	72.6
			AEAE ft-lbs	AEAE kg-m	AGAG ft-lbs	AGAG kg-m
Fluid Cylinder to Frame Connecting Screw			110	15.2	260	36.0
Fluid Cylinder Head Screw			110	15.2	150	20.7
Fluid Cylinder Liner Screw			75	10.4	75	10.4
Fluid Cylinder Cap Screw			150	20.7	260	36.0
Fluid Cylinder Valve Plate Screw			---	---	75	10.4