

WATEROUS COMPANY
South St. Paul, Minnesota 55075

F-1031
Section 4201.1

SECTION 4201.1
OVERHAUL INSTRUCTIONS
FOR
WATEROUS CM SERIES CENTRIFUGAL FIRE PUMPS
REVISED SEPTEMBER 1988

WATEROUS COMPANY

ILLUSTRATIONS AND REFERENCES

Figure 1	Impeller Support Plate
Figure 2	Packing Installation Bushing (CMH Pumps only)
Figure 3	CMH Pump with Third-Stage Head Removed
Figure 4	Threaded Rods Installed for Lowering Volute Cover
Figure 5	Lowering Volute Cover with Transmission Jack
Figure 6	Threaded Rods Installed for Removing M Series Transmission
Figure 7	Removing Second Stage Impeller Snap Ring
Figure 8	Impeller Lock Rings Exposed
Figure 9	Transmission Cap Braced for Removal
Figure 10	Impeller Shaft Assembly Set Up to Install Lock Rings
Figure 11	Impeller Lock Rings Installed
Figure 12	Wear Ring and Stuffing Box End Installed in Volute Body
Figure 13	Installation of Spring for Manual Ball Valve
Table 1	CM Pump Model Designations
Table 2	Tools and Equipment
Table 3	Impeller and Wear-Ring Dimensions

INTRODUCTION

This sections contains overhaul and repair instructions for Waterous CM Series centrifugal fire pumps, except for the transmissions. Since several types of transmissions are available for these pumps, they are covered in separate sections, beginning with Section 4300. Operation and Maintenance Instructions for these pumps are in Section 2101.2.

This section gives complete instructions for disassembling a CM Series pump, repairing it, and reassembling it. For minor repairs, use only those steps which apply. Three methods of pump disassembly are outlined. Before proceeding, check each method to determine which is best suited to a specific pump. Since this is written to cover all CM Series pumps, not all of the steps will apply to any one pump.

The Overhaul Instructions are divided into five major topics as follows: PREPARATION, DISASSEMBLING PUMP, INSPECTION AND REPAIR, REASSEMBLING PUMP, and TESTING. Special instructions or information which apply to pump models such as the CMH pump appear at the end of each topic.

TRANSMISSION TYPE

The CM pump Model designation, which is found on the pump serial plate, will indicate the type of transmission used with the pump. CM pump Model designations and transmission types are listed below, in Table 1.

**TABLE 1
CM PUMP MODEL DESIGNATIONS**

Pump Model	Transmissions		Type
CMB, CMHB, CMUB	MB	M Series	Gear Drive
CMBX, CMHBX, CMUBX	MBX	M Series	Gear Drive
CMC, CMHC, CMUC	MC	M Series	Gear Drive
CMCX, CMHCX, CMUCX	MCX	M Series	Gear Drive
CMBE, CMHBE	MBE		Gear Drive
CMBEX, CMHBE	MBEX		Gear Drive
CMK, CMHK, CMUK	K	K Series	Gear Drive
CMF, CMHF, CMUF	F	F Series	Gear Drive
CMWB, CMHWB	WB	W Series	Chain Drive
CMWBX, CMHWBX	WBX	W Series	Chain Drive
CMYB, CMHYB, CMUYB, CMUHYB	YB	Y Series	Chain Drive
CMYBX, CMHYBX, CMUYBX, CMUHYBX	YBX	Y Series	Chain Drive
CMYC, CMHYC, CMUYC, CMUHYC	YC	Y Series	Chain Drive
CMYCX, CMHYCX, CMUYCX, CMUHYCX	YCX	Y Series	Chain Drive
CMD, CMHD, CMUD, CMUHD	No Transmission		Direct Drive

See Section 4300 for Transmission Overhaul Instructions.

REFERENCE NUMBERS

The text below frequently uses "reference numbers" when discussing specific parts. These numbers refer to the parts called out in the Service Parts Lists at the end of this section. Since several of these parts lists are attached, be sure to determine which one applies to the pump being repaired.

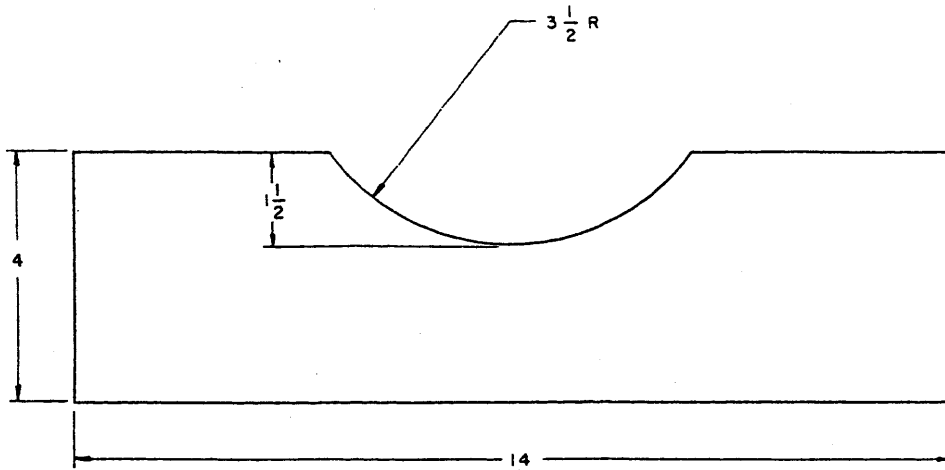
The letter prefix on each reference number identifies the type of assembly to which the number applies. The letter prefixes and their applications are as follows:

PREFIX	APPLICATION
B	Main Pump Body
L	Third Stage Body
S	Impeller Shaft Assembly
A	Electric Transfer Valve Actuator Assembly
AM	Manual Transfer Valve Actuator Assembly

The pump serial number and the part reference number must be supplied when replacement parts are ordered from the Waterous Company.

TOOLS AND EQUIPMENT

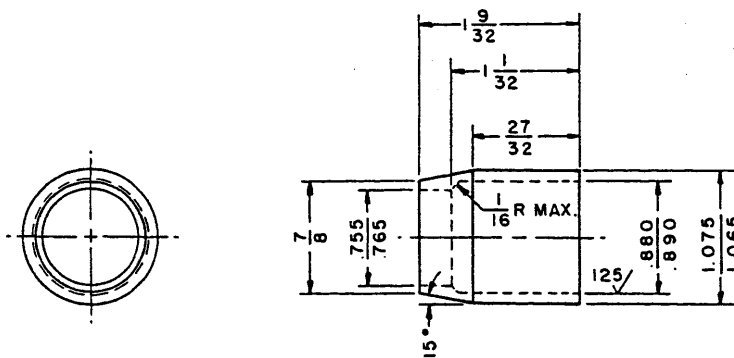
Table 2 lists the items required to overhaul a CM Series pump in accordance with the instructions given below. It supplements the tools and equipment suggested in Section 4100.



CUT FROM 3/4 STEEL PLATE

Fig. 1. Impeller Support Plate

62-10-2



NOTE: FINISH ALL OVER $\frac{63}{\sqrt{}}$
BREAK ALL SHARP CORNERS

Fig. 2. Packing Installation Bushing (CMH Pumps only)

62-10-1

TABLE 2
TOOLS AND EQUIPMENT

ITEM	QUANTITY REQUIRED	APPLICATION
1. Threaded rods, 1/2-13 x 18 in. Hex nuts, 1/2-13 Pipe nipples, 1/2 x 6 in.	1 to 3 3 to 9 1 to 3	Methods 1 and 2
2. Threaded rods, 1/2-13 x 18 in. Hex nuts, 1/2-13	2 6	Method 2
3. Hoist and slings, 1/2-ton capacity	AR	Method 3
4. Saw horses, capable of supporting center section of pump	2	Method 3
5. Impeller support plates, similar to Fig. 1	2	
6. Packing installation bushing, similar to Fig. 2	1	CMH Pumps
7. Transmission Jack	1	Methods 1 and 2

PREPARATION

The following steps are necessary to prepare a pump for disassembly. They are grouped according to the type of CM Series pump to which they apply.

CM PUMPS

1. Disconnect cooling and drain lines, electrical wiring and similar connections to pump, pump transmission, and accessories.
2. Drain lubricant from transmission by removing drain plug.
3. Disconnect propeller or drive shaft(s) from transmission.
4. Loosen unbalanced nuts (B3), and remove packing glands (S3) from each end of impeller shaft.
5. Remove bolts (S32) and lock washers (S36). Pull outboard bearing housing (S14) from bore in body using jack screws in tapped holes in bearing housing.

CMH PUMPS

1. Disconnect cooling and drain lines, electrical wiring and similar connections to pump, pump transmission, and accessories.
2. Drain lubricant from transmission by removing drain plug.
3. Disconnect propeller or drive shaft(s) from transmission.

4. Loosen unbalanced nuts, and remove packing glands from each of the three stages.

5. Disconnect third-stage discharge piping from pump.

6. Remove drain and vent assembly from third-stage pump.

7. Remove cap screws (L20), and pull flange(L2) away from pump head. Turn elbow (L29 or L31) as necessary to move hose (L15) and flange away from pump. Discard gasket (L1).

NOTE

Lack of space between pump and chassis may prevent removing third-stage body. If this condition exists, remove hose and attaching parts as outlined in steps 6 and 7, but wait until impeller shaft assembly is removed from the pump to disassemble third stage.

8. Remove cap screws (L19) and copper washers (L25), and carefully pull off pump head (L7). Discard gasket (L5). (See Fig. 3.)

9. (See Fig. 3.) Remove cotter pin (S47). Unscrew impeller nut (S46), and pull impeller (S5) from end of shaft (S22). Do not lose impeller spacer (S49) which may come off with impeller.

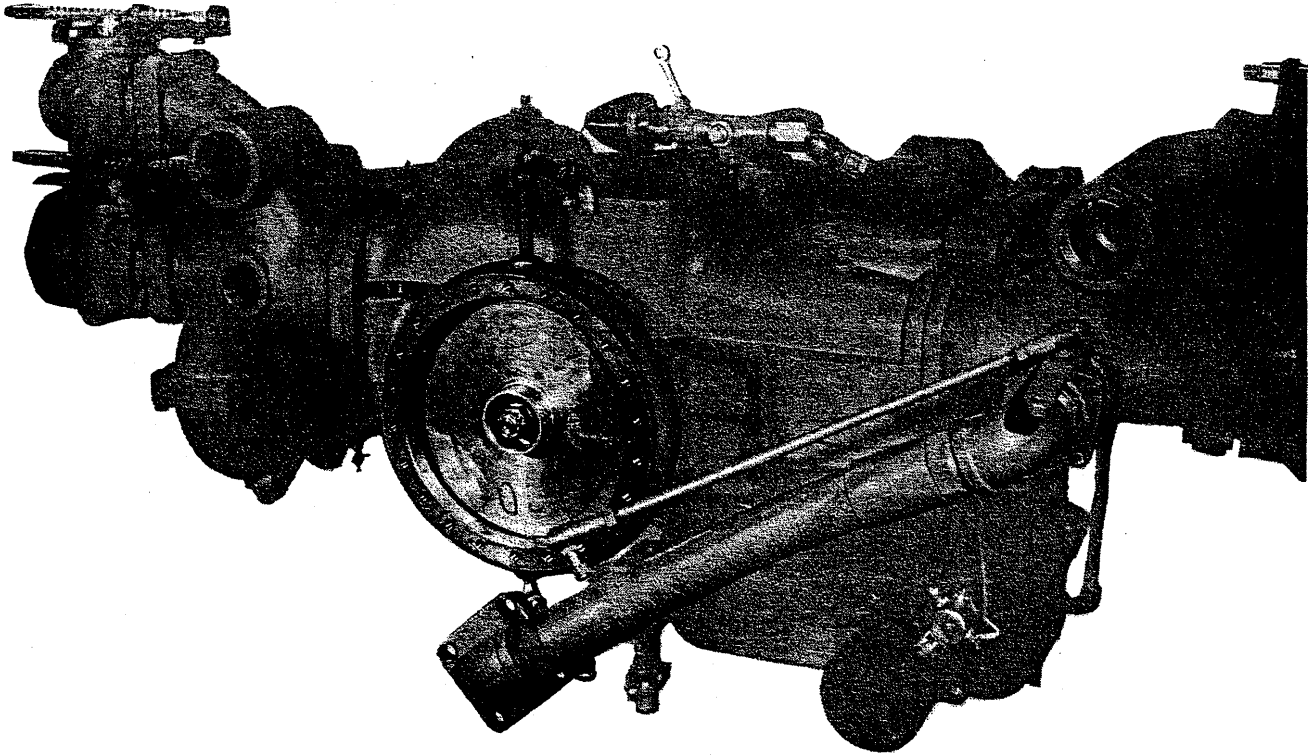


Fig. 3. CMH Pump with Third-Stage Head Removed

1783

NOTE

If no suitable puller is available, use third-stage body to remove impeller. When doing so, be sure to pull evenly on body.

10. Disconnect hose (L14). Remove bolts (L37) and lock washers (L24), and carefully slide third-stage body (L8) from impeller shaft.

DISASSEMBLING PUMP

This portion contains three methods of disassembling a CM Series pump into its major components, except for the transmission. Briefly, these methods are as follows:

METHOD 1 consists basically of removing the transmission and volute cover separately to expose the impeller shaft assembly. Threaded rods or a transmission jack are used to lower the transmission, as well as the volute cover with the assembled impeller shaft resting on the cover. Although the entire procedure may seem longer than the others, it may simplify pump reassembly.

METHOD 2 is essentially the same as Method 1, except that the transmission remains attached to the volute cover. This method speeds up dis-

assembly, and if balance is maintained, it will also speed up reassembly. With this method, separating the volute cover from the body is easier than in Method 1. This method might prove more practical with transmissions in the F, K, and W Series.

METHOD 3 consists basically of removing the transmission, separating the assembled pump body from its suction adapters, and raising or lowering it clear of the chassis. This method is practical only if the construction of the truck body permits free access to the top and sides of the pump.

METHOD 1, PROCEDURE

This method consists of removing the transmission and volute cover separately to expose the impeller shaft assembly. It is especially effective with the M and Y Series transmissions.

1. Remove transmission as directed in transmission overhaul instructions. (Sections 4301 thru 4306.) The M and Y series transmission cap is left attached to the pump shaft.

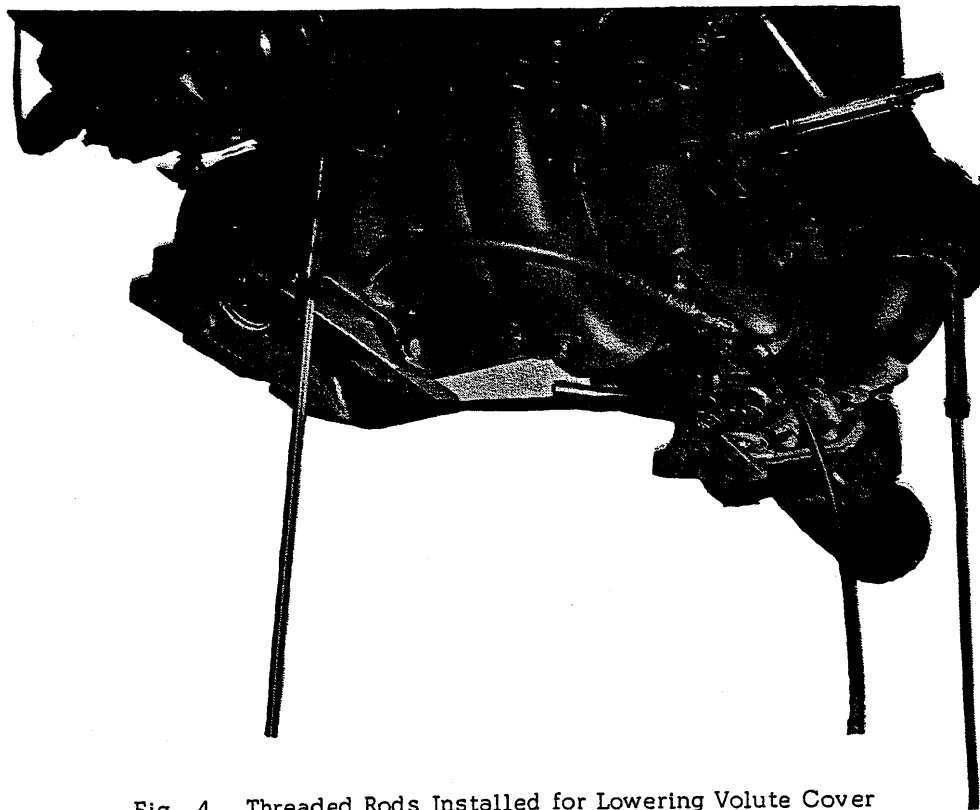


Fig. 4. Threaded Rods Installed for Lowering Volute Cover

1784

2. Remove one cap screw (B17) from each corner near dowel pin locations, and install 1/2-in. threaded rods, hex nuts, plain washers, and pipe nipples (see Fig. 4), or use transmission jack to support cover (B9). Remove all cap screws (B17, B18, B19, B20, and B43), and copper washers (B29) which attach volute cover (B9) to body (B8). Use two of the removed cap screws inserted into the threaded holes next to the dowel pins to jack the cover away from the body.

3. Turn upper hex nuts on threaded rods down evenly to lower the volute cover (B9), or lower the transmission jack. Impeller shaft assembly will come down with cover. (See Fig. 5.)

4. Carefully remove impeller shaft assembly from volute cover. Care must be exercised in removal of the impeller shaft so as not to damage the grooved ends of the body or cover in which the stuffing box end is located.

METHOD 2, PROCEDURE

This method is essentially the same as Method 1, except that the transmission remains attached to the volute cover. This method should be used with the F, K, or W Series transmission. Method 2 will make this type of transmission more accessible for removal and disassembly when the volute cover and transmission are removed from the chas-

sis. This method speeds up disassembly, and if balance is maintained, it will also speed up re-assembly. Parts of this method may be combined with Method 1 to speed up disassembly.

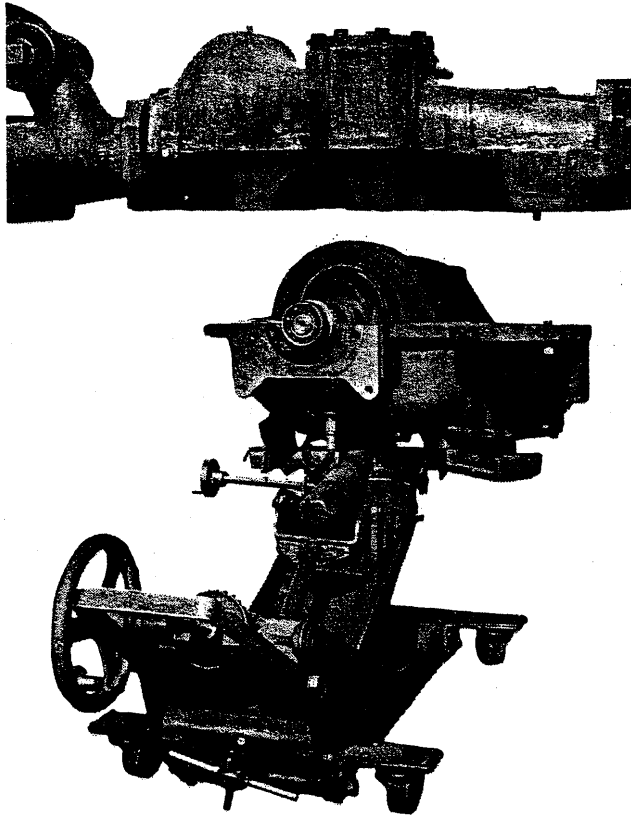
1. Remove two upper bolts and nuts attaching transmission to body.

2. Remove one cap screw (B17) from each corner near dowel pin locations, and one screw from other corner on transmission end of pump. Install 1/2-in. threaded rods, hex nuts, plain washers, and pipe nipples in these holes as shown in Fig. 4, or use a transmission jack as shown in Fig. 5. Remove all cap screws (B17, B18, B19, B20, and B43), and copper washers (B29) which attach volute cover (B9) to body (B8). Use two of the removed cap screws inserted into the threaded holes next to the dowel pins to jack the cover away from the body.

3. Turn upper hex nuts on threaded rods down evenly to lower the volute cover (B9), assembled impeller shaft, and transmission. A transmission jack may also be used to lower the cover and transmission.

4. Remove transmission assembly as directed in Section 4300.

5. Carefully remove impeller shaft assembly from volute cover.



1785

Fig. 5. Lowering Volute Cover with Transmission Jack

METHOD 3, PROCEDURE

This method consists of removing the transmission, separating the assembled pump body from the suction adapters, and raising or lowering it clear of the chassis. It is usable only if space directly above or below the pump permits it to be removed.

1. Remove transmission as directed in transmission overhaul instructions.
2. Loosen, but do not remove, all parts attaching pump to chassis.
3. Attach a suitable sling to pump and a hoist, and take up all slack in sling.
4. Remove all cap screws (B22), bolts (B23 and B24), and hex nuts (B25) attaching assembled pump body to suction adapters (B6 and B7). If possible, move one suction adapter away from body about 1/8 in. Raise or lower pump clear of truck.
5. Rest pump on horses with cover up. Remove all cap screws (B17, B18, B19, B20, B43), and copper washers (B29). Carefully lift volute cover from body to expose impeller shaft assembly.

DISASSEMBLING BALL TRANSFER VALVE

Ball transfer valve disassembly is usually necessary only for repair. To disassemble ball valve, disconnect electric or manual actuator from valve operating arm (A6 or AM7). Remove the 3 cap screws (B21) from transfer valve cover (B83). Use 3/8-16NC bolts as jacking screws in holes provided in cover to remove cover, ball valve, and housing as a unit. The transfer valve bushing (B11) which is mounted in the volute cover (B9) can be punched out through the two holes provided in the pump body (B8).

It should not be necessary to remove valve operating arm (A6 or AM7) except to replace O-rings (B26 or (B85), bushing (B11), or transfer valve ball (B14).

NOTE

Before removing the actuator, scribe or punch reference marks on valve stem and arm or gear sector to aid in reassembly.

DISASSEMBLING IMPELLER SHAFT ASSEMBLY

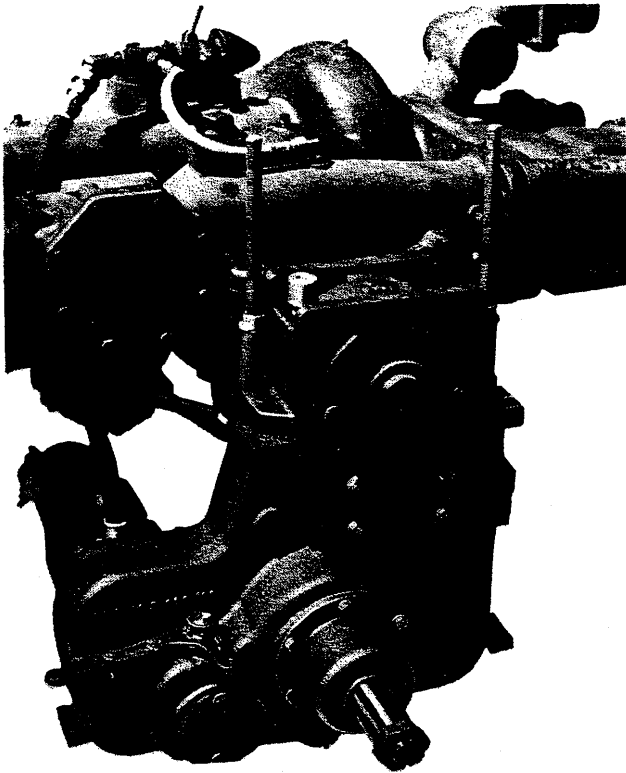
This gives the steps necessary to disassemble completely an impeller shaft assembly. Removal of the driven gear or sprocket and its associated parts (Step 1), applies only to pumps with M and Y series transmissions, and is unnecessary unless some of these parts are damaged or defective. Refer to Sections 4301 thru 4306 for transmission removal procedures.

Figure 1 illustrates a special plate which may be used for disassembling or reassembling an impeller shaft assembly. Two plates similar to the illustration, placed under an impeller and around the inter-stage seal, provide ample support for an impeller in an arbor press.

CAUTION

Removal of the snap ring (S50) is necessary before the front or second stage impeller (S21) is pressed off. See Step 3 below. It will be necessary to remove the rear or first stage impeller (S20) to obtain access to the snap ring.

1. Remove impeller shaft nut and lock washer. With a suitable puller, remove transmission cap, driven gear, spacers, and bearings. Remove cap screws attaching oil seal housing to cap, and discard gasket and oil seal.



1789

Fig. 6. Threaded Rods Installed for Removing M Series Transmission

CAUTION

When removing bearing housing or transmission cap, drivengear, and related parts, be sure to use a puller or press which will apply force to cap on side opposite puller. If necessary, make a steel plate, notched for impeller shaft, and attach puller to plate. If puller does not have a center point, place a piece of brass or similar soft material between puller and shaft to protect shaft center. Brace inside of transmission cap as shown in Figure 9. (Does not apply to W Series transmission.)

2. Carefully remove ball bearing (S1 or S7) and flinger rings (S4 or S6). (On CMH pumps, be sure to remove snap ring (S43), if used, before removing bearing (S7).) Slide packing (S11, stuffing box ends (S15), and wear rings (S17) from each end of shaft.

NOTE

Mark wear rings or keep them with impeller from which they were removed to permit checking impeller-hub clearance later on.

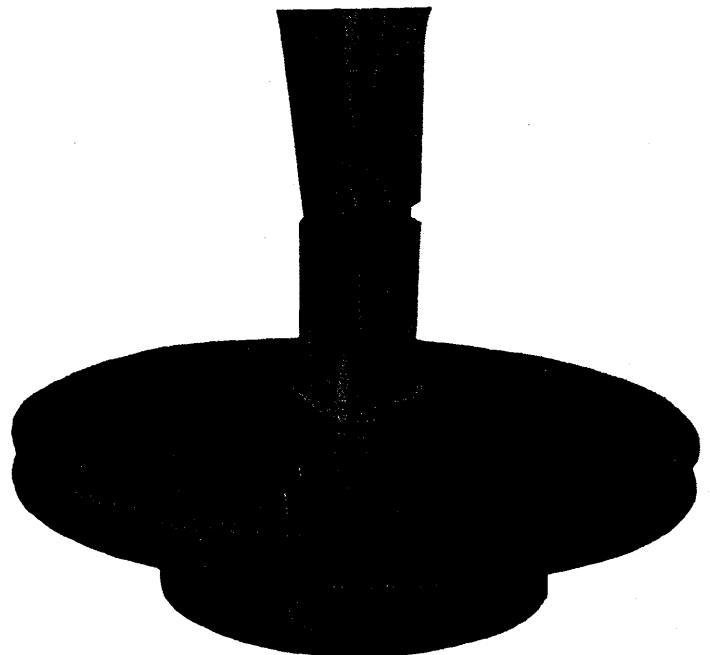
3. Place impeller shaft assembly in an arbor press so it rests on hub of first stage impeller (S20), on special impeller support plates shown. Apply force to upper end of shaft (S22) until lock rings (S8) are exposed or drop free (see Fig. 8). Invert the assembly so it rests on special plates, and press impeller down the shaft until access is available to snap ring (S50). Remove snap ring (S50) (see Fig. 7). Second stage impeller may now be removed from shaft by freeing lock rings in the same manner as for the first stage impeller.

NOTE

If driven gear and related parts were left on impeller shaft, both impellers may be removed from outboard end of shaft.

INSPECTION AND REPAIR

The following points cover inspection and repair of the major components of the CM Series fire pumps. Check parts not covered here in accordance with standard automotive shop practice. If the slightest doubt exists about the actual condition of any part, replacing it during overhaul is much better than taking a chance on its malfunctioning during future operations.



1788

Fig. 7. Removing Second Stage Impeller Snap Ring

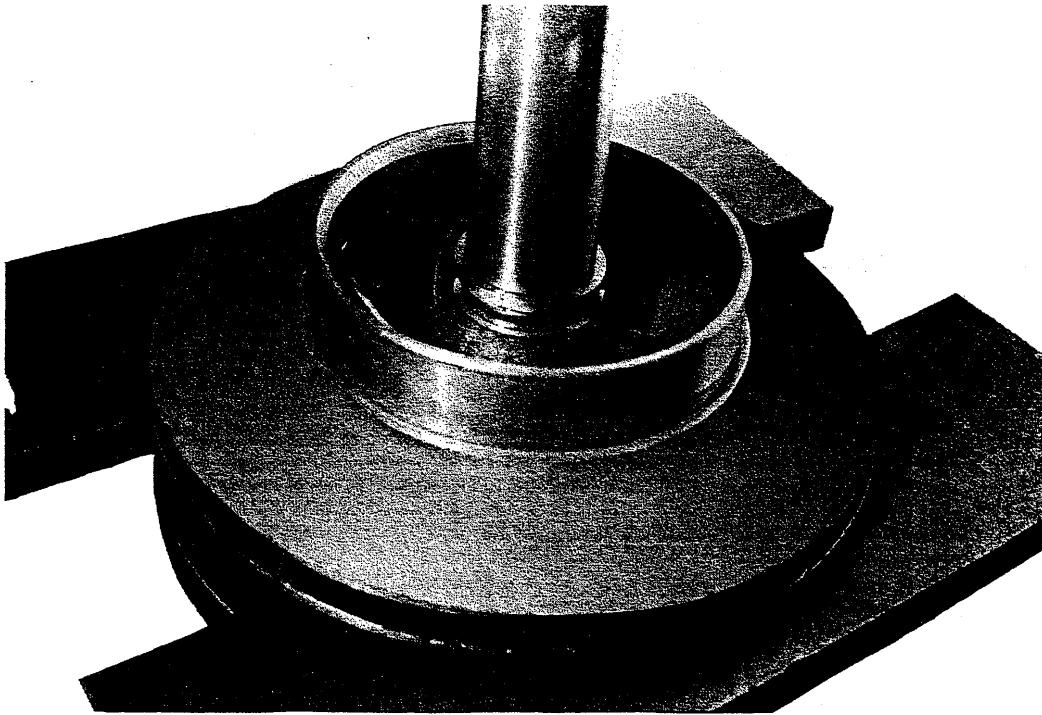


Fig. 8 Impeller Lock Rings Exposed

1. IMPELLERS - Check wear rings and impeller hubs for deep grooves or scratches. Spiral grooves or grooves parallel to the impeller shaft increase leakage. Inspect for excessive wear ring clearance. Diametral clearances in excess of .025 inches may warrant wear ring replacement. (Original factory clearance is .007 to .014 on plain hubs and .007 to .018 on Tungsten Carbide coated hubs.) The diametral clearance should be determined by averaging the results of four measurements taken at 90 degree increments as follows:

Clean and remove small burrs and other protrusions from the wear ring inner diameters and the impeller

hubs. Position each wear ring on the impeller hub on which it was used, hold the wear ring firmly against one side of the hub and measure total clearance on the opposite side using a feeler gauge.

Tungsten carbide coated impeller wear ring clearance is usually restored by installing a replacement wear ring with the same dimensions as the original wear ring since most wear occurs on the wear ring, not the impeller hub.

Plain impeller hub wear ring clearance is restored by turning impeller hubs and installing undersize wear rings as directed in Table 3 below.

TABLE 3

IMPELLER AND WEAR RING REPAIR DIMENSIONS

IMPELLER NO.	IMPELLER O.D.	ORIGINAL HUB DIA	ORIGINAL WEAR RING NO.	REWORKED HUB DIA	NEW WEAR RING NO.
71477-71478 or 71537-71538	9-1/2	5.501/5.500	71476	5.476/5.473 5.451/5.448 5.426/5.423	71476-25 71476-50 71476-75
71796-71797	9-1/2	5.501/5.498	71798	5.476/5.473 5.451/5.448 5.426/5.423	71798-25 71798-50 71798-75
71402T 71403T	10	REPLACE ORIGINAL WEAR RINGS			
71649T 71650T	10	REPLACE ORIGINAL WEAR RINGS			

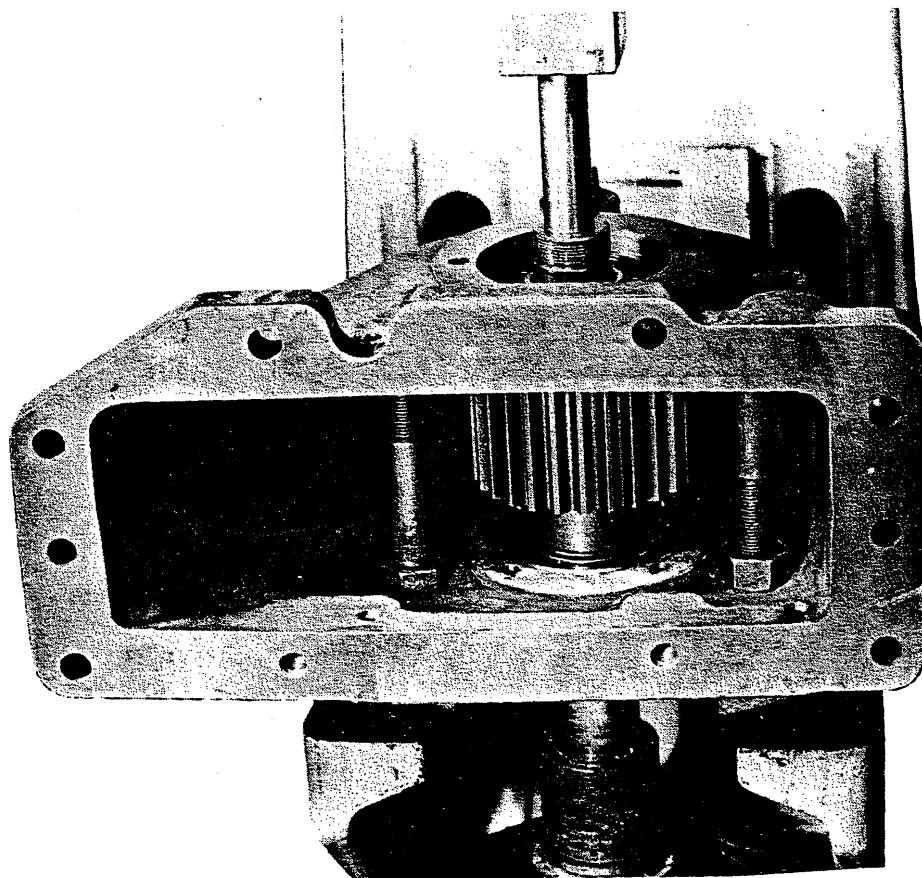


Fig. 9. Transmission Cap Braced for Removal

1786

If replacing an impeller is necessary, be sure to install a new, standard size wear ring. Examine lock rings, snap rings, lock nuts, washers, and keys for corrosion and other damage, and replace if condition is doubtful.

2. INTERSTAGE SEAL AND STUFFING BOX ENDS - These parts seldom need replacing if handled properly during pump disassembly and reassembly. If the total clearance between the interstage seal or stuffing box end and the impeller shaft is much greater than 0.011 in., then replacing the seal or stuffing box end may be desirable.

3. TRANSFER VALVE - Most damage to the transfer valve and its housing results from freezing or pumping very sandy water. Check valve for bulging or severe scratches. Rotate valve several times to make sure it turns freely in housing. If it binds, or if condition is doubtful, then replacement of both the valve and housing may be necessary.

INSTALLING UNDERSIZE WEAR RINGS

If inspection shows that the wear ring clearances are excessive, or the impeller hubs are scored or grooved, turn impeller hub in a lathe to an acceptable dimension at which they will clean up, and install undersize wear rings during reassembly. These repair rings are available in 0.025, 0.050,

and 0.075 in. undersize, except for the third stage on CMH pumps, for which no undersize wear rings are available. Table 3 gives the original hub dimensions for each impeller and the rework dimensions for each degree of undersize.

REASSEMBLING PUMP

REASSEMBLING IMPELLER SHAFT ASSEMBLY

Reassembly procedure is essentially the reverse of disassembly. Be sure the lock rings are seated securely under the impeller hubs as shown in Fig. 11. Also, be sure that impellers have a tight fit on shaft.

NOTE

Install the front or second stage impeller (S21) and snap ring (S50) before installing interstage seal (S16) and rear or first stage impeller (S20). This procedure must be followed only with pumps equipped with a snap ring (S50).

If undersize wear rings are required, install them at this time. If a new impeller is needed, also install a new standard size wear ring for it.

INSTALLING BALL TRANSFER VALVE

The ball valve, housing, cover, and operating arm may be installed as an assembled unit and bolted to the volute cover. Assemble the ball valve as shown on Body Assembly Parts List 80944, page 2 of 3. The dowel pin (B87) in cover (B83) must be correctly positioned with respect to the stops on the ball transfer valve (B14) if the valve is to open and close completely.

The reference marks made on ball valve (B14) stem, operating arm (A6 or AM7), and gear sector (A57 or AM5) during disassembly must be capable of alignment when valve reassembly is complete. To install spring (AM2) on manual transfer valve actuator, note position of parts in Fig. 13.

INSTALLING IMPELLER SHAFT AND COVER

Reassembling the pump is essentially the reverse of disassembly. Be sure to observe the following points regardless of the method of reassembly used.

1. When installing impeller shaft assembly, be sure that interstage seal (S16), wear rings (S17), and stuffing box ends (S15) fit into their respective slots in body (B8) and volute cover (B9). THESE SLOTS MUST BE CLEAN BEFORE REASSEMBLY TO PREVENT POSSIBLE INTERFERENCE. (Figure 12

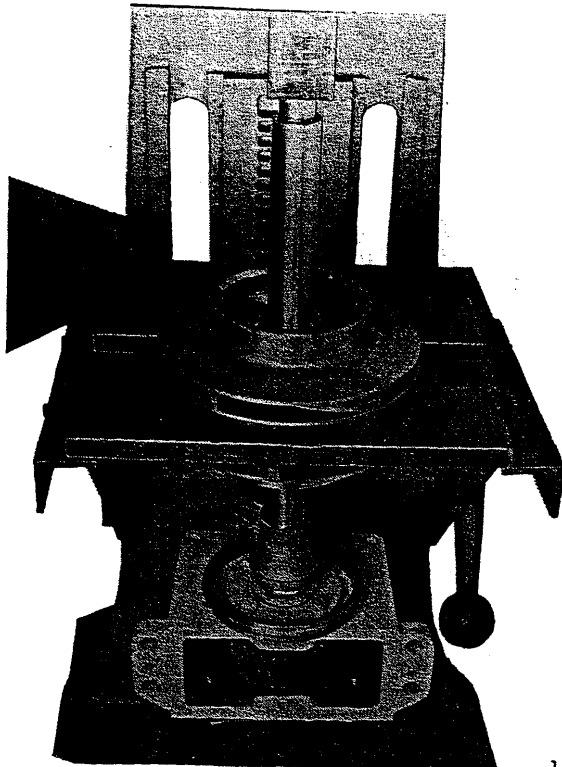


Fig. 10. Impeller Shaft Assembly Set Up to Install Lock Rings

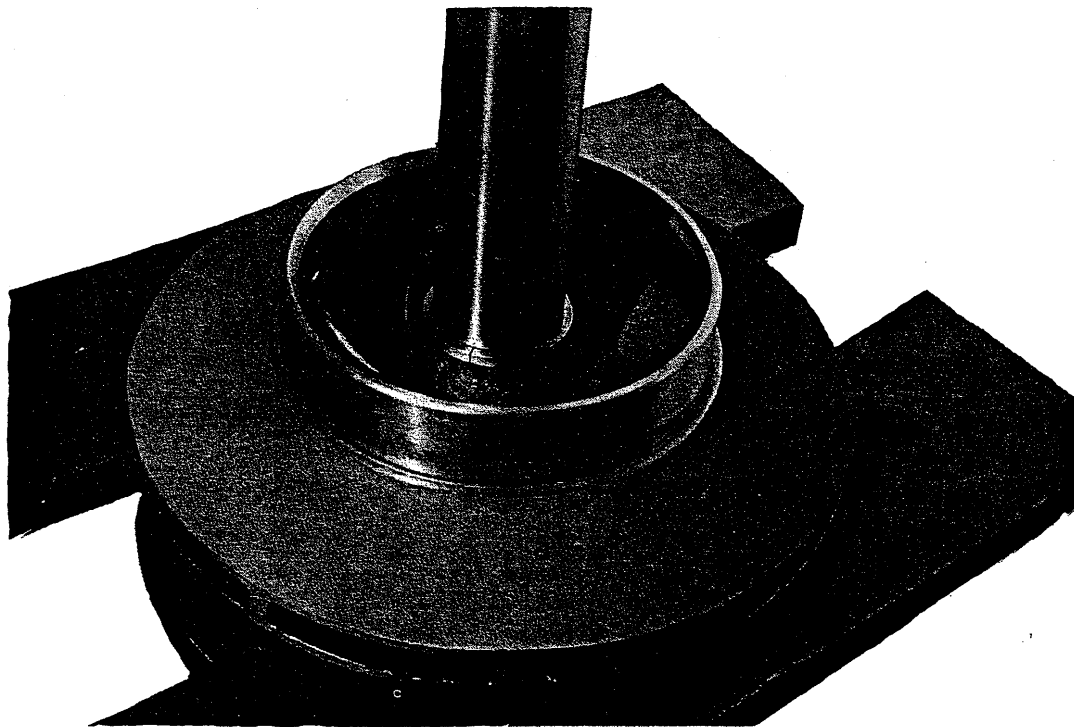


Fig. 11. Impeller Lock Rings Installed

1791

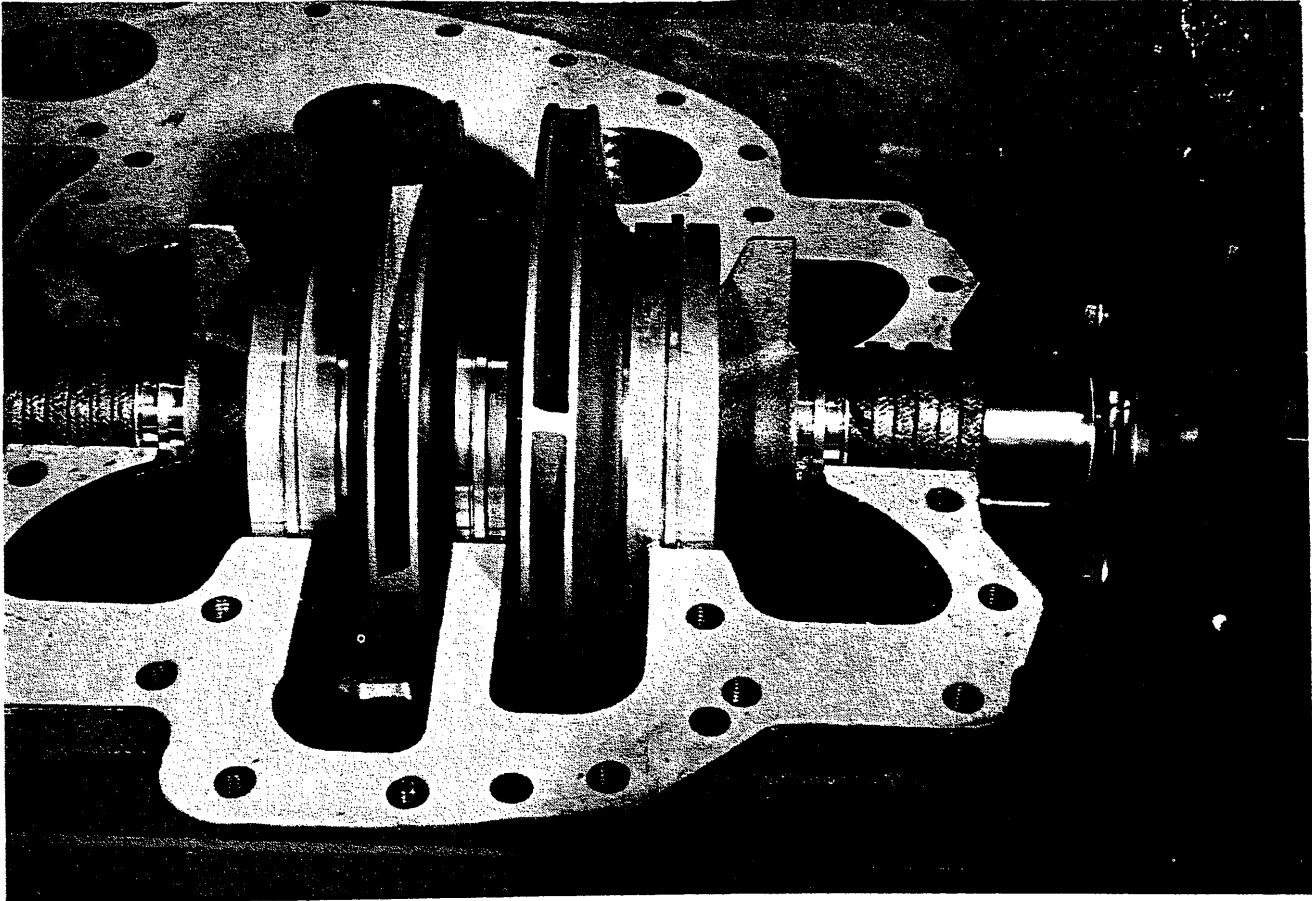


Fig. 12. Wear Ring and Stuffing Box End Installed in Volute Body

1792

shows correct positioning of a wear ring and stuffing box end in volute body). The stuffing box end may be equipped with two alignment pins which are located 180° from each other. Therefore the stuffing box end must be installed so that the fin of the stuffing box end will extend into the volute cover on reassembly.

NOTE

Installing the packing before mounting the transmission or volute cover is easier than waiting until the transmission or volute cover is installed.

NOTE

If third stage body and impeller were removed with the impeller shaft assembly, then install them on volute cover (B9) before proceeding.

FINAL ASSEMBLY

CM PUMPS

2. An effective guide can be made for installing the volute cover by cutting the heads off two 1/2-13 NC x 3" long bolts. Screw these studs into the pump body (B8) near the dowel pin (B30) locations.

1. Install outboard bearing housing (S14) in body bore, and secure with bolts (S32), and lock washers (S36). Lubricate outboard bearing (S1) on re-assembly.

2. Install propeller or drive shaft(s).

3. Whether using the threaded rods or a transmission jack, be sure to raise the volute cover and transmission case evenly, or the impeller shaft parts may not enter the body properly or engage the guides.

3. Connect all cooling and drainlines, electrical wiring, and similar connections to the transmission, pump, and related parts.

4. Install packing as directed in Section 2101.2, Packing Adjustment.

CMH PUMPS

1. Install and adjust packing in main pump as directed in Section 2101.2.

2. The third stage packing may be installed in third stage stuffing box of pump body (L8) before or after body is attached to pump. Care must be taken during installation to prevent damage to packing. Figure 2 illustrates a special bushing which can be made for installing the third-stage body with its packing already in place in the stuffing box. Although the pump can be reassembled without the bushing, its use will speed reassembly. The bushing prevents the impeller shaft threads from tearing or dislodging the packing during reassembly. The method of using it will be explained below.

3. If special bushing (Fig. 2) is used, install packing in third-stage body as directed in Section 2101.2 before mounting, but tighten gland nuts just enough to hold gland in place. If the special bushing is not used, tape can be placed over the shaft shoulder and the splines where the bushing would fit. Grease the inside diameter of the packing before installing the third-stage body.

Slide bushing on end of impeller shaft, and then install third-stage body. Remove bushing, or tape, and install impeller, hoses, and related parts.

NOTE

Packing may be installed after the third-stage body is attached to the pump.

4. Install impeller, hoses, and related parts.
5. Install third-stage discharge piping.
6. Install propeller or drive shaft(s).

7. Connect all cooling and drain lines, electrical wiring, and similar connections to transmission, pump, and related parts.

LUBRICATION

After pump is assembled, lubricate it and its transmission according to instructions in Section 2101.2 for details on pump lubrication and to sections beginning with number 2200 for information on transmission lubrication.

TESTING

Before a pump is returned to service, it is advisable to give it both hydrostatic and operational tests to check it for leaks and to make sure the pump operates properly. The operational tests may be combined with the packing adjustment described in Section 2101.2.

HYDROSTATIC TESTING

1. Connect pump to a hydrant or other pressurized water supply.
2. Close all drain lines, and open discharge and priming valve.
3. On CMH pumps, open control valve to admit water to third stage body.
4. Open hydrant until water runs out through discharge valves and discharge pipe in priming pump. Close all valves. **BE SURE TO EVACUATE ALL AIR FROM PUMP.**

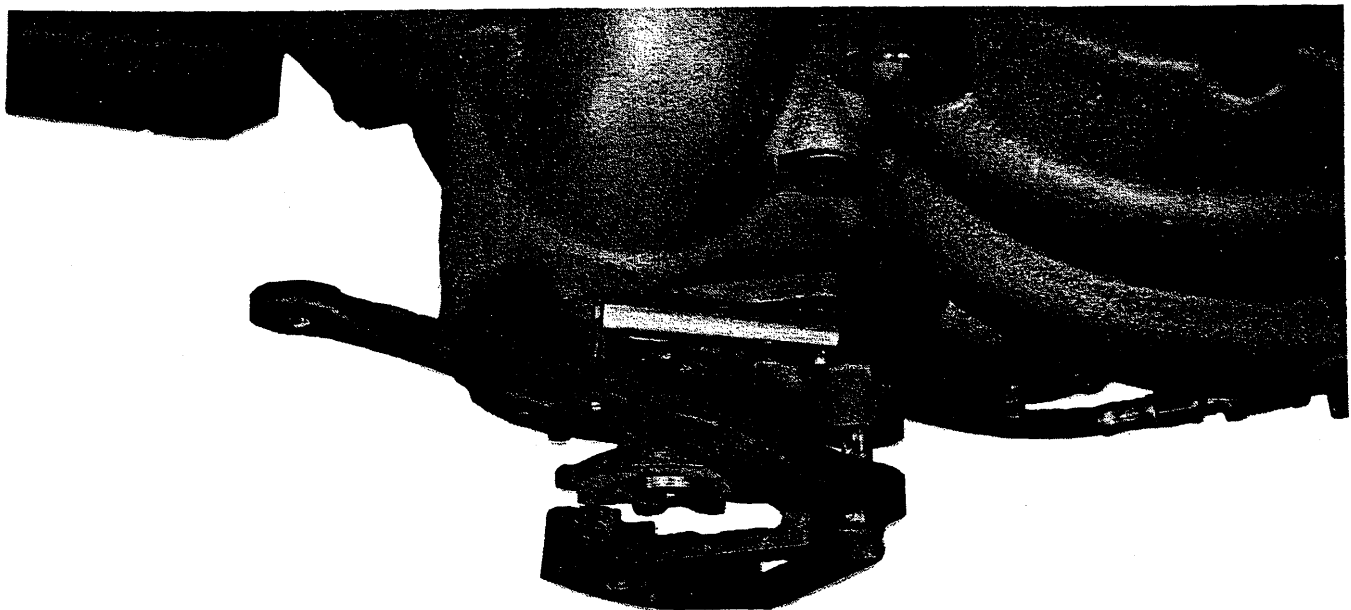


Fig. 13. Installation of Spring for Manual Ball Valve

5. Apply hydrant pressure to pump for 15 minutes. With a portable light, check pump for leaks. If leaks are discovered, tighten connections or attaching parts as necessary. If necessary to tighten packing, be sure to loosen and readjust packing as described in Section 2101.2.

6. After all leaks are eliminated, shut hydrant valve, drain pump completely, and disconnect suction hose.

OPERATIONAL TESTING

If desired, this test may be combined with the packing adjustment described in Section 2101.2.

1. Operate pump at its maximum intended service pressure. Do not exceed 600 psi for two-stage pumps or 800 psi for three-stage pumps.

2. With a portable light, check pump for water leaks. If leaks are discovered, stop pump, and tighten connections or attaching parts as necessary. Repeat until all leaks are eliminated.

3. While pump is running, check for unusual noises, oil leaks, overheated bearings, etc. If anything unusual is discovered, stop pump immediately, and determine the cause.

