

Rev A
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**Repair Instructions
M350 (CT-8) Coldhead
Austin Cryogenics Co.**

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6.2.1 PRELIMINARY DISASSEMBLY OF THE REFRIGERATOR UNIT

(1)... Disconnect the refrigerator return line and the refrigerator supply line piping by separating the self-sealing coupling (9, Figures 3-1A and 3-1B) at the refrigerator unit.

*CAUTION: WHEN DISASSEMBLING A COUPLING,
ALWAYS USE TWO WRENCHES, TO AVOID LOOSENING
THE COUPLING HALVES FROM THEIR TUBING ADAPTERS.*

(2)... Attach either of the refrigerator charging adapters (1C, 1D, Figure 4-1) to the refrigerator supply line connection and vent the system by opening the valve of the adapter. When the pressure has decreased to atmospheric pressure, remove the adapter and use it to vent the refrigerator return line. The refrigerator then will be completely depressurized.

(3)... Disconnect the power cable and the instrumentation leads. Then remove the six cap screws (8, 9, Figure 6-4) that hold the valve plate (4, Figure 3-2) to the cylinder flange.

(4)... Carefully lift the drive-displacer assembly (Figure 3-2), withdrawing it until the displacers are free from the cylinder cavity. Lay the assembly on a clean surface with the sight glass (6, Figure 3-2) facing toward the side and the relief valve (5, Figure 3-4) facing up.

(5)... Remove the refrigerator return and supply line assemblies (7, 8, Figures 3-1A and 3-1B).

CAUTION: IF A ROD IS USED TO AID IN CLEANING THE CYLINDER, THE ROD MUST BE OF EITHER WOOD OR A PLASTIC SUCH AS BAKELITE OR MICARTA. DO NOT USE A METALLIC ROD, BECAUSE THE CYLINDER WALLS CAN BE EASILY SCRATCHED; SUCH SCRATCHES WOULD HAVE AN ADVERSE EFFECT UPON REFRIGERATOR PERFORMANCE.

(6)... Wipe out the inside of the cylinder, using a clean rag moistened with solvent. After removing all wear particles and foreign matter from the bottom and sides of the cylinder, inspect for scratches or unusual wear on the side surfaces of the cylinder. If abnormal conditions are found, contact the 500 INC. Field Service Department for assistance.

(7)... Remove and discard the O-ring (7, Figures 6-6A and 6-6B) on the top surface of the cylinder flange. Then cover the cylinder opening to exclude foreign matter.

(8)... Grasp the displacer assembly and gently extend it to the limit of its stroke.

(9)... Using a 90°-offset, socket-head wrench, loosen the three cap screws (2, Figure 6-1) that secure the upper cap (3, Figure 6-1) to the No. 1 displacer (9, Figure 6-1). Remove the screws with the special wrench provided (Part No. B3681002, Appendix A). The displacer assembly then will be free from the shaft of the scotch yoke (1, Figure 6-1).

(10)... Remove the pin (6, Figure 6-1) that holds the bushing (4, Figure 6-1) to the shaft of the scotch yoke. Slide the bushing and collar assembly (4, 5, Figure 6-1), together with the upper cap, from the shaft.

(11)... Loosen and remove the four cap screws (11, Figure 6-2) that secure the drive motor to the driver housing. The special wrench (Part No. B3592202, Appendix A) provided with the special tools is convenient for removing the cap screws after they have been loosened. Carefully remove the motor, with the driver attached, taking care not to mar the O-ring sealing surface on the face of the driver housing.

(12)... Detach the sight glass from the driver housing, discarding the O-ring (3, Figure 6-5A). If necessary, insert a finger through the opening in the driver housing and press off the sight glass from the inside. Do not attempt to pry the glass from the outside with a tool, since the edges and surface of the glass might be damaged.

(13)... Remove the hex-head plug (12, Figure 6-5A) and the relief valve (11, Figure 6-5A).

(14)... Insert the special socket wrench (Part No. B3592203, Appendix A) in the relief valve opening of the driver housing. Engage the wrench with the stop nut on the adjusting bolt (15, 32, Figure 6-4) of the exhaust-valve rocker arm (16, Figure 6-4). Loosen the stop nut, by rotating it counterclockwise one turn.

(15)... Loosen the inlet-valve stop nut in the same manner, inserting the socket wrench through the opening normally closed by the hex-head plug (12, Figure 6-5A).

(16)... Remove the four recessed cap screws (26, Figure 6-4) that secure the valve plate to the driver housing. Because of the friction of the O-ring (23, Figure 6-4) between the parts, two jacking screws (Part No. B3592211, Appendix A) are provided to facilitate disassembly. Use the jacking screws in diagonally opposite holes, as shown in Figure 6-8, tightening the screws uniformly until the valve plate is free.

*CAUTION: WHEN REMOVING THE VALVE PLATE,
BE CAREFUL NOT TO DAMAGE THE O-RING SEALING SURFACE.*

(17)... Remove and discard the O-ring (23, Figure 6-4) in the top groove of the valve plate. Then remove the retaining ring, the gland washer, the Kap-seal and its O-ring (14, 13, 11, 12, Figure 6-4).

CAUTION: WHEN REMOVING THE KAP-SEAL, TAKE PARTICULAR CARE NOT TO MAR THE SEALING SURFACE FOR THE KAP-SEAL O-RING IN THE SCOTCH-YOKE GLAND (10, FIGURE 6-4).

6.2.1.1 Replacement of the Inlet Valve Teflon O-Ring. -

(1)... Remove the two retaining cap screws (17, Figure 6-4) and the support bracket (20, Figure 6-4).

(2)... Using pliers with the jaws padded, firmly grasp the protruding valve stem of the inlet valve (5, Figure 6-4) and extract the valve subassembly from its cavity within the valve plate.

(3)... Withdraw the valve stem from the valve body. Then, using a suitable pointed instrument, extract and discard the Teflon O-ring.

CAUTION: DO NOT SCRATCH OR MAR THE SEALING SURFACE IN THE VALVE BODY.

(4)... Lightly grease the valve stem with vacuum grease and re-install it. Then carefully slip the new Teflon O-ring over the valve stem.

(5)... Insert the end of the valve stem in any convenient hole in the support bracket. Then gently press the valve body against the flat surface of the support bracket to seat the Teflon O-ring in its recess within the valve body.

(6)... Remove and discard the O-rings (2, 4, Figure 6-4) from the inlet-valve body. Carefully clean the O-ring grooves. Then lightly coat new O-rings with vacuum grease and install them.

(7)... Thoroughly clean the inlet-valve cavity, using a cotton swab moistened with solvent. When the cavity is dry, reinstall the inlet-valve assembly.

Note: Make sure that the valve spring (6, Figure 6-4) and the compression spring (7, Figure 6-4) are firmly seated in their respective recesses at the bottom of the valve cavity. Also be certain that the valve spring remains upright while the valve is installed.

(8)... Reinstall the support bracket (20, Figure 6-4).

6.2.2 MAINTENANCE OF THE DRIVER ASSEMBLY AND THE DRIVE MOTOR

6.2.2.1 Maintenance of the Driver Assembly. -

(1)... Loosen the setscrew (8, Figure 6-2) that secures the driver to the shaft of the drive motor. Then remove the driver and the key (5, 6, Figure 6-5) from the shaft.

(2)... Separate the crankshaft from the valve eccentric (3, 7, Figure 6-2).

(3)... Place Tool #1 (Part Number A3592299) in the small end of the valve eccentric (7, Figure 6-2).

(4)... Attach the bearing puller as shown in Figure 6-16, with the tip of its spindle seated in the countersink on Tool #1.

(5)... Turn the spindle until the hub is pushed out of the exhaust-valve actuating bearing (5, Figure 6-2).

(6)... Place Tool #1 in the slotted end of the crankshaft (3, Figure 6-2) as shown in Figure 6-17.

(7)... Attach the bearing puller with its arms hooked over the inlet-valve actuating bearing (4, Figure 6-2) and its spindle seated in the countersink on Tool #1.

(8)... Turn the spindle until the crankshaft is pushed out of the inlet-valve actuating bearing.

(9)... Remove the retainer from the driver bearing (1, 2, Figure 6-2) using the snap ring pliers.

(10)... Slide the crankshaft over the leg of Tool #4 (Part Number A3761061) which has the pin, so that the pin engages the slot as shown in Figure 6-18.

(11)... Attach the bearing puller with its arms over the large flange of the crankshaft and its spindle seated in the countersink on Tool #4.

(12)... Turn the spindle until the driver bearing is pushed off the crankshaft.

Note: Bearings that have been removed with these tools are unfit for further service.

(13)... Insert the hub of the crankshaft into the inlet-valve actuating bearing.

CAUTION: BE SURE THAT THE BEARING IS PROPERLY ALIGNED AND IS NOT COCKED ON THE HUB.

(14)... Place Tool #2 (Part Number A3592298) over the inlet-valve actuating bearing and Tool #3 (Part Number A3592297) over the flange on the crankshaft, as shown in Figure 6-19.

(15)... Attach the bearing puller with its arms hooked over Tool #2 and its spindle seated in the countersink on Tool #3.

(16)... Turn the spindle until the bearing is fully seated on the crankshaft.

(17)... Set the inlet-valve actuating bearing on Tool #4 so that the spindle on the attached crankshaft faces up and is directly over one of the legs of the tool, as shown in Figure 6-20.

(18)... Place the driver bearing on the spindle of the crankshaft.

(19)... Tap the driver bearing onto the spindle using Tool #5 (Part Number A3592296) and a mallet until the bearing is seated against the flange of the crankshaft.

(20)... Install the driver bearing retainer.

(21)... Insert the hub of the valve eccentric into the exhaust-valve actuating bearing.

CAUTION: BE SURE THAT THE BEARING IS NOT COCKED ON THE HUB.

(22)... Place Tool #2 over the exhaust-valve actuating bearing and Tool #1 in the opposite end of the valve eccentric, as shown in Figure 6-21.

(23)... Attach the bearing puller with its arms hooked over Tool #2 and its spindle seated in the countersink on Tool #1.

(24)... Turn the spindle until the bearing is fully seated on the valve eccentric.

6.2.2.2 Maintenance of the Drive Motor and Reassembly with the Driver. -

CAUTION: WHILE OVERHAULING THE MOTOR DO NOT WITHDRAW THE ROTOR FROM THE STATOR. SHOULD THIS BE DONE, THE MOTOR WOULD BECOME PARTIALLY DEMAGNETIZED, WITH RESULTING DECREASE IN TORQUE. IF THE ROTOR IS EVER REMOVED FROM THE STATOR, THE COMPLETE MOTOR ASSEMBLY MUST BE RETURNED TO 500 INCORPORATED FOR REMAGNETIZATION IN ORDER TO RESTORE ITS FULL TORQUE CAPABILITY.

(1)... Carefully remove the jam nut (13, Figure 6-3) from the hermetic connector (8, Figure 6-3). It is essential to prevent the connector from rotating, so that the attached wires will not be broken. (If necessary, grasp the connector gently with a suitable tool.)

(2)... Remove the eight studs (11, Figure 6-3) and then remove the motor end bells (1, 12, Figure 6-3).

Note: Do not attempt to remove the allen nuts (18, Figure 6-3) from the end of the studs. The nuts are cemented with LOCTITE so that the studs can be unscrewed from the front end bell. If necessary, recement loose nuts with LOCTITE; take care to obtain as much thread engagement as possible but allow sufficient depth for seating of the allen wrench.

If necessary, tap lightly around the edges of the end bells with a soft-faced hammer. The bearing puller (Part Number 57-97-68) is the only tool needed to remove the two bearings. Figure 6-22 shows the removal of the drive-end bearing, and Figure 6-23 shows removal of the rear-end bearing.

(3)... Remove and discard the three O-rings (2, 7, Figure 6-3). Carefully clean the O-ring grooves, using a clean rag moistened with solvent.

CAUTION: BE SURE TO PRESS THE BEARINGS ON STRAIGHT. TO AVOID DAMAGE TO THE BEARINGS, PRESS ONLY AGAINST THE INNER RACES.

(4)... Place one ball bearing on the drive end of the rotor shaft. Slide Tool #8 (Part Number A3592301P2) over the end of the shaft as shown in Figure 6-24 and tap the tool with a mallet until the bearing is firmly seated against the shoulder on the shaft.

(5)... Place the other ball bearing on the rear end of the rotor shaft. Set Tool #6 (Part Number A3592300) over the bearing as shown in Figure 6-25 and tap it with a mallet until the bearing is firmly seated against the shoulder on the shaft.

(6)... Lightly coat with vacuum grease the three replacement O-rings and install them as shown in Figure 6-3.

(7)... Reassemble the wavy spring washer(s), the flat washer (9, 10, Figure 6-3), and the end bells, as shown in Figure 6-3.

Notes: (1) A particular drive motor may have either one or two wavy spring washers, depending upon the accumulation of tolerances at the time of original assembly. The washer(s) establish the necessary end play; never alter either the number of washers or their original relative positions.

(2) Be careful not to twist, rotate or misalign the hermetic connector when installing the rear end bell.

(3) When reassembling the motor, be sure to orient the gas outlet port (14, Figure 6-3) in its original position so that it can be connected to the return piping.

(8)... Reinstall the eight studs, drawing them up evenly so that the O-rings will seat properly.

(9)... Reinstall the jam nut on the hermetic connector, to complete reassembly of the drive motor, again taking care not to rotate the connector. Reinstall the driver, making sure that it is properly lined up with the key. Use the special tool provided (Part Number B3592219, Appendix A) to establish the correct position of the driver on the shaft, as shown in Figure 6-9. When the driver has been positioned correctly, tighten the setscrew to complete reassembly.

6.2.3 MAINTENANCE OF THE DRIVER HOUSING ASSEMBLY

(1)... Withdraw the scotch yoke (13, Figure 6-5A) from the driver housing. Inspect the yoke at all points of contact with the guide pin (9, Figure 6-5A) and with the driver bearing, looking for damage or unusual wear.

(2)... Remove the two plugs (1, 9, Figure 6-5A), discarding all of the associated O-rings (2, 10, Figure 6-5A). (Reassembly of the various housing components will be accomplished later in the procedure.)

(3)... Inspect the guide pin for evidence of unusual wear; replace the guide pin and plug (9, Figure 6-5A), if necessary.

6.2.4 ADJUSTMENT OF THE INLET AND EXHAUST VALVES

It is assumed that all of the steps in Section 6.2.1 to 6.2.3, inclusive, have been completed but that the various subassemblies have not been reassembled further.

To adjust the valves, first reassemble the drive motor and the valve plate to the driver housing, leaving out all interface O-rings and the scotch yoke. Then proceed as follows:

(1)... Insert the timing tool (Part Number B3592213, Appendix A) in the sight-glass opening. (The end of the tool having the drilled hole is to be inward.) Rotate the timing tool until the overhung crank on the driver crankshaft engages the hole in the tool.

(2)... Slowly rotate the timing tool and the crankshaft in either direction until the 30° mark on the tool lines up with the scribe mark on the face of the driver housing, as shown in Figure 6-10 (left). Then carefully remove the tool, making sure that the assembly does not rotate.

CAUTION: IT IS VERY IMPORTANT THAT THE 30° MARK, AND NOT THE BDC MARK, BE USED; OTHERWISE, THE ROCKER ARMS PROBABLY WILL BREAK IN LATER OPERATION.

(3)... Insert a finger through the sight-glass opening and touch the outer race of the ball bearing that actuates the inlet valve. Slowly retighten the inlet-valve stop nut until the rocker arm just touches the outer race. At this point there should be a very light, but definite, resistance to rotation of the outer race.

CAUTION: DO NOT TIGHTEN THE STOP NUT MORE THAN DESCRIBED ABOVE. ANY FURTHER ADJUSTMENT WILL OPEN THE VALVE AND LEAKAGE WILL RESULT. FURTHERMORE, IMPROPER ADJUSTMENT CAN CAUSE BREAKAGE OF THE ROCKER ARM.

(4)... Tighten the stop nut of the exhaust-valve rocker arm in the same manner, while touching the outer race of the corresponding ball bearing. As before, do not overtighten the nut.

(5)... Reinsert the timing tool in the same manner as before and verify that the 30° mark is still at the scribe mark on the driver housing. If the marks are not still correctly aligned, the adjustment is incorrect; valve leakage and/or rocker-arm damage can result. If necessary, reset the timing tool and repeat the valve-timing procedure. When the valves have been correctly timed, disassemble the drive unit and the valve plate from the driver housing.

Note: If desired, the valve-adjusting procedure may be performed with the scotch yoke and all O-rings installed. However, it is difficult to "feel" the correct point on the exhaust-valve actuating bearing with the scotch yoke in place.

6.2.5 REASSEMBLY OF THE DRIVE UNIT

Note: During the reassembly procedure carefully clean all O-ring grooves with a clean cloth moistened in solvent. Use only new O-rings and lightly coat them with vacuum grease before installation. Do NOT clean the O-rings with solvent; use soap and water only.

- (1)... Place two drops of light machine oil (supplied with the spare parts) on the surface of the lower scotch-yoke bushing (22, Figure 6-4), in the valve plate. Also, place two drops of the oil on the upper scotch-yoke bushing (7, Figure 6-5A), in the driver housing. Place a small amount (approximately the size of a match-head) of Beacon grease in the guide groove (16, Figure 6-5A).
- (2)... Reinstall the sight glass, with its O-ring and retaining ring. Tighten the cap screws evenly so that the O-ring will seat properly.
- (3)... Install new O-rings on the guide pin and plug, the hex-head plugs, and the relief valve of the driver housing. Then reinstall the guide pin and plug, relief valve, and the sealing plugs.
- (4)... Reinstall the scotch yoke, engaging its grooved edge with the guide pin.
- (5)... Install the O-ring (23, Figure 6-4) in the top groove of the valve plate.
- (6)... Carefully clean the sealing surface of the scotch-yoke gland (10, Figure 6-4). Then install the Kap-seal, the O-ring, the gland washer, and the retaining ring (11, 12, 13, 14, Figure 6-4).
- (7)... Install the valve plate over the lower end of the scotch yoke, taking care not to damage the Kap-seal and the scotch-yoke gland. Slide the valve plate upward and into position against the driver housing. The gas inlet port (25, Figure 6-4) must be toward the side of the driver housing that will be attached to the drive motor. (See Figure 6-5.) Attach the two components with the cap screws previously removed, tightening the cap screws evenly so that the O-rings will seat properly.
- (8)... At this point temporarily set the assembled components aside and proceed with Section 6.2.6.

6.2.6 MAINTENANCE OF THE DISPLACER ASSEMBLY

(1)... Remove the seal ring and the expander ring (15, 16, Figure 6-1), being careful not to scratch or mar the sides of the seal groove.

(2)... Using a clean rag moistened with solvent, clean all of the surfaces of the displacer assembly, including the seal grooves.

(3)... Inspect the outside surfaces of the displacers for scratches and other signs of abnormal wear. Also inspect the seal grooves to be sure that they are free from scratches. If abnormal wear or other unusual conditions are encountered, either at this point or later in maintenance procedures, contact the 500 INC. Field Service Department for assistance.

(4)... Support the displacer assembly on a padded surface. Then, using a straight punch, push the No. 1 displacer locking pin (11, Figure 6-1) from the No. 1 displacer pin (10, Figure 6-1).

(5)... Push out the displacer pin and separate the two displacers.

(6)... Using nitrogen or helium gas at approximately 50 psig pressure, blow all dust and other particles from the displacers.

Notes: (1) Blow into the open end of each displacer; the particles will be expelled from the small gas ports at the opposite end.

(2) Be careful not to allow the inserting tool (14, Figure 6-1) to fall from the displacer. If this happens, reinstall the tool with the inside chamfer of the tool toward the bottom of the displacer. The tool must be between the seal groove and the top of the particular displacer.

(3) If the bottom closure of any displacer is loose or separates from the displacer, call the 500 INCORPORATED Field Service Department for assistance.

(7)... When the displacers have been blown clean, reassemble them, using the foregoing steps in inverse order. Make certain that the locking pin is centered in the displacer pin.

(8)... Install the No. 2 displacer seal. To do this, slide the expander ring (16, Figure 6-1) over the displacer and into the seal groove. Next, slip the seal ring (15, Figure 6-1) over the displacer and into the seal groove in the same manner. Stagger the opening in the seal ring 180° around the circumference of the displacer from the opening in the expander ring.

CAUTION: DO NOT TRY TO FORCE THE RINGS MORE THAN NECESSARY TO SLIP THEM OVER THE END OF THE DISPLACER. THE SEAL WILL BE RUINED IF IT IS PERMANENTLY DEFORMED. TAKE PARTICULAR CARE NOT TO SCRATCH OR MAR THE SOFT SEAL RING. DO NOT ATTEMPT TO COMPRESS IT WITH THE FINGERS. SEE STEP 10 BELOW.

(9)... Carefully work the inserting tool (14, Figure 6-1) downward along the No. 2 displacer to the vicinity of the No. 2 displacer seal.

(10)... Make a temporary ring compressor for the seal from a thin piece of cardboard. Then slide the inserting tool over the compressed seal, while slowly removing the cardboard. Leave the inserting tool in place as the final ring compressor for reassembly.

Note: If, for any reason, it ever is necessary to replace the inserting tool be sure to orient the replacement correctly. The inside chamfer of the inserting tool must be toward the closed end of the displacer, and the inserting tool must be above the seal groove.

6.2.6.1 Replacing the No. 1 Displacer Kap-Seal. - It is most important for the seal and O-ring that comprise the No. 1 displacer Kap-seal to be correctly matched with the inside diameter of the cylinder. If the seal fits too tightly, there will be excessive friction between it and the cylinder wall; in such an event the drive unit will be overloaded. If the fit is too loose, there will be excessive blow-by past the seal and performance will deteriorate.

The matched seal and O-ring assemblies provided with the 3000-hour kit (and also available as spare-parts items) usually are satisfactory for use as received. The replacement Kap-seals should never be disassembled nor should their components be interchanged.

6.2.7 REASSEMBLING THE REFRIGERATOR UNIT

Note: In this section it is assumed that the collar and bushing assembly (9, 4, Figure 3-6) has not been disassembled and that the adjustment of the displacer end clearance has not been disturbed. If in doubt, or if new parts have been installed that would affect this adjustment, refer to Section 6.2.9.

(1)... Fully extend the scotch yoke and then reinstall the upper cap of the No. 1 displacer, the collar, and the pin (3, 4, 6, Figure 6-1) as shown in Figure 6-1.

(2)... Reattach the displacer assembly to the upper cap. Be sure that the screw heads do not project above the surface of the upper cap; if necessary, remove the screws and file their heads.

(3)... Reinstall the drive motor O-ring (9, Figure 6-2) and then reattach the drive motor to the driver housing, making sure that the gas outlet port (14, Figure 6-3) is oriented toward the cylinder flange. Next, install the O-ring (7, Figures 6-6A and 6-6B) on top of the cylinder flange.

(4)... With the inserting tool in place (14, Figure 6-1) hold the refrigerator unit over the cylinder cavity and gently lower the displacers into the cylinders.

Note: It is desirable for the cylinder assembly to be in a vertical position when the displacers are inserted. Installation can be made in other positions, but alignment of the No. 2 displacer with its cylinder then may be more difficult.

The No. 2 displacer probably will contact the shoulder at the bottom of the first-stage cylinder instead of entering the second-stage cylinder. If this happens, gently rotate the displacer assembly until the No. 2 displacer enters its cylinder; then lower the refrigerator unit in one continuous motion.

As the displacers are lowered, the seal inserting tool will be pushed from the seal ring when the latter enters the second-stage cylinder. The refrigerator unit thereafter cannot be raised without causing the seal ring to spring outward as it leaves the second-stage cylinder.

CAUTION: IF THE DISPLACERS HAVE BEEN WITHDRAWN ENOUGH FOR THE SEAL RING TO EXPAND, DO NOT ATTEMPT TO REINSERT THE ASSEMBLY WITHOUT COMPLETELY WITHDRAWING THE DISPLACER ASSEMBLY AND RETURNING THE INSERTING TOOL TO ITS CORRECT POSITION.

(5)... When the valve plate is seated firmly against the cylinder flange, orient the refrigerator unit as shown in Figures 3-1A and 3-1B.

(6)... Secure the assembly with the cap screws previously removed.

(7)... Reconnect the instrumentation and power leads.

(8)... Reinstall the return and supply line assemblies, using new O-rings.

6.2.8 EVACUATING AND RECHARGING THE REFRIGERATOR UNIT

(1)... First, connect the evacuating and charging adapter (2A, Figure 4-1) to the refrigerator piping, and then connect a vacuum pump to the evacuating and charging adapter.

(2)... Evacuate the refrigerator unit to a level of 20 microns, or better, and continue the evacuation for at least 30 minutes. Then close the valve of the evacuating and charging adapter, and recharge the refrigerator unit to 190 psig with clean, dry helium.

Note: To reduce the time required for decontamination, the refrigerator unit may be evacuated to 30 microns, or better, and then charged to 75-100 psig three times in succession. Reduce the pressure to 25 psig after each charging. During the third charging, pressurize the unit to 190 psig; thereafter, it is ready for operation.

(3)... When recharging has been completed, stop the vacuum pump, disconnect the adapter, and reconnect the refrigerator unit to the system.

CAUTION: TO PREVENT DAMAGE TO THE ELECTRICAL COMPONENTS, DO NOT ENERGIZE THE REFRIGERATOR OR COMPRESSOR WHILE EITHER IS EVACUATED.

6.2.9 ADJUSTMENT OF THE DISPLACER-ASSEMBLY END CLEARANCE

Note: This adjustment normally is not required, since all original and replacement assemblies are adjusted prior to shipment. However, the adjustment is essential if the scotch-yoke collar and bushing have been disassembled. It is good practice always to check the clearance, in the manner described below, whenever the refrigerator unit has been disassembled. It is also wise to check replacement assemblies before installation.

(1)... Detach the displacer assembly from the scotch yoke, in the usual manner. Then reattach the upper cap to the top of the No. 1 displacer.

(2)... Fully insert the displacer and cap assembly into the cylinder. It is immaterial whether the displacer seals are attached to the displacer. However, if the No. 2 displacer seal is in place, install the seal-inserting tool before sliding in the assembly.

(3)... Using a micrometer-type depth gauge, measure the distance "A" (Figure 6-12, left) from the top surface of the cylinder flange to the top surface of the No. 1 displacer cap. Then remove the displacer assembly from the cylinder.

(4)... Remove the upper cap from the displacer assembly and then remount the upper cap on the scotch-yoke shaft, together with the collar, bushing, and pin. (The threaded end of the bushing must be toward the valve plate.)

(5)... Remove the sight glass and insert the special timing tool into the sight-glass opening, as when adjusting the valves. Engage the hole in the timing tool with the overhung crank of the crankshaft. Then slowly rotate the timing tool and the driver assembly, in either direction, until the BDC (Bottom Dead Center) mark on the tool coincides with the scribe mark on the driver housing, as shown in Figure 6-10 (right).

(6)... Measure the distance "B" (Figure 6-12, right) from the bottom of the valve-plate projection to the top of the upper cap. This dimension should be equal to dimension "A" minus 0.265" (plus or minus 0.005").

(7)... If dimension "B" is not within the prescribed tolerance, remove the scotch-yoke pin, the collar, and the bushing. Heat the collar and the bushing to 350°F - 400°F and separate the two (at this temperature, the parts will be a light straw color). Clean the threads of both, first with a wire brush and then with a solvent such as acetone, to remove all particles of the sealant. Next, coat the threads of both the collar and the bushing with LOCTITE. After they have been coated, attach the collar to the bushing, screwing them together firmly.

(8)... Slide the upper cap of the No. 1 displacer on the shaft of the scotch yoke. Mount the collar and bushing assembly in the usual manner, with the threaded end toward the valve plate. Install the scotch-yoke pin in the shaft of the scotch yoke.

(9)... Adjust the scotch-yoke collar until dimension "B" is within the proper limits.

(10)... Carefully remove the scotch-yoke pin from the scotch yoke and, without disturbing the relative positions of the collar and the bushing, gently withdraw the latter two components. Place the collar and bushing, still without disturbing their relative positions, in boiling water for 15 minutes to cure the LOCTITE and bond the subassembly. The end clearance then will be correct when reassembly has been completed.

6.3 6000-HOUR PREVENTIVE MAINTENANCE PROCEDURE (SEE APPENDICES B-11 AND B-12)

The 6000-hour preventive maintenance procedure includes all of the steps of the 3000-hour and the 1500-hour preventive maintenance procedures, plus special maintenance of the refrigerator valve-plate assembly and replacement of the compressor valve plate.

6.3.1 MAINTENANCE OF THE REFRIGERATOR VALVE-PLATE ASSEMBLY

(1)... First, carry out, in succession, steps 1 through 17 given in Section 6.2.1.

(2)... Then remove the two retaining cap screws (17, Figure 6-4) and the support bracket (20, Figure 6-4).

(3)... Using pliers with the jaws padded, gently grasp the protruding valve stem of each valve and extract the valve subassembly from its cavity within the valve plate.

Note: Although the valves are to be replaced in this procedure, it is well to avoid damaging them, so that they may be retained as emergency spare parts.

(4)... Remove and discard the valve spring and the compression spring (6, 7, Figure 6-4) from each valve cavity.

(5)... With a drift pin, press out and discard the dowel pins (18, Figure 6-4) in the support bracket (20, Figure 6-4), taking care not to damage the ears of the bracket. The rocker arms then will be free from the support bracket.

(6)... Remove and discard the stop nut (15, Figure 6-4) from each rocker-arm adjusting bolt (19, 32, Figure 6-4) and then extract both adjusting bolts. Check that the lengths are equal. If the bolts are not of the same length, be sure to reinstall the shorter adjusting bolt in the rocker arm which will operate the exhaust valve.

(7)... Install the replacement rocker arms, securing them with new dowel pins.

Note: The rocker arms need not be replaced if there are no indentations greater than .010 inch on the surfaces that contact the valve stems.

(8)... Reinstall the adjusting bolts and the replacement stop nuts. Do not tighten the stop nuts more than necessary to maintain the bolts in position, since the positions of the nuts must be changed during the later valve-adjustment procedure.

(9)... Lightly grease the stem of the replacement inlet valve with vacuum grease and reinstall it. Then carefully slip the new Teflon O-ring over the valve stem.

(10)... Insert the end of the valve stem in any convenient hole in the support bracket. Then gently press the new valve body against the flat surface of the support bracket to seat the Teflon O-ring in its recess within the valve body.

(11)... Lightly coat the stem of the replacement exhaust valve with vacuum grease and reinstall it.

(12)... Lightly coat the replacement O-rings (2, 4, Figure 6-4) with vacuum grease and install them on the new valve bodies.

(13)... Thoroughly clean both valve cavities in the valve plate, using a clean cloth or cotton swab moistened with solvent.

(14)... Install two new valve springs and two new compression springs.

Note: The compression springs will present no difficulty, since they fit snugly within the valve cavities. Take particular care, however, to place the valve springs upright and to see that they are firmly seated in their respective recesses at the bottom of the cavities.

(15)... Install the new valve subassemblies in their cavities. Make sure that the locating notch (27, Figure 6-4) on the exhaust-valve body lines up with the locating notch (28, Figure 6-4) on the corresponding cavity in the valve plate.

(16)... Reinstall the support bracket and the rocker-arm assembly, engaging the locating pin (29, Figure 6-4) in the locating notches of both the exhaust-valve body and the valve cavity. Secure the support bracket with the cap screws previously removed.

(17)... Continue with the remainder of the 3000-hour procedure, beginning with Section 6.2.2, and with the 1500-hour maintenance.

Note: Do not reinstall the old guide pin and plug (9, Figure 6-5A) in the driver housing as instructed in Section 6.2.5. During the 6000-hour procedure, replace this pin and plug with a new one from the spare parts.

6.3.2 REPLACEMENT OF THE COMPRESSOR VALVE PLATE

CAUTION: BEFORE OPENING THE COMPRESSOR FOR ANY MAINTENANCE OTHER THAN OIL DRAINING, BE SURE TO RELIEVE THE HELIUM PRESSURE FROM THE SYSTEM BY ATTACHING THE EVACUATING AND CHARGING ADAPTER (2A FIGURE 4-1) TO THE GAS SUPPLY AND GAS RETURN CONNECTIONS OF THE COMPRESSOR.

LEGEND - FIGURE 6-1

<u>Item No.</u>	<u>Part Name</u>	<u>Part Number</u>
1	Scotch Yoke	B3761009
2	Cap Screw, Socket Hd., S.Stl., 1/4-20 x 1/2" Lg.	52-13-35
3	Upper Cap, No. 1 Displacer	B3761044
4	Collar, Displacer Rod	A3657076
5	Bushing, Displacer Rod	A3657063
6	Pin, S.Stl., .125 Dia. x .50 Lg.	52-01-01
7	Kap-Seal	A3657013
8	O-Ring, 2-329, Parker Compound N219-7	58-14-45
9	No. 1 Displacer Assembly	-----
10	Pin, No. 1 Displacer	A3657025P2
11	Locking Pin, No. 1 Displacer	B3657066
12	Displacer Seal Groove	-----
13	No. 2 Displacer Assembly	-----
14	Inserting Tool	A3657028P1
15	Seal Ring	B3657074P2
16	Expander Ring	B3657073P2

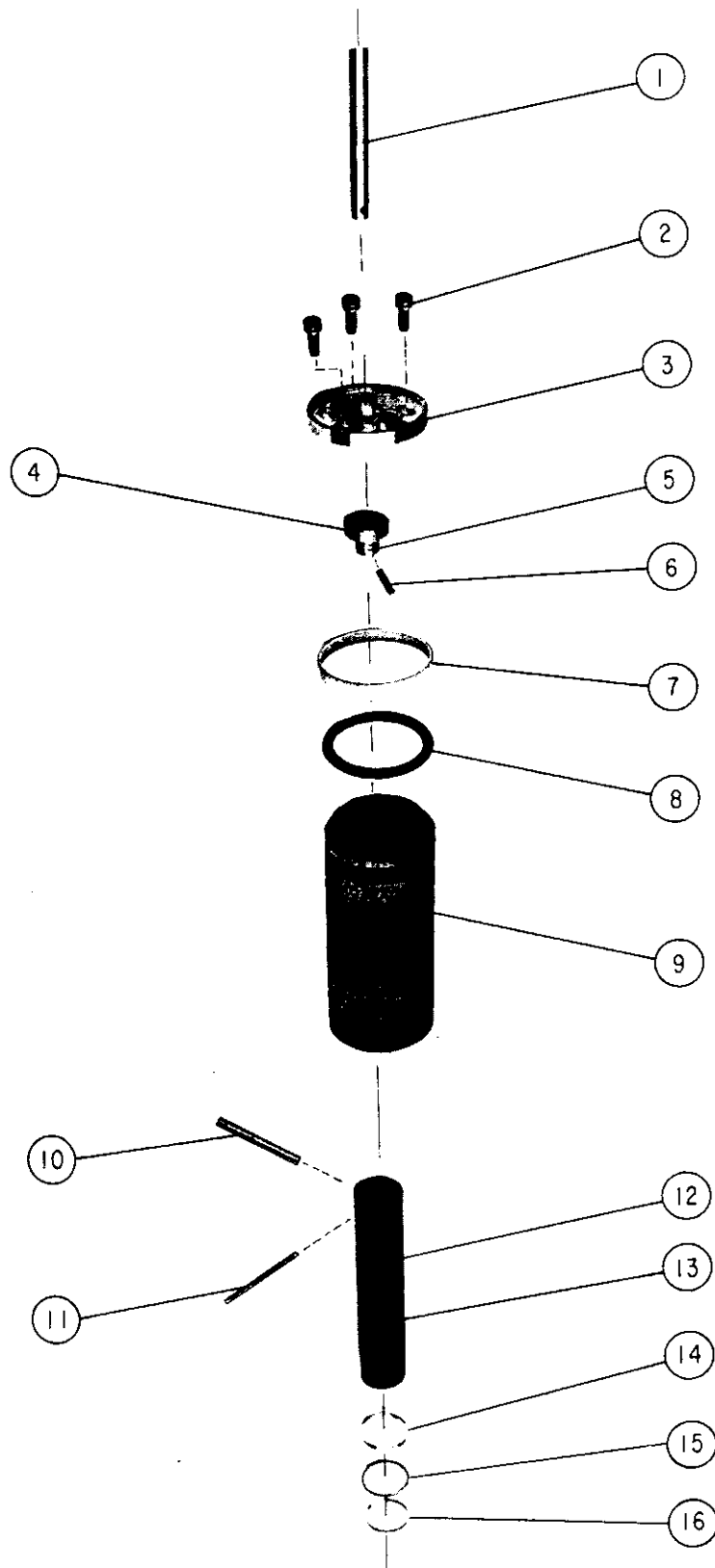


FIGURE 6-1 EXPLODED VIEW OF THE DISPLACER ASSEMBLY

LEGEND, FIGURE 6-2

Item No.	Part Name	Part Number
1	Retainer, Valve Cover #N 5100 25X	20-02 15
2	Driver Bearing	A0543012
3	Crankshaft	03761007
4	Ball Bearings, Inlet Valve Actuating	A3563016
5	Ball Bearings, Exhaust Valve Actuating	A3563016
6	Key	A3588020
7	Valve Eccentric	B3588066
8	Setcrew, Socket Head, S11, #10-32 x 3/8" Lx.	52-14-48
9	O-Ring, #2-139, Parker Compound N219 /	98 04 52
*10	Inlet Motor	D165 036
11	Cap Screw, Socket Head, S141L, 1/4" 20 x 7/8" Lx.	52 10 96
12	Inlet Gas Ports	-----

*See exploded view in Figure 6-1

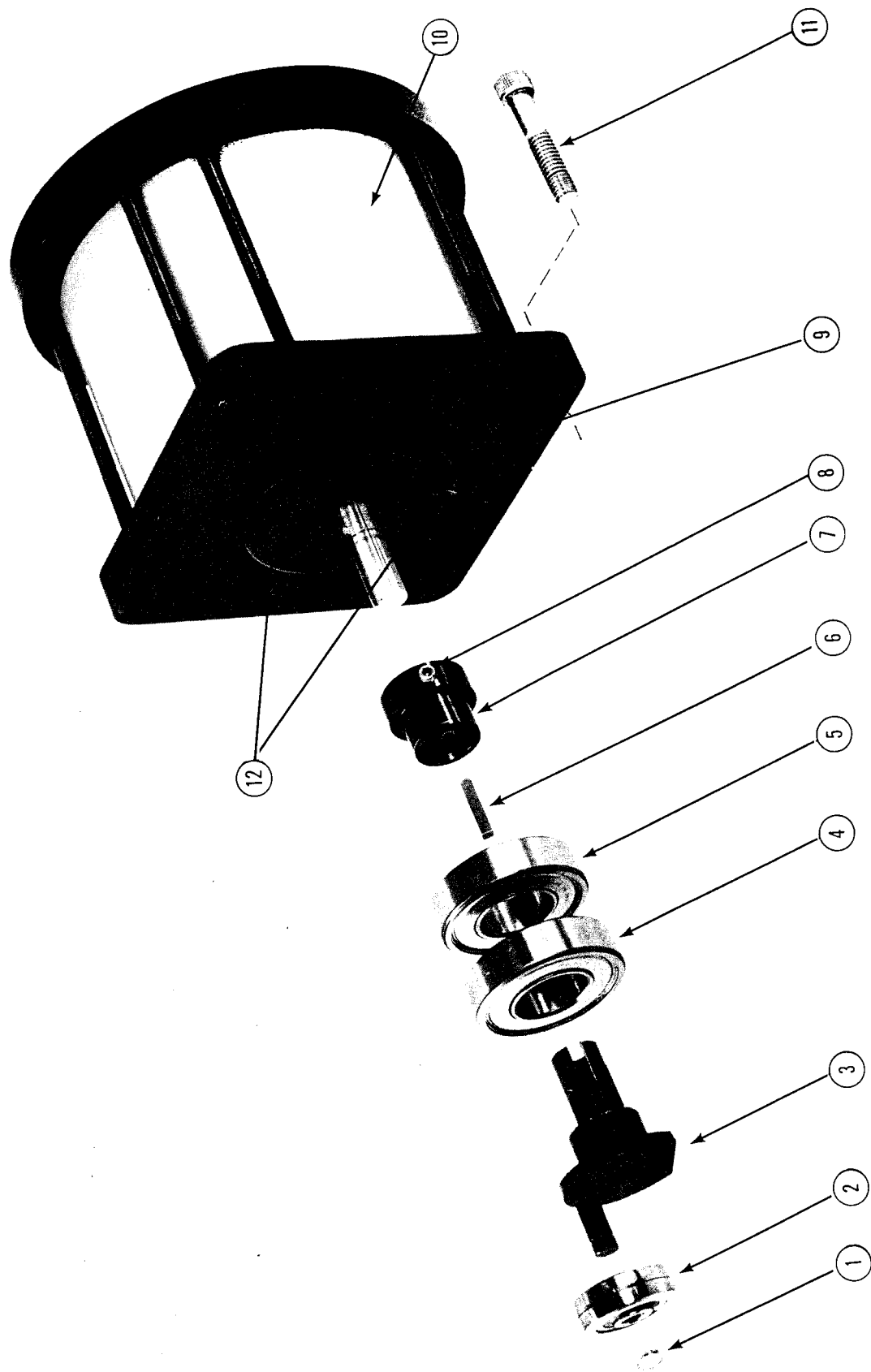


FIGURE 6-2 EXPLODED VIEW OF THE DRIVER MECHANISM

LEGEND - FIGURE 6-3

<u>Item No.</u>	<u>Part Name</u>	<u>Part Number</u>
1	Front End Bell	C3588039P2
2	O-Ring, #2-44, Parker Compound N219-7	58-04-95
3	Ball Bearing - Front	A3543018
4	Motor Housing	B3657045
5	Printed Circuit Board	-----
6	Motor Shaft	-----
7	O-Ring, #2-15, Parker Compound N219-7	58-04-53
8	Hermetic Connector, Deutsch DM-5605-3P	80-10-25
9	Wavy Spring Washer, Wallace Barnes #30 (One may be used)	52-16-90
10	Flat Washer, C.R.S. 1.718" OD x .815" ID x .030" Thick	52-16-91
11	Stud	A3657044
12	Rear End Bell	C3657043
13	Jam Nut (Supplied with Item 8)	-----
14	Gas Outlet Port	-----
15	Rotor	-----
16	Stator	-----
17	Gas Inlet Ports	-----
18	Allen Nut, Stl., 10-32	52-26-73
19	Ball Bearing - Rear	A3543017

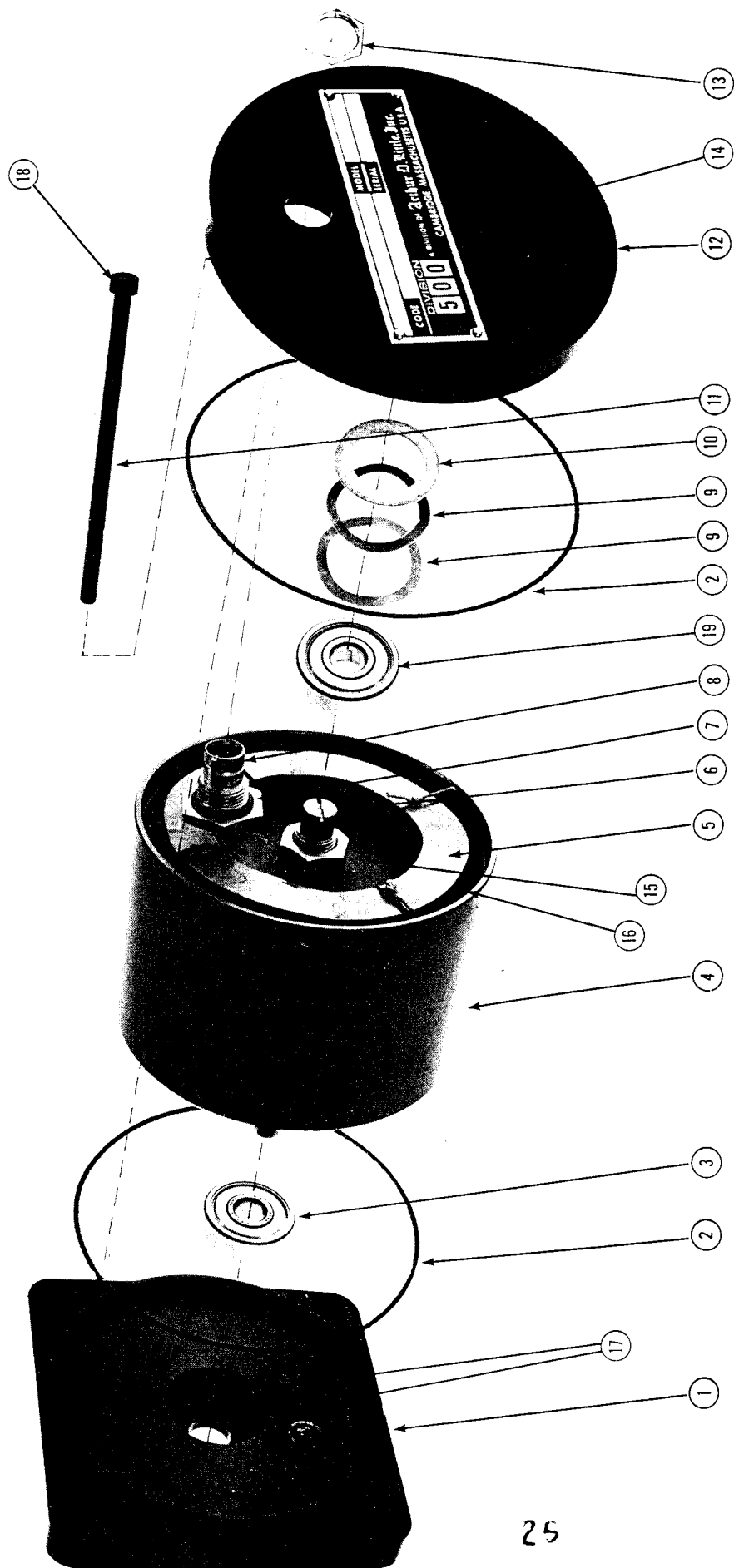


FIGURE 6-3 EXPLODED VIEW OF THE DRIVE MOTOR

LEGEND - FIGURE 6-4

<u>Item No.</u>	<u>Part Name</u>	<u>Part Number</u>
1	(Deleted)	
2	O-Ring, Parker #2-111, Compound N219-7	58-03-10
3	Inlet-Valve Body	B3588085
4	O-Ring, Parker #2-13, Compound N219-7	58-04-52
5	Valve	A3588017
6	Valve Spring, Hardware Prod. #SC12, 1/2" x 1/4" x .031"	57-98-21
7	Compression Spring, Instrument Special- ties Co., #288-16	57-98-98
8	Cap Screw, Socket Head, S.Stl., 10-32 x 1-1/4" Lg.	52-13-63
9	Cap Screw, Socket Head, S.Stl., 10-32 x 1/2" Lg.	52-13-59
10	Gland, Scotch Yoke	A3588011
11	Kap-Seal, Minnesota Rubber Co. KIN-5011, .312" Dia. x .080" Wide	58-01-55
12	O-Ring, Parker #2-11, Compound N219-7	58-03-03
13	Gland Washer, Scotch Yoke	A3588064
14	Retaining Ring, Waldes Truarc N-5000-62W	56-02-10
15	Stop Nut, Elastic Stop Nut #22NM107-62	52-26-10
16	Exhaust-Valve Rocker Arm	B3588013
17	Cap Screw, Socket Head, S.Stl., #6-32 x 3/8" Lg.	52-13-46
18	Dowel Pin, Hardened Steel, 1/8" Dia. x 1/2" Lg.	52-01-01
19	Adjusting Bolt, Inlet-Valve Rocker Arm	B3588014
20	Support Bracket	B3588069
21	Exhaust-Valve Body	B3588084
22	Lower Bushing, Scotch Yoke, Boston Gear #B-58-7	51-03-43
23	O-Ring, Parker #2-234, Compound N219-7	58-03-35
24	Valve Plate	D3669075
25	Gas Inlet Port	-----
26	Cap Screw, Socket Head, S.Stl., 1/4" -20 x 1-1/4" Lg.	52-13-68
27	Locating Notch, Exhaust-Valve Body	-----
28	Locating Notch, Valve Plate	-----
29	Locating Pin	-----
30	O-Ring Teflon (Special)	B3588079
31	Inlet-Valve Rocker Arm	B3588013
32	Adjusting Bolt, Exhaust-Valve Rocker Arm	B3588014

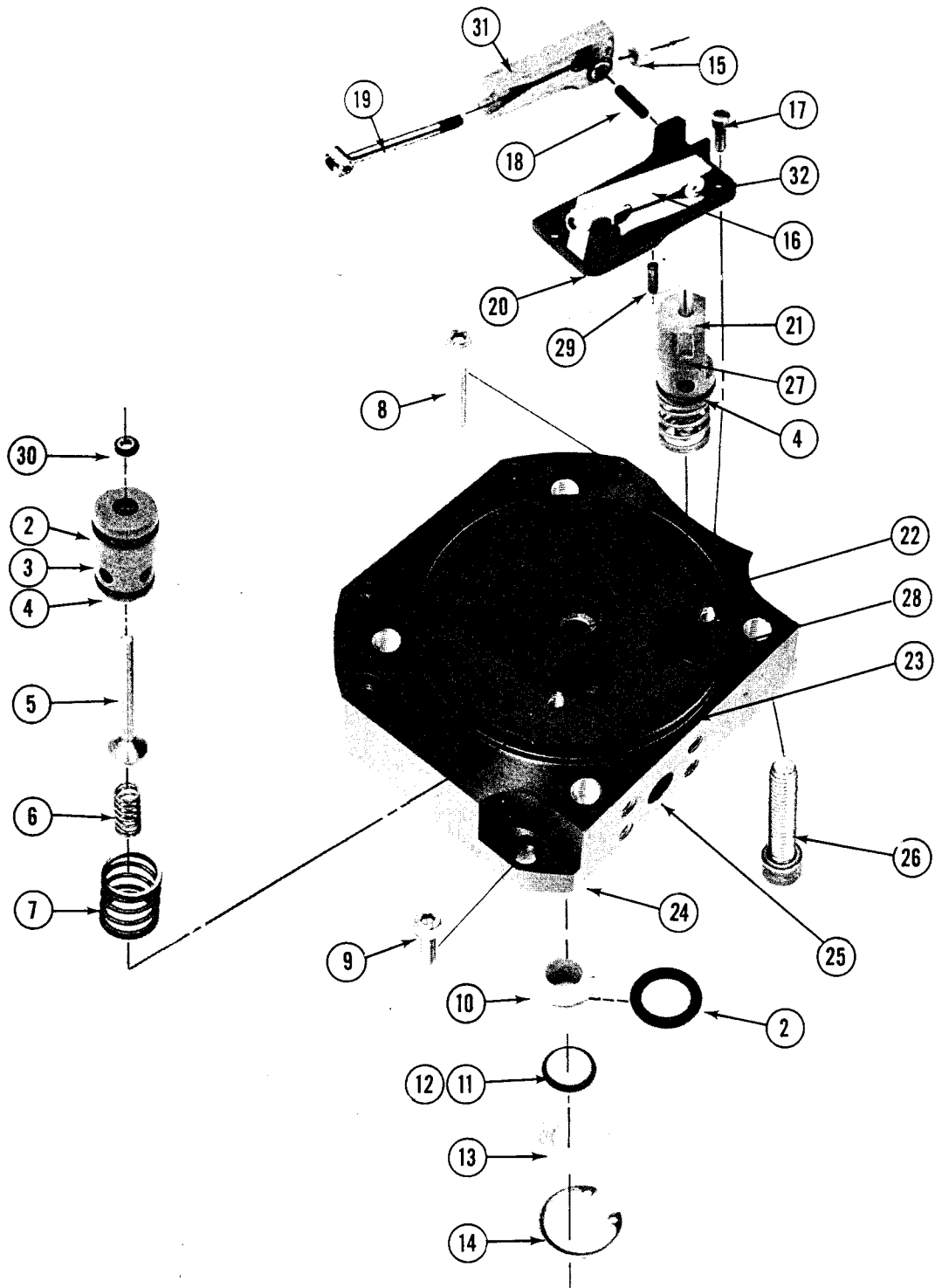


FIGURE 6-4 THE VALVE PLATE--EXPLODED VIEW

LEGEND - FIGURE 6-5

<u>ITEM NO.</u>	<u>PART NAME</u>	<u>PART NO.</u>
1	Drive Motor	D3657046
2	Driver Housing	D3588061
3	Valve Plate	-----
4	Scotch Yoke	B3761009
5	Driver	B3761033
6	Key	A3588020
7	Relief Valve, Pneu-Hydro 1121017 (225 psi)	51-34-28
8	Sight Glass	B3588056
9	Sight-Glass Retainer	B3588057
10	Retaining Screw, Cap Screw, Socket Head, S.Stl., #8-32 x 5/8"Lg.	52-13-51
11	Cap Screw, Socket Head, S.Stl., 1/4"-20 x 1" Lg.	52-13-67
12	Plug, Hex Head, Parker #4P50N-S	51-10-36
13	O-Ring, #2-129, Parker Compound N219-7	58-04-56
14	Cap Screw, Socket Head, S.Stl., 1/4"-20 x 1-1/4" Lg.	52-13-68
15	O-Ring, #2-234, Parker Compound N219-7	58-03-35

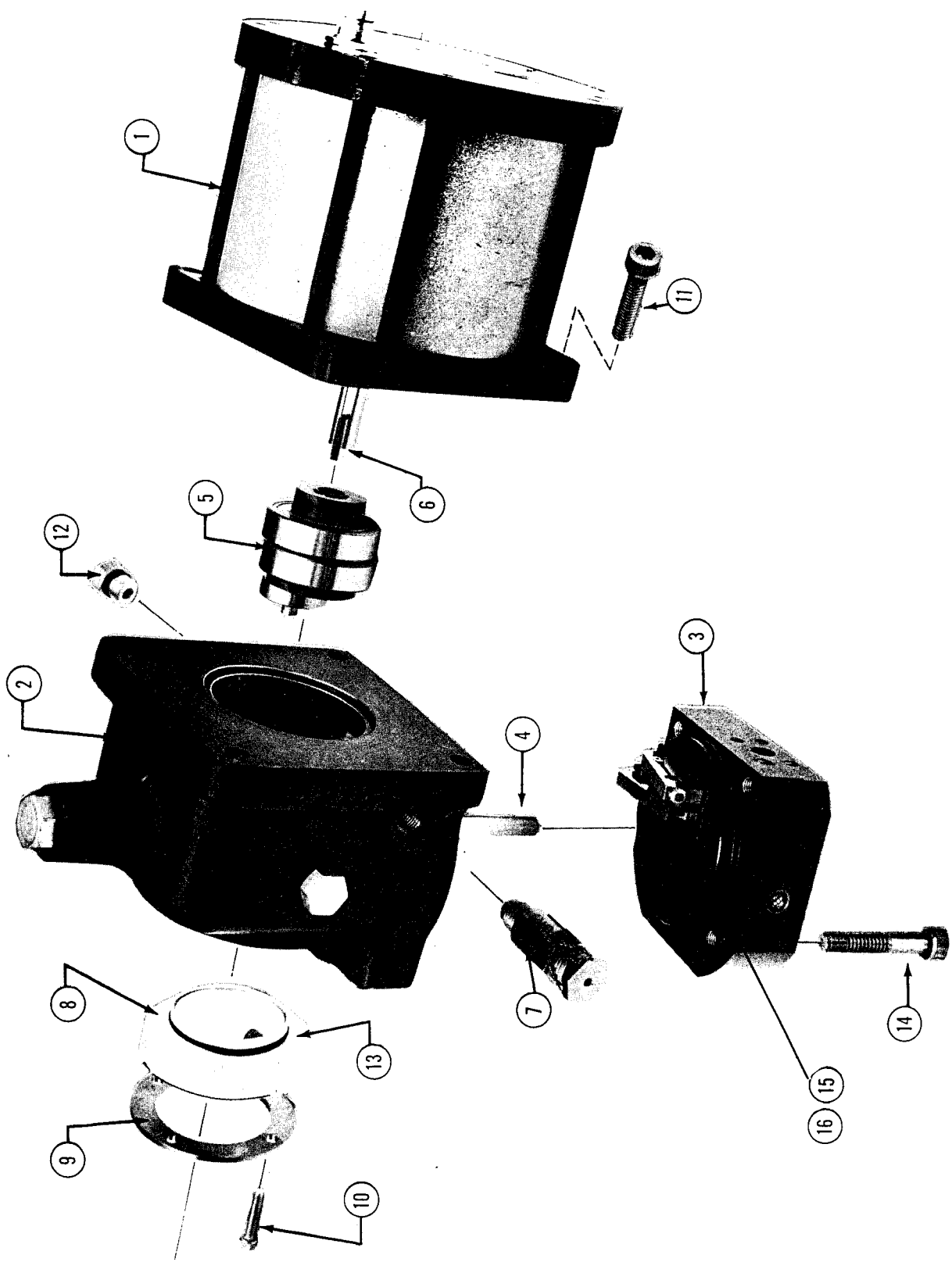


FIGURE 6-5 THE DRIVE UNIT, EXPLODED VIEW

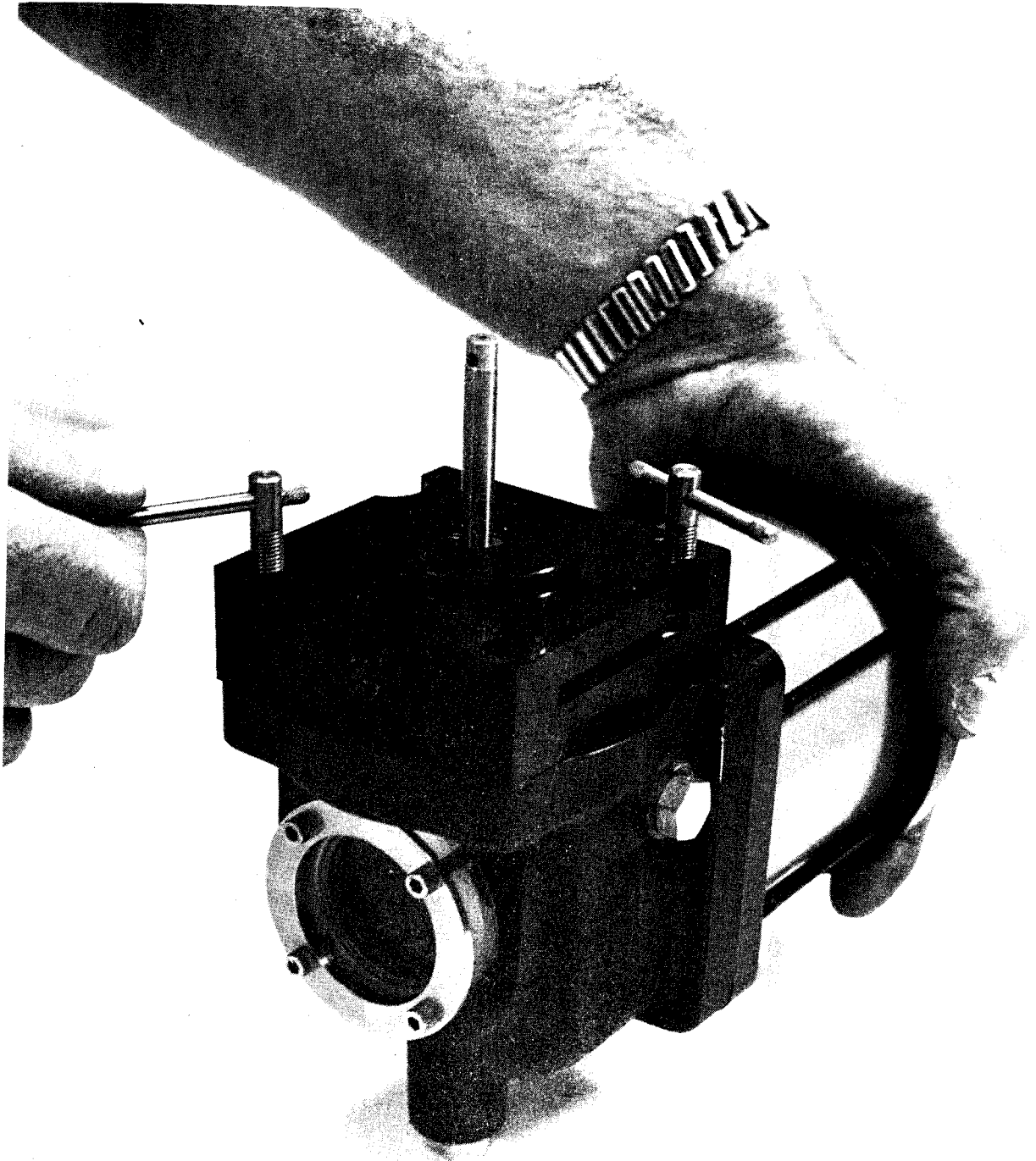


FIGURE 6-8 USE OF THE VALVE-PLATE JACKING SCREWS

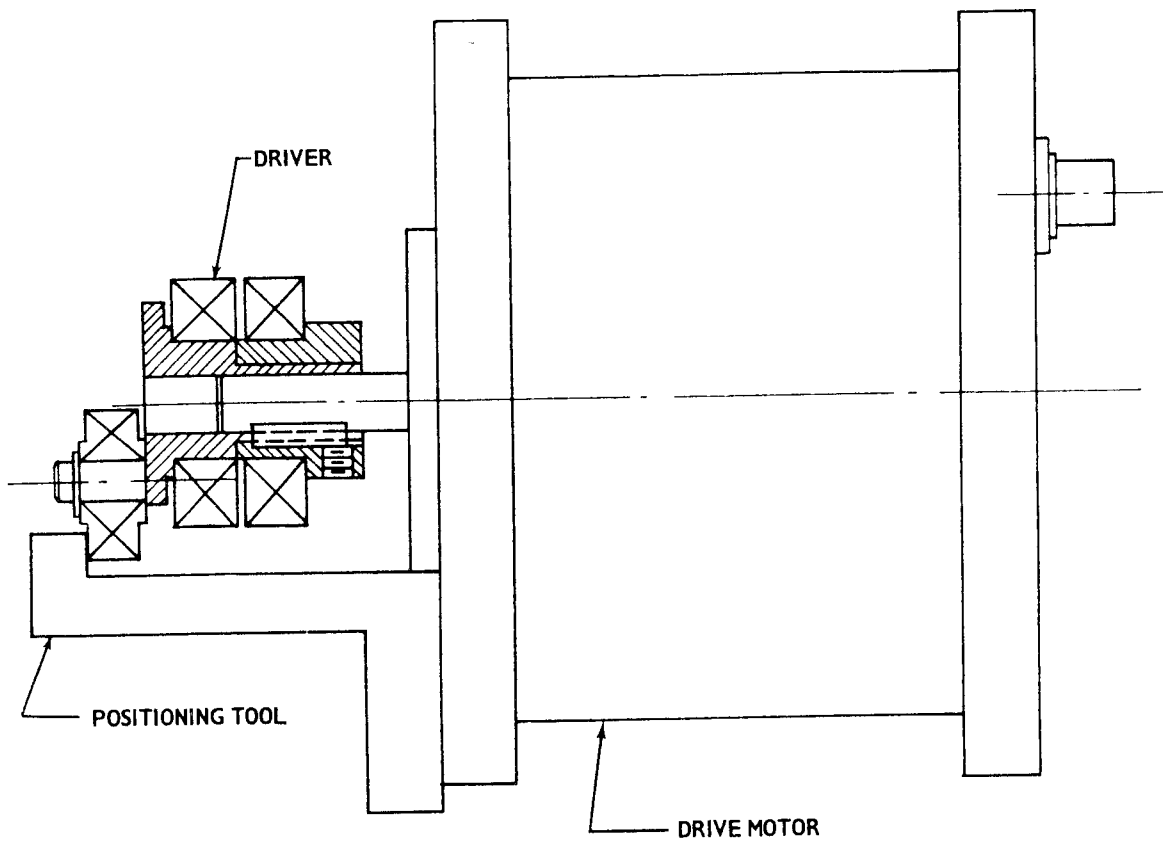


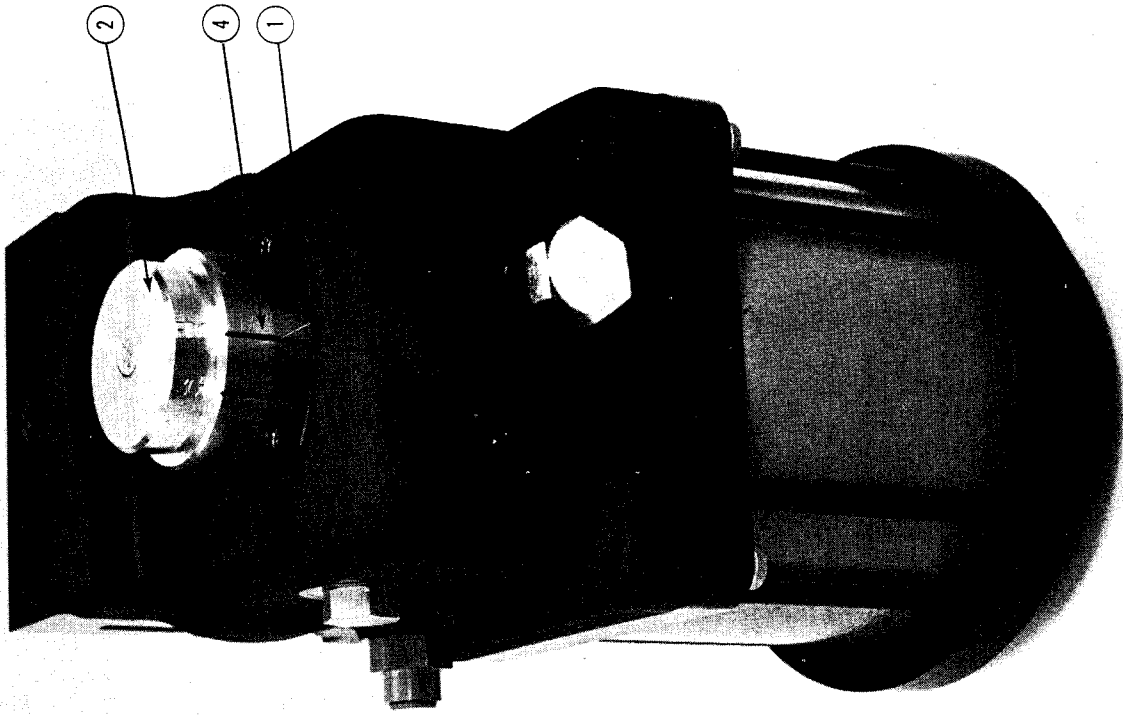
FIGURE 6-9 METHOD OF POSITIONING THE DRIVER ON THE DRIVE MOTOR SHAFT

LEGEND - FIGURE 6-10

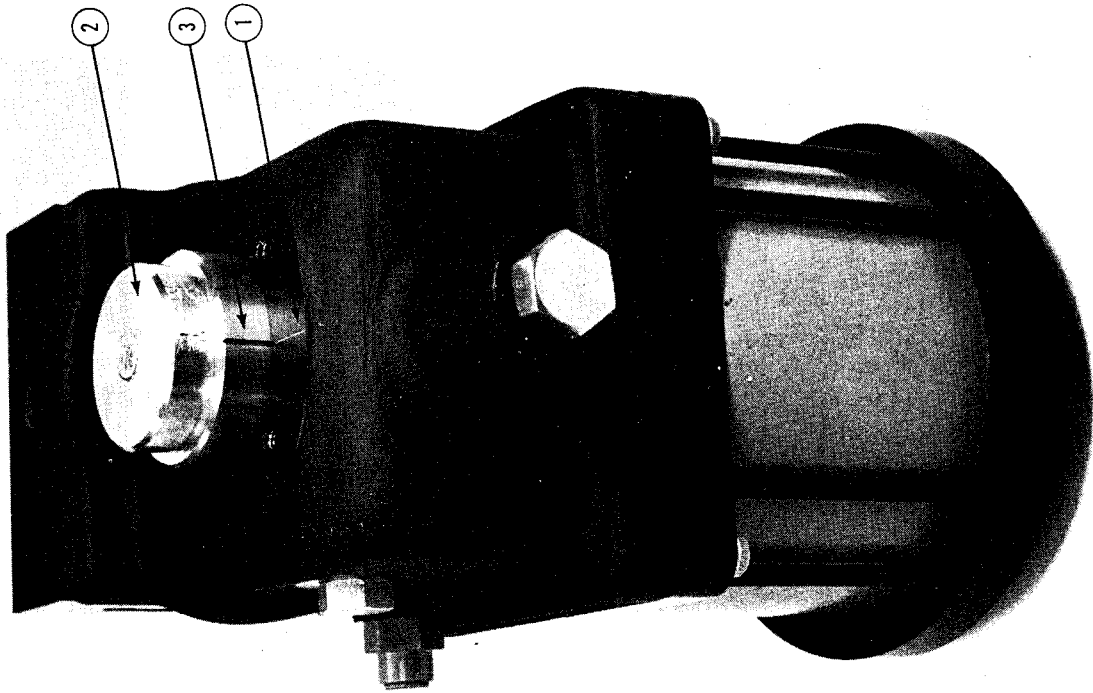
ITEM NO.

PART NAME

- | | |
|---|-----------------------------|
| 1 | Scribe Mark, Driver Housing |
| 2 | Timing Tool |
| 3 | 30°-Mark, Timing Tool |
| 4 | BDC-Mark, Timing Tool |



BDC - MARK



30° - MARK

FIGURE 6-10 USE OF THE TIMING TOOL

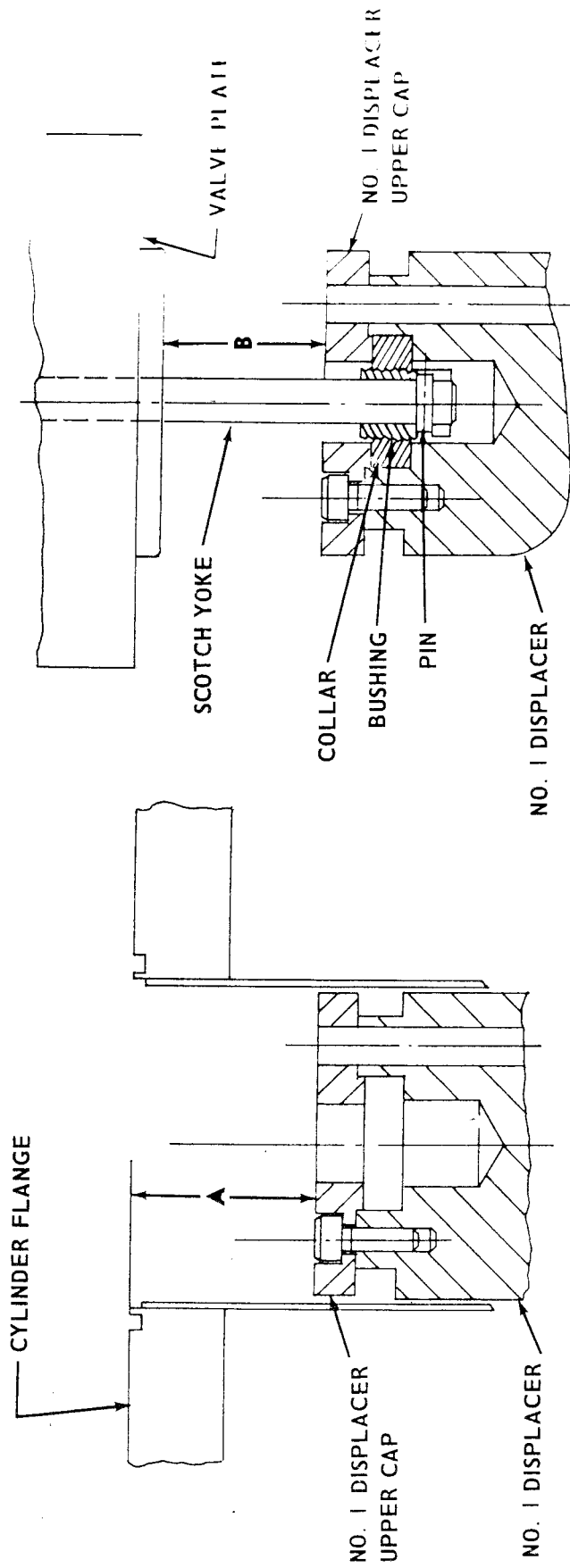


FIGURE 6-12 DISTANCES "A" AND "B" USED IN ADJUSTING THE DISPLACER END CLEARANCE

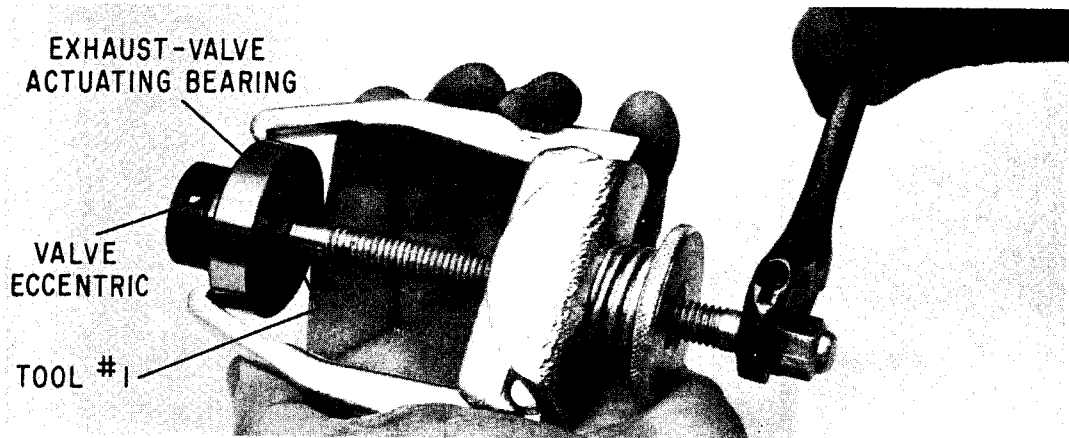


FIGURE 6-16 REMOVING THE EXHAUST-VALVE ACTUATING BEARING

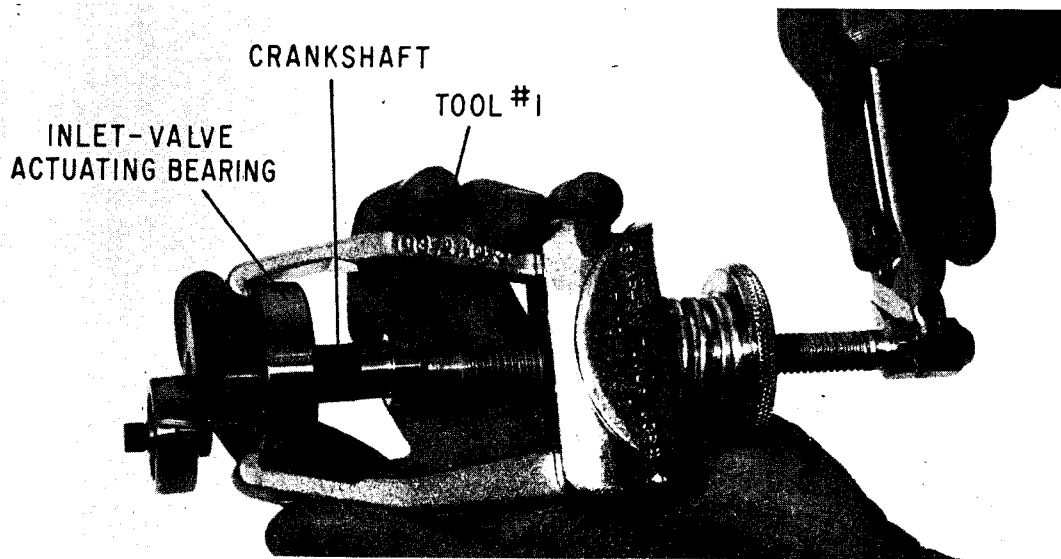


FIGURE 6-17 REMOVING THE INLET-VALVE ACTUATING BEARING

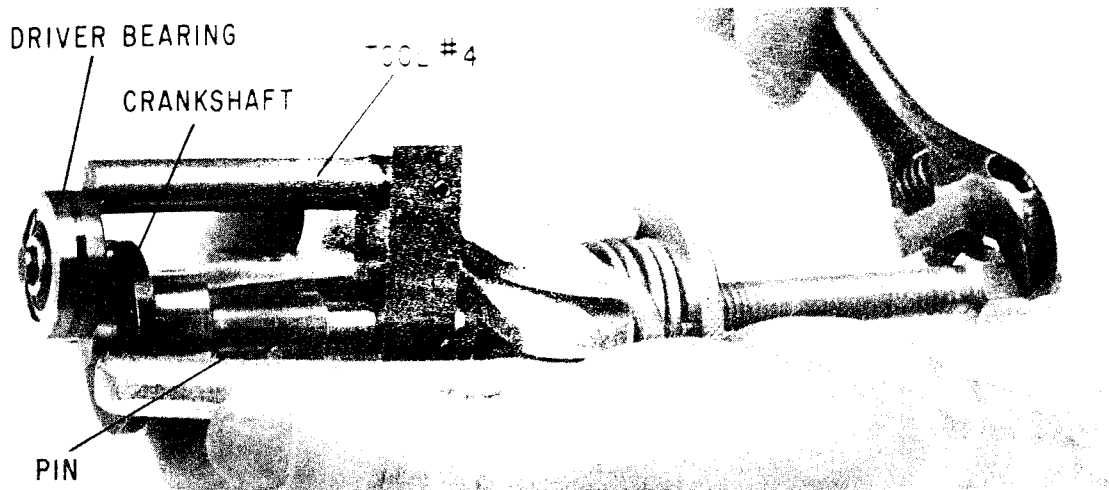


FIGURE 6-18 REMOVING THE DRIVER BEARING

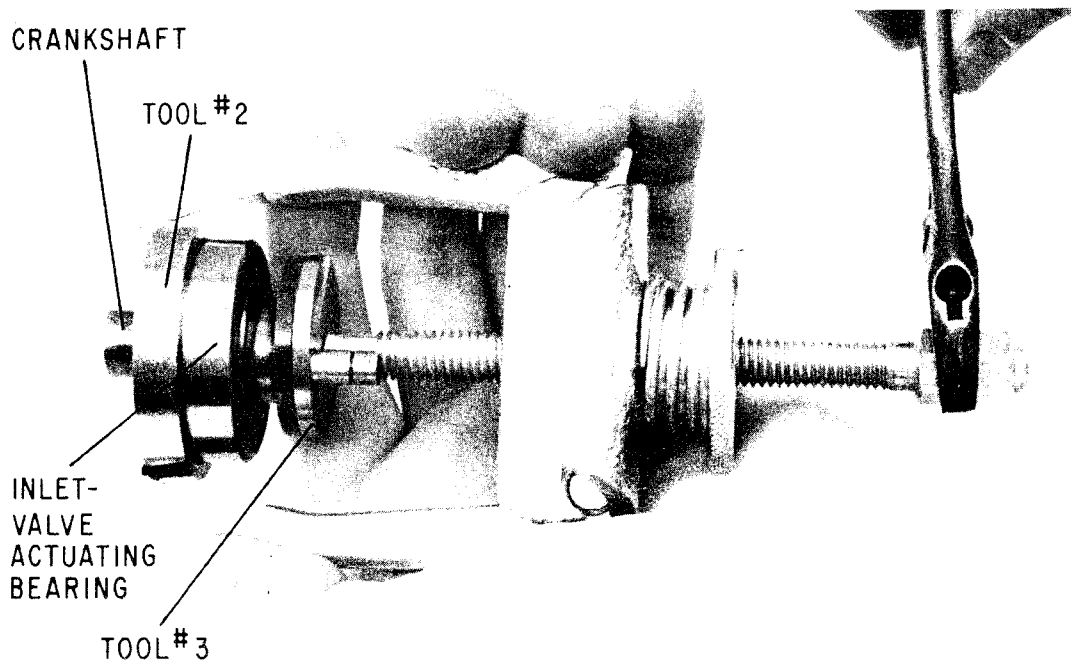


FIGURE 6-19 INSTALLING THE INLET-VALVE ACTUATING BEARING

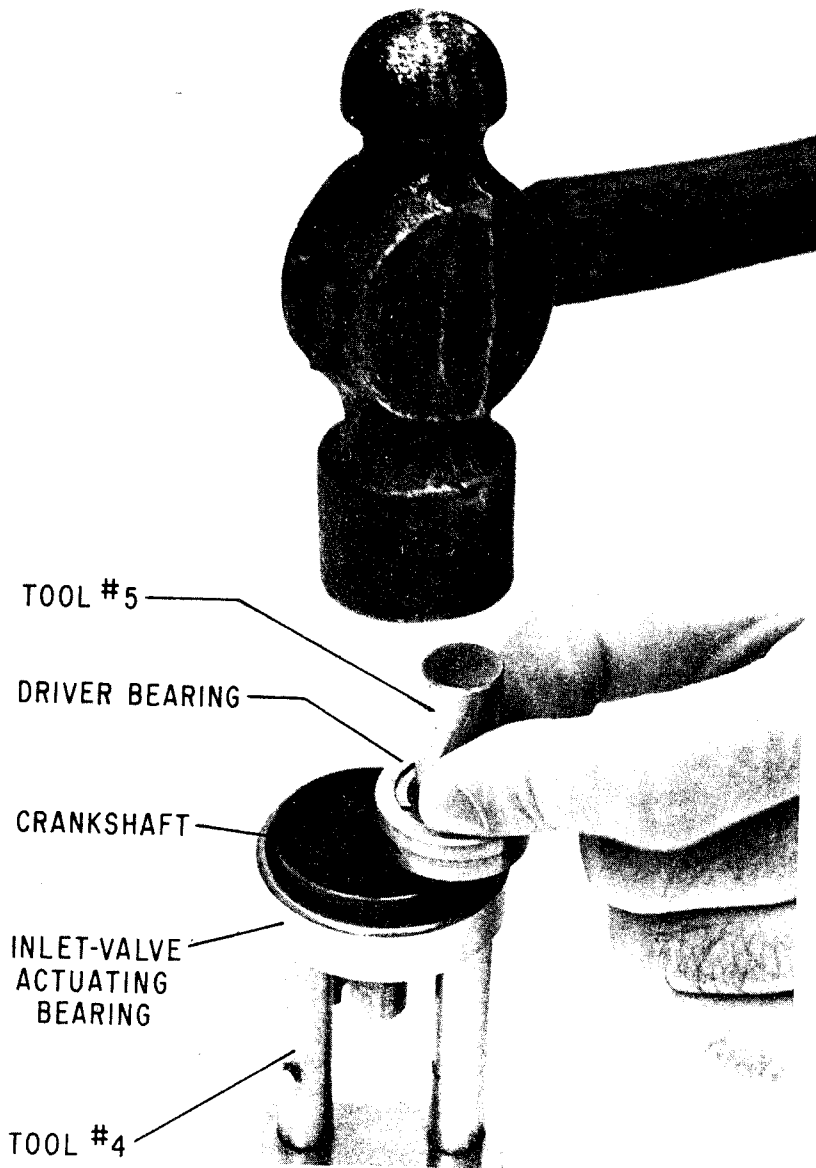


FIGURE 6-20 INSTALLING THE DRIVER BEARING

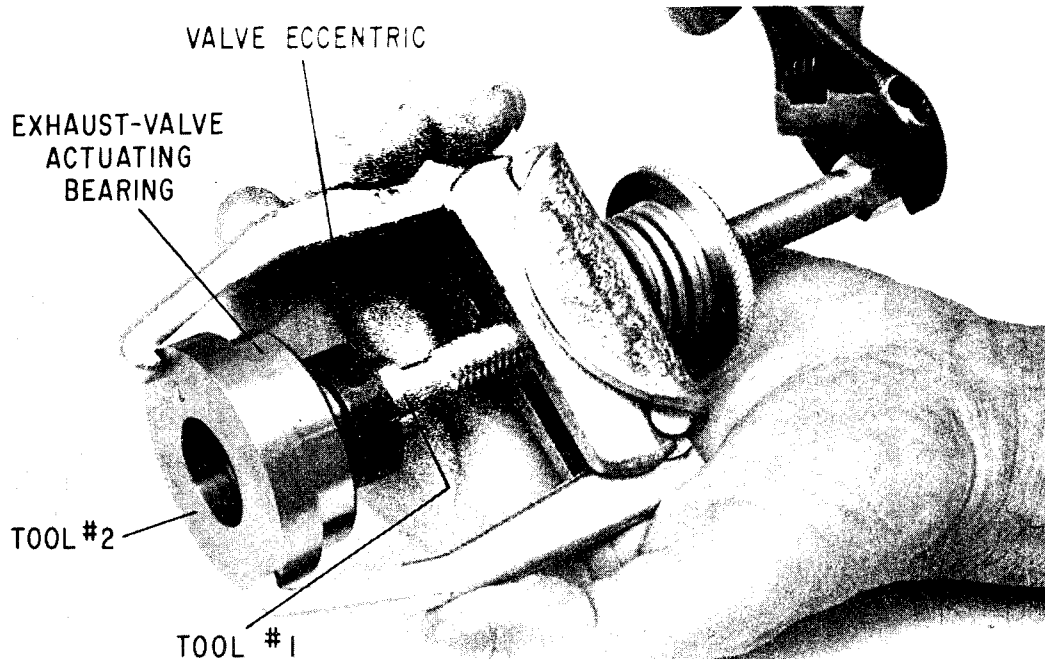


FIGURE 6-21 INSTALLING THE EXHAUST-VALVE ACTUATING BEARING

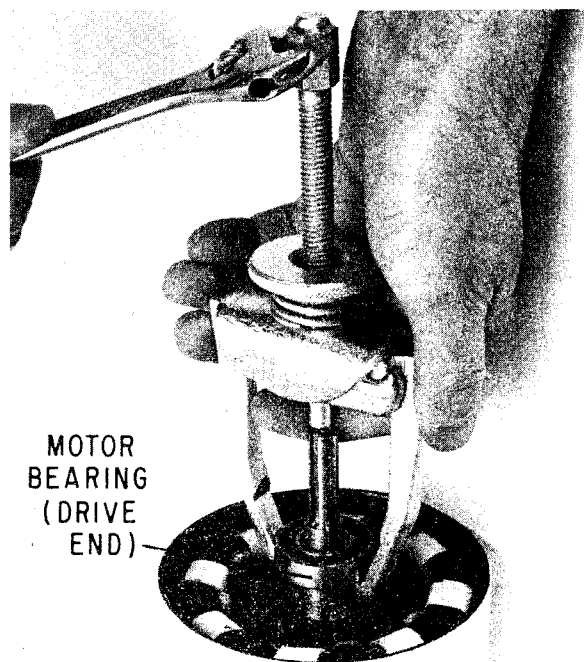


FIGURE 6-22 REMOVING MOTOR BEARING (DRIVE END)

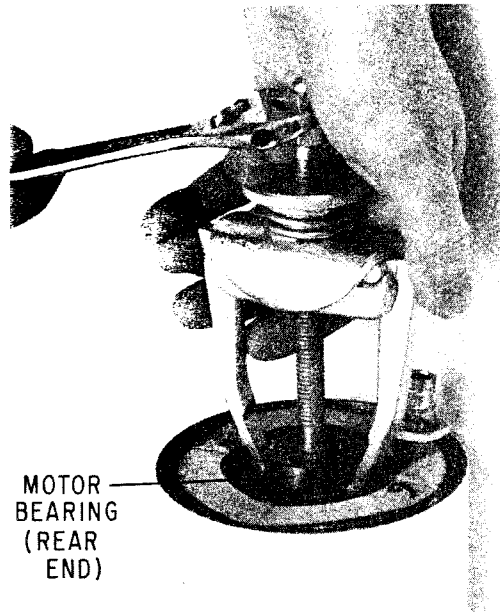


FIGURE 6-23 REMOVING MOTOR BEARING (REAR END)

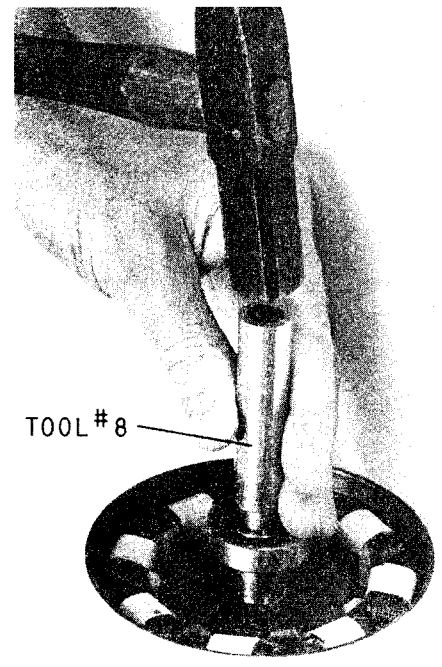


FIGURE 6-24 INSTALLING MOTOR BEARING (DRIVE END)

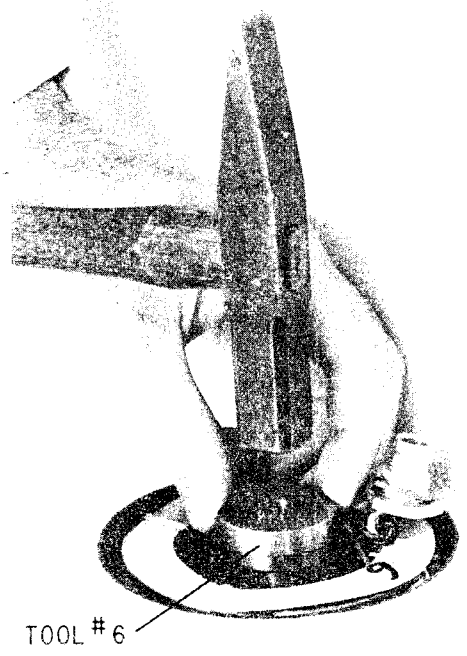
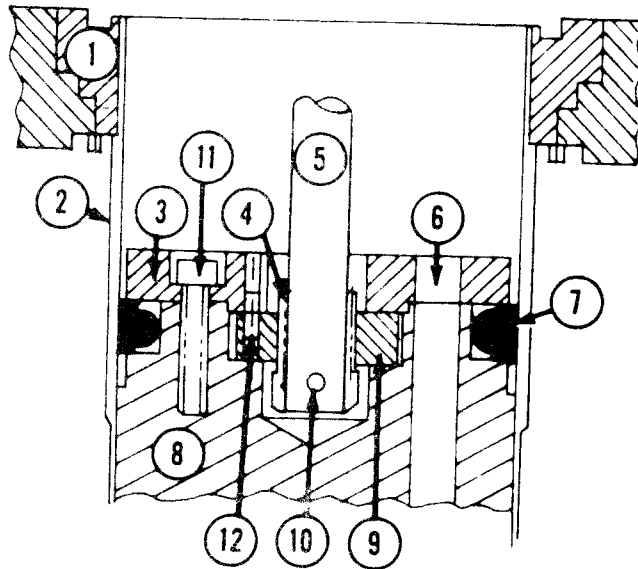
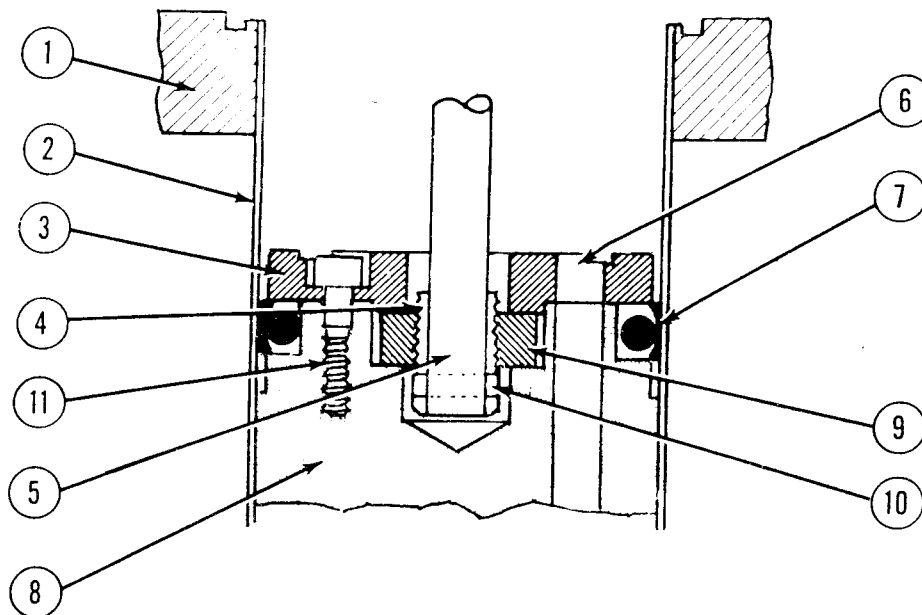


FIGURE 6-25 INSTALLING MOTOR BEARING (REAR END)



<u>ITEM NO.</u>	<u>PART NAME</u>
1	Cylinder Flange
2	Cylinder Wall
3	Upper Cap of First-Stage Displacer
4	Bushing
5	Scotch Yoke
6	Gas Port
7	Kap-Seal
8	First-Stage Displacer
9	Collar
10	Pin
11	Cap Screw
12	Locking Pin

FIGURE 6-1A CROSS-SECTION SHOWING THE ATTACHMENT OF THE SCOTCH YOKE TO THE DISPLACER



<u>ITEM NO.</u>	<u>PART NAME</u>
1	Cylinder Flange
2	Cylinder Wall
3	Upper Cap of First-Stage Displacer
4	Bushing
5	Scotch Yoke
6	Gas Port
7	Kap-Seal
8	First-Stage Displacer
9	Collar
10	Pin
11	Cap Screw, Socket Head

FIGURE 3-6 CROSS-SECTION SHOWING THE ATTACHMENT OF THE SCOTCH YOKE TO THE DISPLACER

LEGEND - FIGURE 3-5

<u>Item No.</u>	<u>Part Name</u>
1	Rocker Arm, Inlet Valve
2	Stop Nut
3	Rocker Arm, Exhaust Valve
4	Adjusting Bolt
5	Exhaust Valve
6	Discharge Port
7	Valve Plate
8	Support Bracket
9	Inlet Port

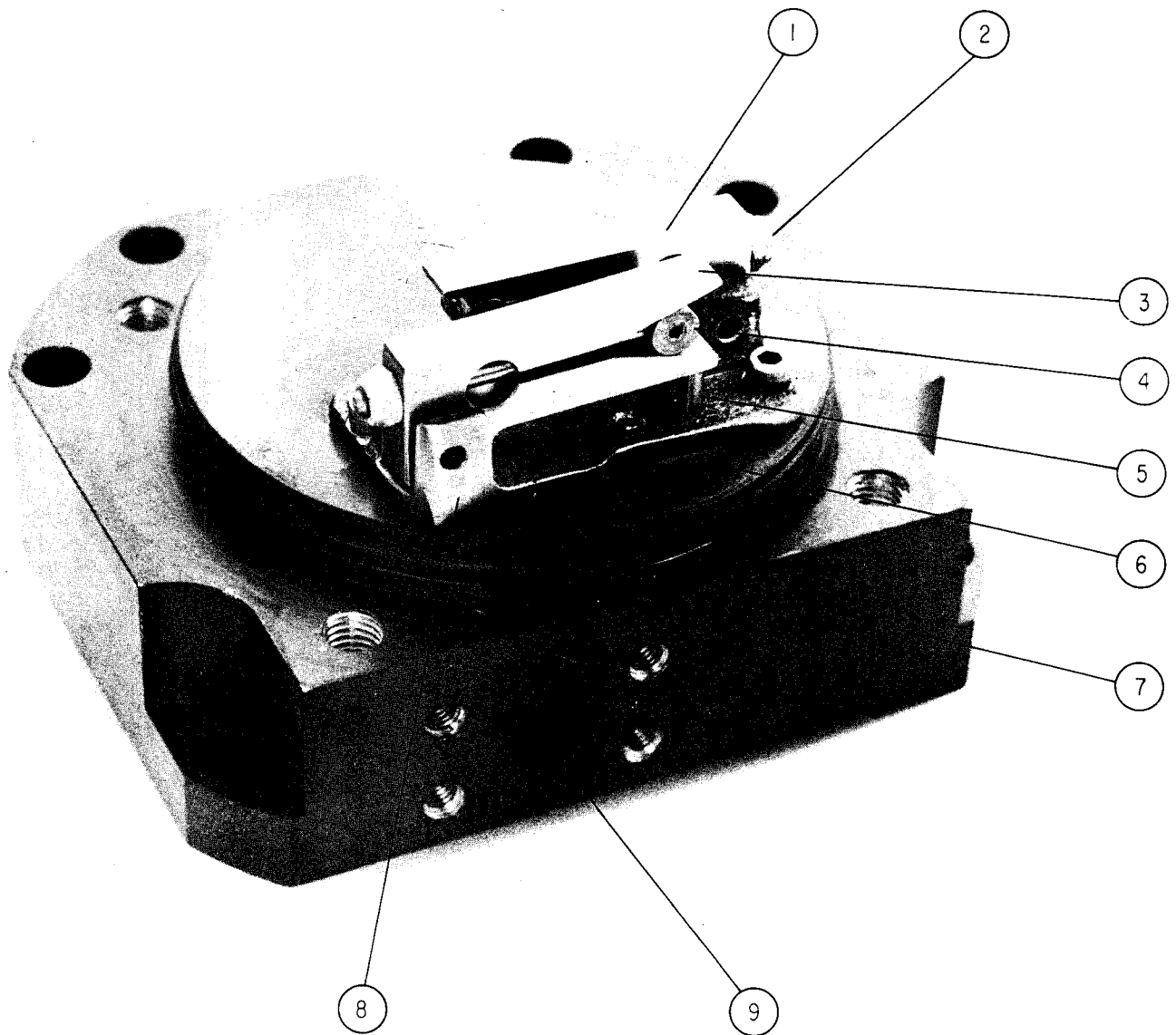


FIGURE 3-5 VALVE-PLATE ASSEMBLY

APPENDIX FIGURE 6-2

<u>ITEM NO.</u>	<u>PART NAME</u>	<u>PART NO.</u>
1	Spring Scale (3000 grams)	87-37-51
2	Test Clip	B35-2223921

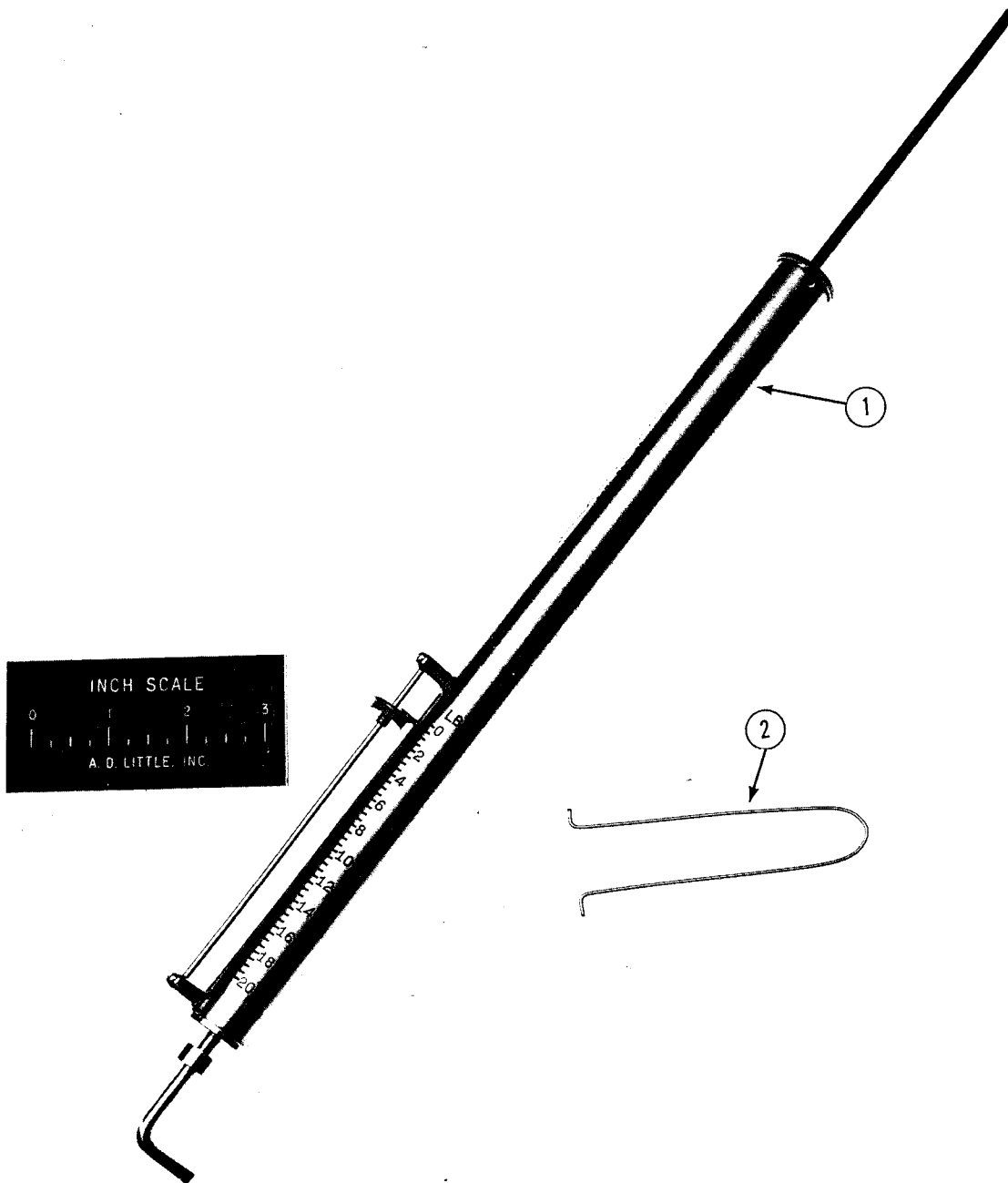


FIGURE 6-2 THE SPRING SCALE AND TEST CLIP

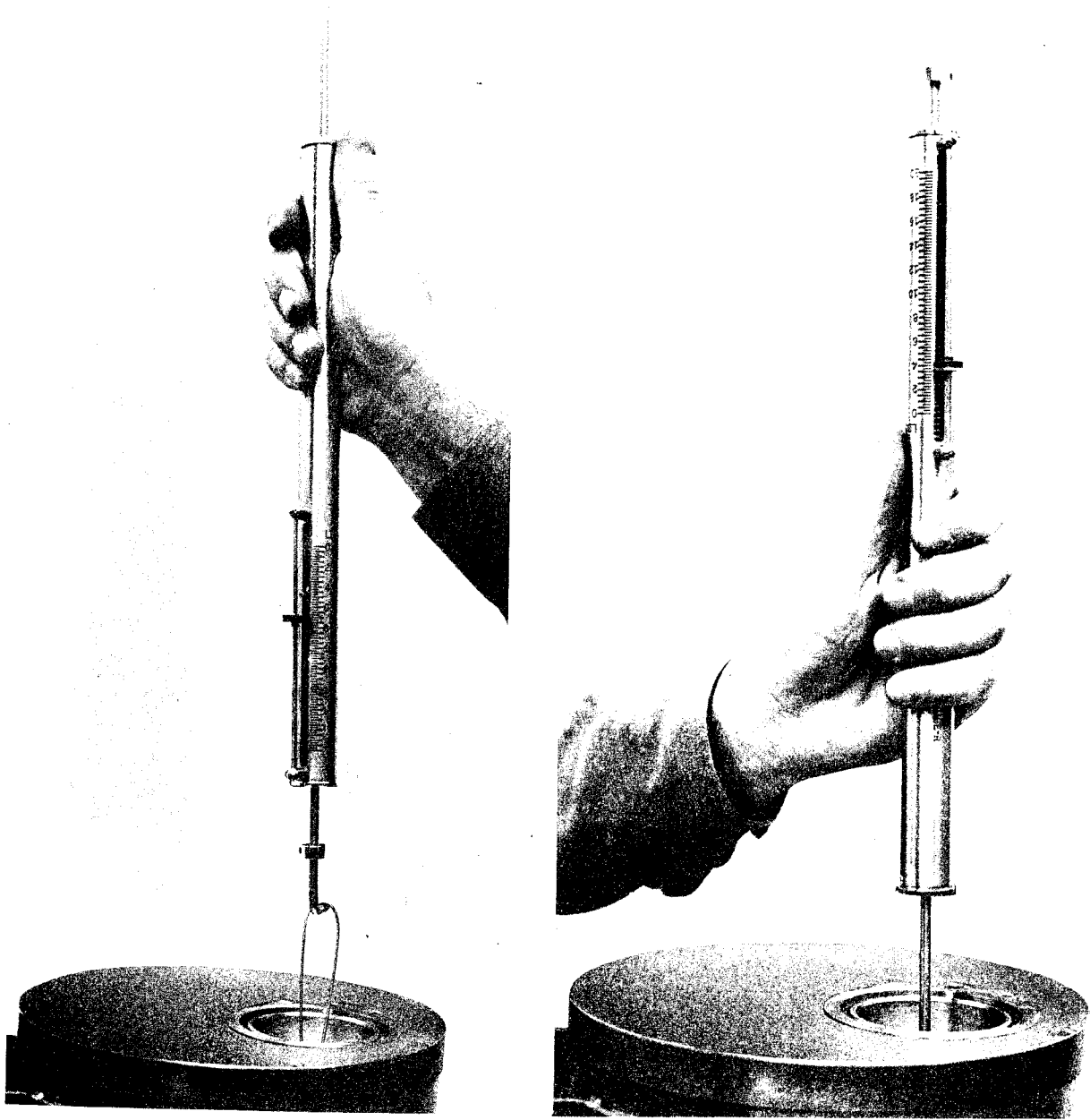


FIGURE 6-3 USE OF THE SPRING SCALE IN MAKING THE PUSH-PULL TEST