CHAPTER 13

REPAIR WORK

CHAPTER LEARNING OBJECTIVES

Upon completing this chapter, you should be able to do the following:

- *Explain the removal of broken studs and taps.*
- *Describe the repair and inspection of pumps.*
- *Explain the procedure used to straighten shafts.*
- *Describe the inspection of constant-pressure governors.*
- *Explain the uses of in-place machining equipment.*
- *Explain the purpose of METCAL.*
- *Explain the purpose of the quality assurance program.*
- *Explain the purpose of the planned maintenance system.*

In this chapter we'll discuss some of the different jobs you may encounter as an MR. We'll also discuss some of the things you need to know before you start the job, such as quality assurance, calibration, and planning.

JOB PREPARATION

There are a number of things you must do before you actually start a job in a machine shop. If you ignore these things, the job may turn out to be inaccurate. Even worse, it may be perfect but still not useable because of improper documentation. We'll now discuss some of the things you must do to prepare for the job.

As with any shop equipment you must observe all posted safety precautions. Review your equipment operators manual for safety precautions. Also read any chapters of *Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat,* OPNAV Instruction 5100.l9B, that apply to the equipment.

CALIBRATION

Calibration assures us that the parts we manufacture will fit together as they should. The increased complexity of ship systems has made it necessary to improve the accuracy of measurements. The Navy addressed this problem by creating the Navy Metrology and Calibration (**METCAL**) Program. This program ensures the traceability and accuracy of instrument calibration. To operating personnel, this means that any instrument used for quantitative measurement must be calibrated.

Simply stated, you must always be sure the instruments you use for quantitative measurement are calibrated. Never use an instrument with an outdated calibration sticker. If you suspect a measuring instrument has been damaged, be sure it is taken out of use and calibrated. For more information on the **METCAL** program refer to *Instrumentman* 3 & 2, NAVEDTRA 10193-D.

QUALITY ASSURANCE

The philosophy of quality assurance (QA) is unique in that it does not recognize degrees of success. QA is

pass-fail. In our educational system, a student who answers 99 percent of the questions correctly will get straight A's. By contrast, an MR may manufacture 99 percent of a part perfectly, but the part ends up in the scrap bin because of the 1 percent done improperly. The part must be redone and the costs are additional time, effort, money, and embarrassment to the machinist.

Quality assurance is used to lay out procedures in which we assemble and disassemble components and repair their parts. All MRs must be familiar with QA since it is something they will use every day on the job. Refer to your type commander's quality assurance manual, which is developed according to SECNAVINST 4855.1, for information on the quality assurance program. *Engineering Administration,* NAVEDTRA 12147, also contains a chapter on QA that is condensed and easily understood.

PLANNED MAINTENANCE SYSTEM

Maintenance is one of the most important jobs you will do in the Navy. The degree of accuracy to which you can machine a part is often directly related to the condition of the machine tools you are using. If preventive maintenance is not done properly, or not done at all, your equipment may be put out of commission until it can be repaired.

Preventive maintenance includes actions to prevent equipment from failing, such as taking oil samples, changing the oil, greasing, cleaning or replacing filters, or simply cleaning each machine before and after its use.

Information on the planned maintenance system is found in *Ships' Maintenance and Material Management (3-M) Manual,* OPNAVINST 4790.4.

PLANNING WORK

Occasionally you may be fortunate enough to have a TRS (technical repair standard) to give you step-by-step instructions for a job. Unfortunately there are very few TRSs for machine shop work. You normally have to plan the steps for each job.

To start with, you will need to research technical publications or blueprints for job specifications. If a job is as-per-sample, you may need to draw your own blueprint. Decide which machines are required to make the part and calculate all necessary dimensions. Choose the most logical sequence of machining operations so that the part is machined in a minimum of setups. Be sure the correct material is on hand for the job.

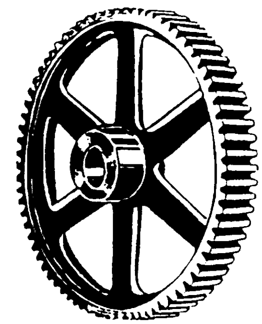


Figure 13-1.—Part made in a machine shop.

Once you have the job planned, be sure all documentation is properly recorded from the start of the job until the finish.

REPAIR JOBS

The Navy supply system usually provides replacement parts for most equipment, but occasionally you will need to make parts such as shafts and gears. (See fig. 13-1).

A major portion of the repair work done in shipboard machine shops involves machining worn or damaged parts so that they can be placed back in service. For example, you will machine the sealing surfaces of leaking valves and pumps, remove broken studs, and repair bent or damaged shafts. Repair work is usually more difficult than manufacturing work because of alignment problems in the machining operation.

SHAFTS

If you work in a machine shop, some of your common jobs will be to manufacture, straighten, and stub shafts. We will discuss them in the following paragraphs.

Manufacturing a New Shaft

In figure 13-2, the circled numbers show a sequence of operations by which a shaft might be made in a machine shop. The manufacturer's technical manual for the equipment that contains the shaft will normally have this information. Look at figure 13-2 as you read the following material.

Select and cut a piece of round stock at least 1/16 inch larger in diameter and 1/8 inch longer than the shaft. Face and center drill each end of the stock. In

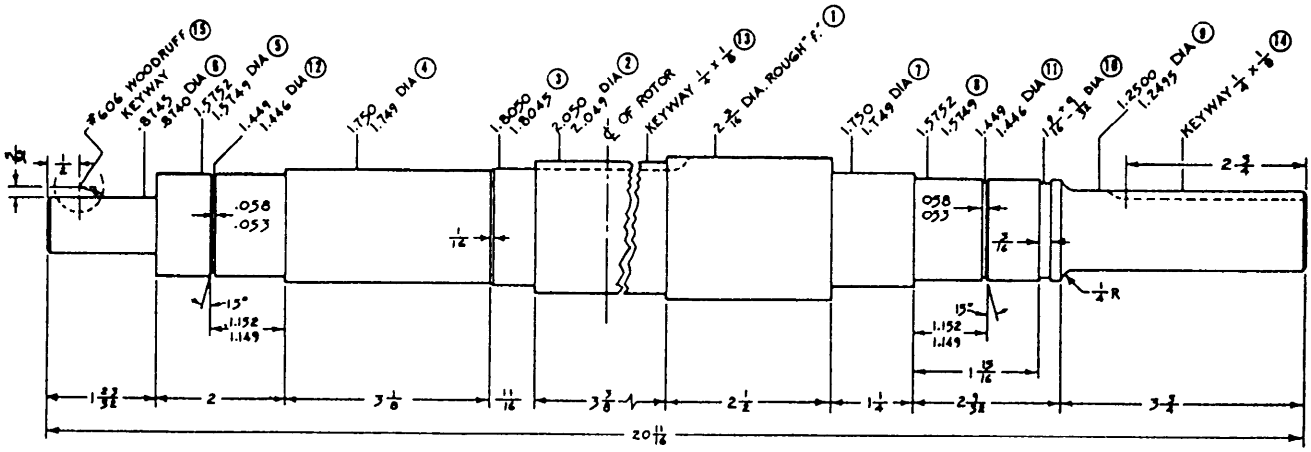


Figure 13-2.—Steps in making a shaft.

facing, be sure you face the workpiece to the correct length for the shaft, which in this example is 20 11/16 inches. Most of the linear dimensions in figure 13-2 are given in the form of mixed numbers of proper fractions; this indicates that you can use a rule to measure the dimensions. However, the linear position of the grooves at numbers 11 and 12 are in decimal fractions; you must measure these with an instrument more accurate than a rule. When you manufacture a new shaft, you must take all linear dimensions from the same reference point to ensure the correct lengths.

You can machine this particular shaft in two lathe setups and two mill setups. In the first lathe setup, do the plain turning required on surfaces 1 through 6; then machine surfaces 7 through 12 in the second lathe setup. Machine keyways 13 and 14 in the first milling setup; and then change the cutter to machine the Woodruff keyway (15). To machine the shaft, take the following steps:

1. Turn the workpiece to a 2 3/16-inch diameter. Check the diameter for taper and make corrections as necessary.

2. Set hermaphrodite calipers to 11 3/32 inches and lay out the shoulder between the 2 3/16 inch diameter and the 2.050 inch finish diameter. Using the crossfeed handwheel with the micrometer collar set on zero, feed the tool in 0.068 inch (one-half of the difference between 2.050 and 2 3/16). Make a short length of cut at the end of the shaft and measure the diameter with a micrometer. Adjust the crossfeed handwheel as required to provide the 2.050 + 0.000 - 0.001 diameter and complete the cut to the layout line.

3. Use procedures similar to those described in step 2 to machine surfaces 3 through 6. Be extremely careful to accurately measure the diameter of the beginning of each cut to ensure that you hold the dimensions within the range provided in the illustration.

4. Turn the workpiece end-for-end and machine surfaces 7, 8, and 9 as described in step 2.

5. Set a 3/16-inch parting tool in the toolholder, position the tool (by rule measurement) to make groove 10, and make the groove.

6. Set the compound rest parallel to the axis of the workpiece to lay out grooves 11 and 12. Place a sharp pointed tool in the toolholder and align the point of the tool with the shoulder between surfaces 7 and 8. Then use the compound rest to move the tool 1.152 inches longitudinally as indicated by the micrometer collar on the compound feed screw. Feed the tool toward the work with the crossfeed until a thin line is scribed on the surface of the workpiece. Now swivel the compound rest to the angle required to cut the chamfer, and cut the chamfer. (Calculate the angular depth from the given dimensions.) Then use a parting tool between 0.053 and 0.058 inch wide to make the groove.

7. With a fine cut file, remove all sharp edges from shoulders and grooves.

8. Remove the shaft from the lathe, mount it in the milling machine, and mill the keyways to the required dimensions.

Straightening a Shaft

In many cases, bent shafts can be straightened so they have less than 0.001 inch runout. Before you try to

straighten a shaft, however, always be sure the leading petty officer of the shop is informed of the operation. Use the following steps to straighten a shaft:

1. Mount the shaft between centers in a lathe. If the shaft is too long, mount it on rollers.

2. Clamp a dial indicator on the compound rest, locate the area of the bend, and measure how much the shaft is bent (runout). To determine the area of the bend, run the dial indicator along the shaft longitudinally. The greatest variation of the pointer from zero indicates the bend area. With the dial indicator set at this point, rotate the shaft and note the amount of fluctuation of the pointer. This fluctuation is the amount of runout. Mark the longitudinal position of the bend and the high side of the bend with chalk or a grease pencil.

3. Remove the shaft from the lathe and place it on a hydraulic press. Place a V-block on each side of the bend area and turn the shaft so the high side is up. Move the press ram downward until it touches the shaft. Set up a dial indicator so that the contact point contacts the high side of the shaft as near to the ram as possible.

4. Carefully apply pressure on the shaft with the ram. Watch the pointer of the dial indicator to determine how much the shaft is "sprung" in the direction opposite the bend. When the indicator reading is 0.002 or 0.003 inch greater than the amount of runout, release the ram pressure.

5. Set up the shaft between centers and check again as expiained in step 1. Repeat steps 2, 3, and 4 until the runout is decreased to within acceptable limits.

If the first attempt produces little or no change in runout, spring the shaft further in the second operation to overcome the elasticity of the shaft so that it bends in the required direction. It's better to make several tries and gain a few thousandths of an inch at a time than to do it in one or two tries and perhaps bend the shaft too fur in the opposite direction.

Stubbing a Shaft

You can repair the damaged ends of shafts by removing the bad section and replacing it with a new "stub" end. Always check to see if your type commander allows stubbing of shafts. Use the following steps to stub a shaft:

1. If a blueprint is not available, make a drawing of the shaft showing all dimensions.

2. Begin with a piece of scrap stock (spud) of the same material as the shaft. Use a lathe to machine it to the diameter of the shaft at the point where the center rest will be used. Carefully align the center rest on this spud.

3. Mount the undamaged end of the shaft in a 4-jaw chuck and "zero in" the shaft near the jaws of the chuck Use soft jaws or aluminum shims to prevent damage to the shaft surface.

4. Position the previously set center rest under the shaft so the center rest is between the chuck and the damaged end of the shaft.

5. Cut off the damaged portion of the shaft.

6. Face, center drill, and drill the end of the shaft. The diameter of the hole should be about 5/8 of the diameter of the shaft; the depth of the hole should be at least 1/2 times the hole diameter.

7. Chamfer the end of the shaft liberally to allow space for weld deposits.

8. Make a stub of the same material as the shaft. The stub should be 1/4 inch larger in diameter and 3/8 inch longer than the damaged portion of the shaft plus the depth of the hole drilled in the shaft. This provides ample machining allowance.

9. Machine one end of the stub to a press fit diameter of the hole in the shaft. The length of this portion should be slightly less than the depth of the hole in the shaft. (A screw fit between the shaft and stub can be used instead of the press lit.)

10. Chamfer the shoulder of the machined end of the stub the same amount as the shaft is chamfered.

11. Press (or screw for a threaded fitting) the stub into the shaft and have the chamfered joint welded and stress relieved.

12. Mount the shaft with the welded stub back in the lathe, and machine the stub to the original shaft dimensions provided by the drawing or blueprint.

REPAIRING VALVES

To repair valves, you must have a knowledge of the materials from which they are made. Each material has its limitations of pressure and temperature; therefore, the materials used in each type of valve depend upon the temperatures and pressures of the fluids that they control.

Valves are usually made of bronze, brass, cast or malleable iron, or steel. Steel valves are either cast or forged and are made of either plain steel or alloy steel.

Alloy steel valves are used in high-pressure, high-temperature systems; the disks and seats of these valves are usually surfaced with a chromium-cobalt alloy known as Stellite. This material is extremely hard.

You will find information on the commonly used types of valves and their construction in *Fireman*, NAVEDTRA 12001. The information in the following sections applies to globe, ball, and gate valves, but the procedures can usually be adapted to repair any type of valve.

Repairing Globe Valves

Begin with an inspection of all parts of the valve for wear and alignment and, if you find them defective, repair or renew them. However, most valve repair is limited to overhaul of the seat and disk, and we will concentrate on those procedures.

Make a close inspection of the valve seat and disk. Look for erosion, cuts on the seating area, and proper fit of the disk to its seat. In a normal overhaul, you will grind-in the seat and disk, or lap the seat and machine the disk in a lathe. When the parts are in such bad condition that the normal procedure will not work, you must machine both the valve disk and valve seat in a lathe. If the disk and seat appear to be in good condition, use the spotting-in procedure described in the next paragraphs to be sure.

SPOTTING-IN.—Use this procedure to visually determine whether or not the seat or disk make good contact with each other. To spot-in a valve seat, first apply a thin coating of prussian blue evenly over the entire machined face surface of the disk. Next, insert the disk into the valve and rotate it a quarter turn, using a light downward force. The prussian blue will adhere to the valve seat at points where the disk makes contact. Figure 13-3 shows the patterns of prussian blue on a correct seat and on imperfect seats. After you have noted the condition of the seat surface, wipe all the prussian blue off of the disk face surface, then apply a thin, even coat on the contact face of the seat. Again place the disk on the valve seat and rotate the disk a quarter turn. Examine the resulting blue ring on the valve disk. If the ring is unbroken and of uniform width, and there are no cuts, scars, or irregularities on the face, the disk is in good condition. If the ring is broken or wavy, the disk is not making proper contact with the seat and must be machined.

GRINDING.—Valve grinding is the method of removing small irregularities from the contact surfaces of the seat and disk. You also will use this process to on seats or disks you have machined.

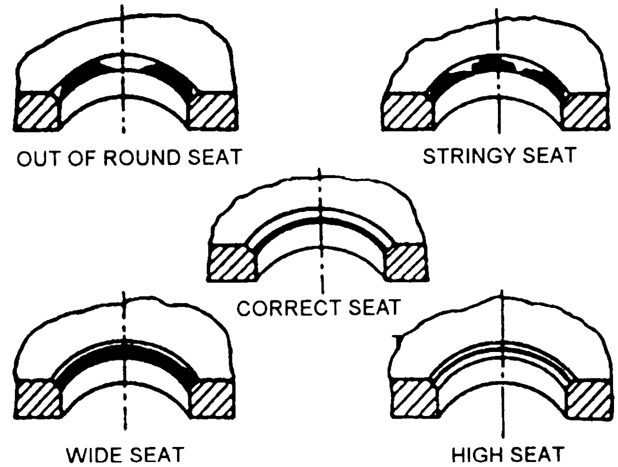


Figure 13-3.—Examples of spotted-in valve seats.

To grind-in a valve, apply a small amount of grinding compound to the face of the disk, insert the disk into the valve and rotate the disk back and forth about a quarter turn. Shift the disk-seat relation from time to time so the disk will be rotated gradually in increments through several rotations. The grinding compound will gradually be displaced from between the seat and disk surfaces, so you must stop every minute or so to replenish the compound. For best results when you replenish, wipe the old compound off the seat and the disk before you apply the new compound. When it appears that the irregularities have been removed, spot-in the disk to the seat as described previously.

When you first spot-in a machined valve seat and disk, the scat contact will be very narrow and located close to the edge of the bore. Grinding-in, using finer compounds as the work progresses, causes the seat contact to become broader until it looks like the “correct seat” shown in figure 13-3. The contact area should be a perfect ring, covering approximately one-third of the seating surface.

Avoid over-grinding. It will produce a groove in the seating surface of the disk and it may round off the straight angular surface of the seat. You will have to machine the surfaces to correct the effects of overgrinding.

LAPPING.—Lapping serves the same purpose as grinding, but it works only on the valve seat and it removes slightly larger irregularities than grinding. In this procedure, you will use a cast-iron lapping tool that

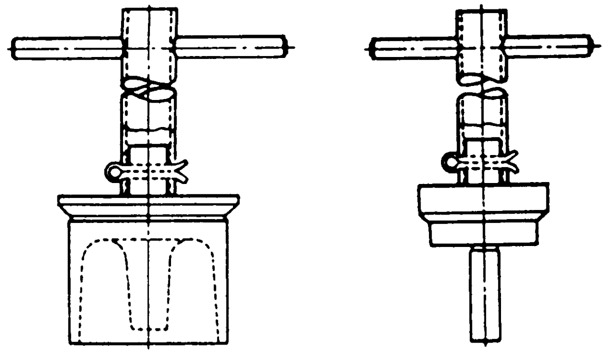


Figure 13-4.—Lapping tools.

has the same angle as the valve seat (fig. 13-4). You will use the lapping tool and grinding compounds in almost the same way you used the disk in the grinding process. However, you NEVER use the valve disk as a lap. The following list shows the essential points you must keep in mind while using the lapping tool:

- Do not bear heavily on the handle of the lap.
- Do not bear sideways on the handle of the lap.
- Shift the lap-valve seat relation so that the lap will gradually and slowly rotate around the entire seat circle.
- Check the working surface of the lap; if a groove wears on it, have the lap refaced.
- Use only clean compound.
- Replace the compound often.
- Spread the compound evenly and lightly.
- Do not lap more than is necessary to produce a smooth and even seat.
- Always use a fine grinding compound to finish the lapping job.
- When you complete the lapping job, spot-in and grind-in the disk to the seat.

Abrasive compound needed to grind-in and lap-in valve seats and disks is available in Navy stock in four grades. The following list shows grades and the recommended sequence of use:

GRADE	USE
Coarse	To lap-in seats that have deep cuts and scratches or extensive erosion.
Medium	To follow up the coarse grade: also may be used at the start of the reconditioning process where damage is not too severe.
Fine	To use when the reconditioning process nears completion.
Microscopic fine	To finish lap-in and do final grind-in.

REFACING.—The seat of a valve may be so deeply cut, scored, or corroded that lapping will not correct the condition. If so, you must machine it, or, in an extreme case, replace it with a new seat.

Many valves have removable seats that are threaded, welded, threaded and welded, or pressed into the valve body. In view A of figure 13-5, the valve seating surface has been welded so that it has become

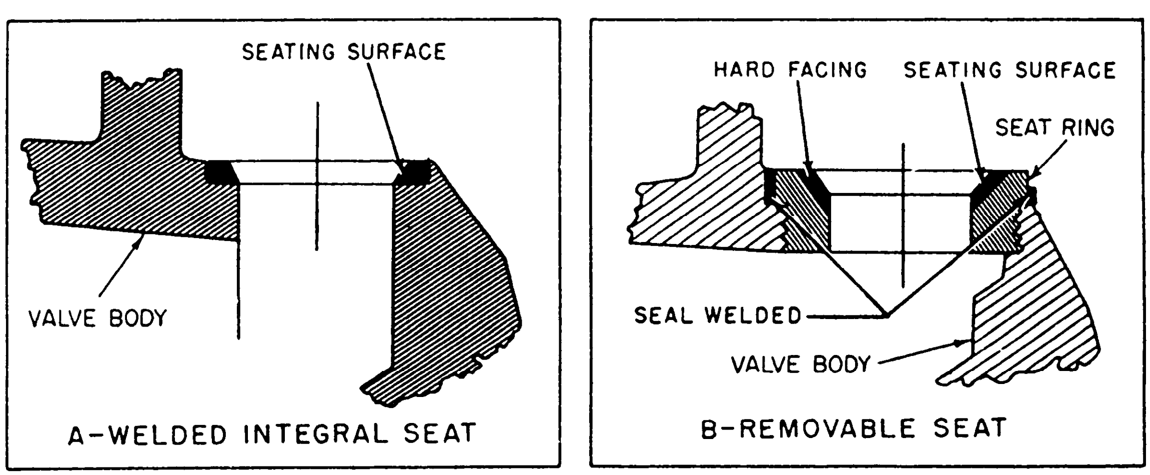


Figure 13-5.—Valve seat construction.

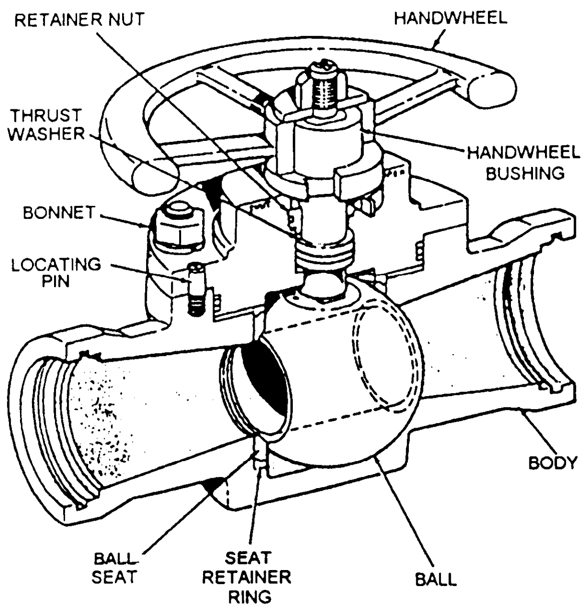


Figure 13-6.—Typical seawater ball valve.

an integral part of the valve body. In view B, the seating surface has been welded so that it has become an integral part of the seat ring. The seat ring is threaded into the body and then seal-welded. If you must renew the seating surface of A, you need only machine away the existing weld material and then rebuild the seating surface with successive deposits of new weld material. Then you can machine a new seating surface. If you must renew the seating surface shown in view B, first machine the seal weld from the ring and remove the ring from the valve body. You may then either install a new seat ring or remove, rebuild, and machine the existing seat surface.

After you have completed the machining, spot-in, and lightly grind-in the seat and disk. Then respot the seat and disk to be sure contact between the two is as it should be.

Repairing Ball Valves

Ball valves, as the name implies, are stop valves that use a ball to stop or start the flow of fluid. The ball, shown in figure 13-6, performs the same function as the disk in a globe valve. When you turn the handwheel to open the valve, the ball rotates to a point where the hole through the ball is in line with the valve body inlet and outlet. When you shut the valve, the ball rotates so the hole is perpendicular to the flow openings of the valve body, and the flow stops.

Most ball valves are the quick-acting type; they require only a 90-degree turn of a simple lever or

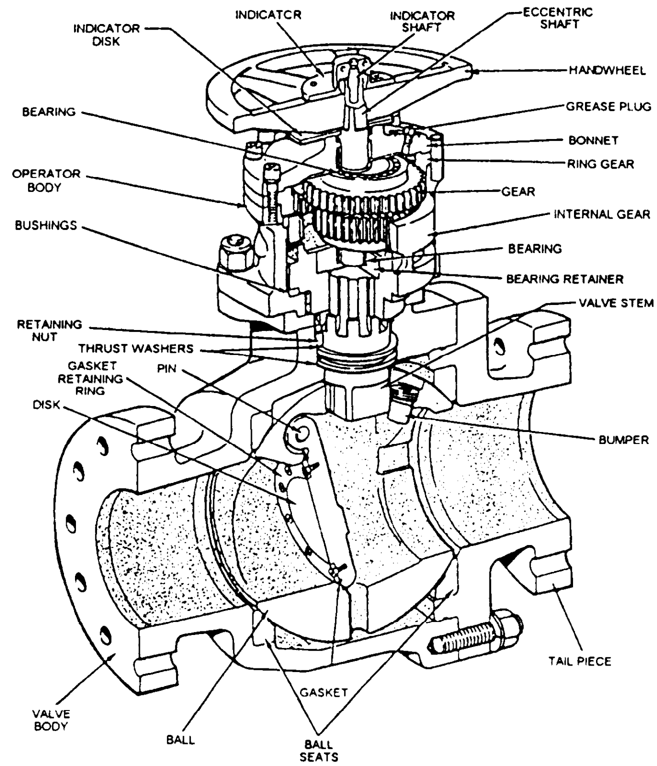


Figure 13-7.—Typical ball stop swing-check valve for seawater service.

handwheel to completely open or close the valve. Others are operated by planetary gears that use a relatively small handwheel and opening force to operate a fairly large valve. The gearing does, however, increase the time needed to open and close the valve. Some ball valves have a swing-check located within the ball to give the valve a check valve feature. Figure 13-7 shows a ball stop swing-check valve with planetary gear operation. Ball valves are normally found in the following systems aboard ship: seawater, sanitary, trim and drain, air, hydraulic, and oil transfer. Portsmouth Process Instruction 4820-921-339D contains repair procedures for ball valves. In the smaller types, you will normally replace parts rather than machine and rebuild them.

Repairing Gate Valves

Gate valves answer a need for a straight line flow of fluid with minimum flow restriction. Gate valves are so named because the part (gate) that either stops or allows flow through the valve acts somewhat like the opening or closing of a gate. The gate is usually wedge-shaped. When the valve is wide open, the gate is fully drawn up into the valve. This leaves an opening for flow through the valve that is the same size as the

pipe in which the valve is installed. Gate valves are not suitable for throttling purposes because turbulence makes it difficult to control flow. Also, fluid force against a partially open gate causes it to vibrate, causing extensive damage to the valve.

Gate valves are classified as either rising stem (fig. 13-8) or nonrising stem valves (fig. 13-9). In a rising stem gate valve, the stem is attached to the gate, and the gate and the stem rise and lower together as the valve is operated. In a nonrising stem gate valve, the stem is threaded on its lower end into the gate. As you rotate the handwheel on the stem, the gate travels up or down the stem on the threads while the stem remains vertically stationary. This type of valve almost always has a pointer type of indicator threaded onto the upper end of the stem to show the gate's position.

With this basic information on the principles of the gate valve, you are ready to learn about repair procedures and the manufacture of repair parts.

You should use lapping to correct defects such as light pitting or scoring and imperfect seat contact. Use a lapping tool designed for the type of valve to be reconditioned. NEVER use the gate as a lap.

USC the same lapping process for gate valves that we described earlier for globe valves. But with gate valves, turn the lap by a handle extending through the inlet or outlet end of the valve body. Insert the lapping tool, minus the handle, into the valve so you cover one of the seat rings. Then attach the handle to the lap and begin the lapping work. You can lap the wedge gate to a true surface by using the same lap you used on the seat rings. In some cases when a gate is worn beyond repair and a shim behind the seat will not give a proper seat, you may need to plate the gate or seat.

NOTE: A shim has to be applied behind both seats to maintain the proper angle.

As another alternative, you may weld repair the damaged gate, then use a mill or lathe with an angle plate or fixture to machine it to its original specifications. Plating has one advantage over welding; the selective brush plating method does not heat the gate. When you build up metal by welding, it always heats the surfaces and can cause loss of temper or other weaknesses in the metal.

Repairing Constant-Pressure Governors

Many turbine driven pumps are fitted with special valves called constant-pressure governors. This governor maintains a constant pump discharge pressure under varying conditions of load. It is installed in the steam line to the pump. It controls the amount of steam admitted to the driving turbine, thereby controlling the pump discharge pressure.

Two of the most common types of constant-pressure pump governors used by the Navy are the Leslie and the Atlas. The two are very similar in operating principles. Our discussion is based on the Leslie governor, but most of the information also applies to the Atlas governor.

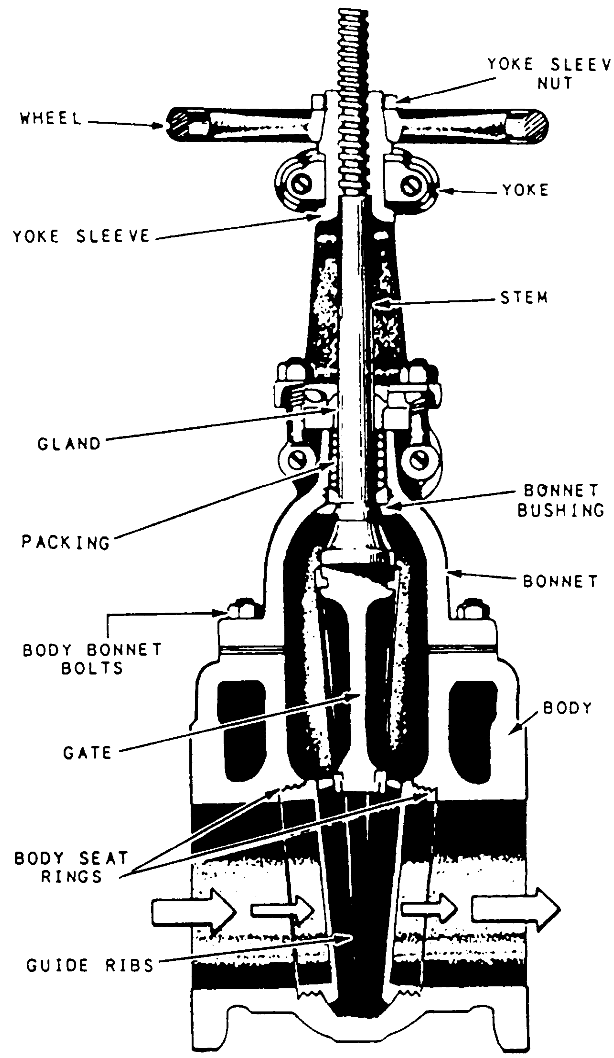
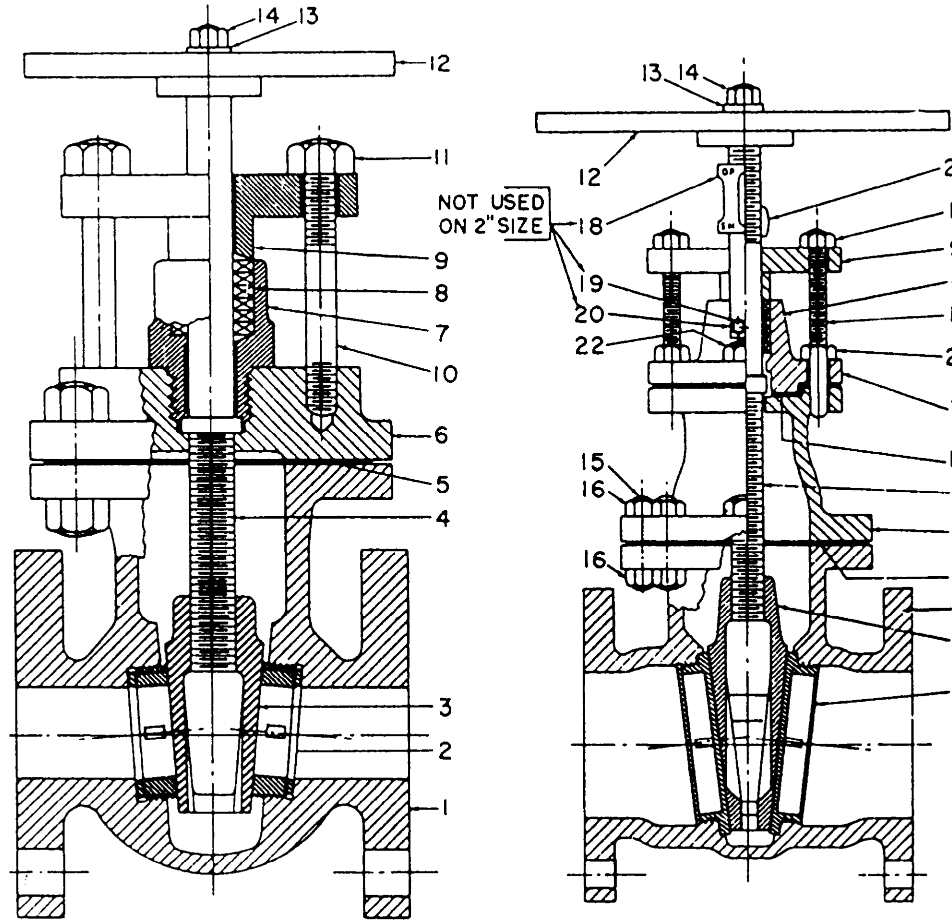


Figure 13-8.—Cutaway view of a gate stop valve (rising stem type).



LIST OF PARTS			
PART NO.	NAME OF PART	PART NO.	NAME OF PART
1	BODY	13	HANDWHEEL WASHER
2	SEAT RING	14	HANDWHEEL NUT
3	GATE	15	BONNET STUD
4	STEM	16	BONNET STUD NUT
5	BONNET GASKET	17	STUFFING BOX GASKET
6	BONNET	18	INDICATOR PLATE
7	STUFFING BOX	19	LOCK WASHER
8	PACKING	20	INDICATOR PLATE SCREW
9	GLAND	21	INDICATOR NUT
10	GLAND STUD	22	STUFFING BOX STUD
11	GLAND STUD NUT	23	STUFFING BOX STUD NUT
12	HANDWHEEL		

Figure 13-9.—Cross-sectional views of gate stop valves (nonrising stem type).

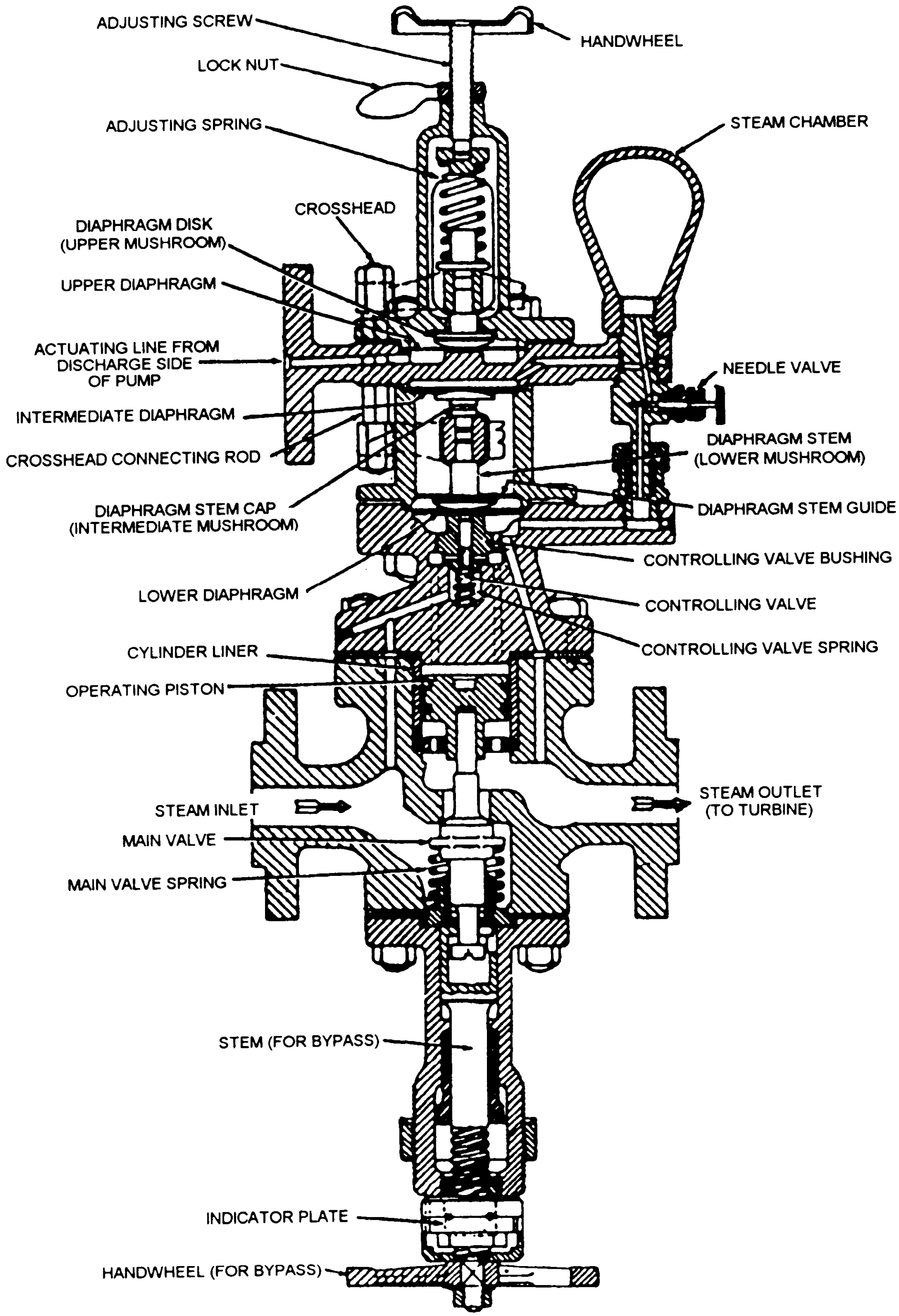


Figure 13-10.—Constant-pressure governor for main feed pump.

Figure 13-10 shows a Leslie constant-pressure governor for a main feed pump. The governors used on fuel oil service pumps, lube oil service pumps, fire and flushing pumps, and various other pumps are almost identical. The chief difference between governors used for different services is in the size of the upper diaphragm. A governor used for a pump that operates with a high discharge pressure has a smaller upper diaphragm than one used for a pump that operates with a low discharge pressure.

Two opposing forces are involved in the operation of a constant-pressure pump governor. Fluid from the pump discharge, at discharge pressure, is led through an actuating line to the space below the upper diaphragm. The pump discharge pressure exerts an UPWARD force on the upper diaphragm. Opposing this, an adjusting spring exerts a DOWNWARD force on the upper diaphragm.

When the downward force of the adjusting spring is greater than the upward force of the pump discharge prcssurc, the spring forces both the upper diaphragm and the upper crosshead downward. A pair of connecting rods connects the upper crosshead rigidly to the lower crosshead, so the entire assembly of upper and lower crossheads moves together. When the crosshead assembly moves downward, it pushes the lower mushroom and the lower diaphragm downward. The lower diaphragm is in contact with the controlling valve. When the lower diaphragm is moved downward, the controlling valve is forced down and open.

The controlling valve is supplied with a small amount of steam through a port from the inlet side of the governor. When the controlling valve is open, steam passes to the top of the operating piston. The steam pressure acts on the top of the operating piston, forcing the piston down and opening the main valve. The extent to which the main valve is opened controls the amount of steam admitted to the driving turbine. Increasing the opening of the main valve therefore increases the supply of steam to the turbine and so increases the speed of the turbine.

The increased speed of the turbine is reflected in an increased discharge pressure from the pump. This pressure is exerted against the underside of the upper diaphragm. When the pump discharge pressure has increased to the point that the upward force acting on the underside of the upper diaphragm is greater than the downward force exerted by the adjusting spring, the upper diaphragm is moved upward. This action allows a spring to start closing the controlling valve, which, in turn, allows the main valve spring to start closing the main valve against the now-reduced pressure on the operating piston. When the main valve starts to close, the steam supply to the turbine is reduced, the speed of the turbine is reduced, and the pump discharge pressure is reduced.

At first glance, it might seem that the controlling valve and the main valve would open and close constantly and the pump discharge pressure would vary continually over a wide range. But this does not happen because the governor prevents such excessive opening or closing. An intermediate diaphragm bears against an intermediate mushroom, which, in turn, bears against the top of the lower crosshead. Steam is led from the governor outlet to the bottom of the lower diaphragm and also through a needle valve to the top of the intermediate diaphragm. A steam chamber provides a continuous supply of steam at the required pressure to the top of the intermediate diaphragm.

Any up or down movement of the crosshead assembly is therefore opposed by the force of the steam pressure acting on either the intermediate diaphragm or the lower diaphragm. The whole arrangement prevents extreme reactions of the controlling valve in response to variations in pump discharge pressure.

Limiting the movement of the controlling valve in the manner just described reduces the amount of hunting the governor must do to find each new position. Under constant-load conditions, the controlling valve takes a position that causes the main valve to remain open by the required amount. A change in load conditions causes momentary hunting by the governor until it finds the new position required to maintain pump discharge pressure at the new load.

A pull-open device, consisting of a valve stem and a handwhcel, is fitted to the bottom of the governor. Turning the handwheel to the open position draws the main valve open and allows full steam flow to the turbine. When the main valve is opened with the handwhcel, the turbine must be controlled manually. Under all normal operating conditions, the bypass remains closed and the pump discharge pressure is raised or lowcrcd, as necessary, by increasing or decreasing the tension on the adjusting spring.

CONTROL AND MAIN VALVE.—If there is leakage in the generator through the control valve or its bushing, steam will flow to the top of the operating piston, opening the main valve, and holding it open, even though there is no tension on the adjusting spring. The main valve must be able to close off completely or else the governor cannot operate properly. The only remedy is to disassemble the governor and stop the steam leakage. In most instances, you must renew the control valve. If the leakage is through the bottom of the bushing and its seat, you must lap the scat. A cast-iron lap is best for this type of work.

Rotate the lap through a small angle of rotation, lift it from the work occasionally, and move it to a new position as the work progresses. This will ensure that the lap will slowly and gradually rotate around the entire scat circle. Do not bear down heavily on the handle of the lap. Replace the compound often, using only clean compound. If the lap should develop a groove or cut, redress the lap. Continue lapping only long enough to remove all damaged areas.

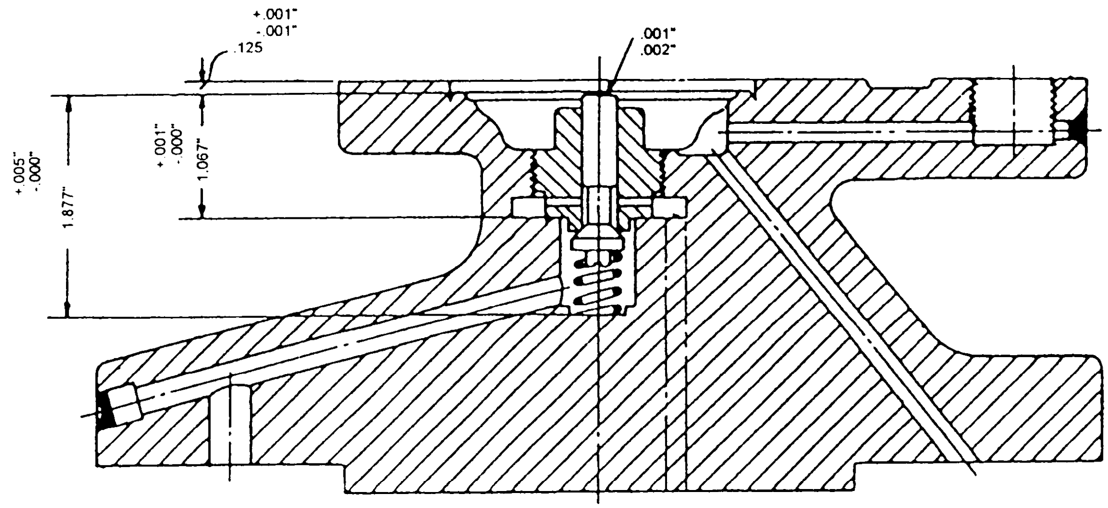


Figure 13-11.—Critical dimensions of the Leslie top cap.

When you install the control valve and its bushing, remember that the joint between the bottom of the bushing and its seat is a metal-to-metal contact. Install the bushing tightly, and when it is all the way down, tap the wrench lightly with a hammer, to ensure a steam-tight joint.

When the controlling valve is installed, you must check the clearance between the top of the valve stem and the diaphragm. It is absolutely mandatory that this clearance be between 0.001 and 0.002 inch (fig. 13-11). If the clearance is less than 0.001 inch, the diaphragm will hold the control valve open, allowing steam to flow to the main valve at any time the throttle valve is open. If the clearance is more than 0.002 inch, the diaphragm will not fully open the control valve. This means the main valve cannot open fully, and the unit cannot be brought up to full speed and capacity.

When the main valve seating area is damaged, it must be lapped in by the same process. ALWAYS lap in the main valve with the piston in the cylinder liner to ensure perfect centering.

If the damage to the seating surfaces is excessive, you must install new parts. Use parts supplied by the manufacturer if they are available.

TOP CAP.—If the top flange of the top cap of the governor becomes damaged, you must be extremely careful when you machine it. Consult the manufacturer's technical manual for the correct clearances. (See fig. 13-11.)

All seating surfaces must be square with the axis of the control valve seat threads and must have the smoothest possible finish. Before you start the reassembly, be sure that all ports in the top cap and the diaphragm chamber are free of dirt and other foreign matter. Be sure that the piston rings are free in their grooves and that the cylinder liner is smooth and free of grooves, pits, and rust.

When installing the cylinder liner, be sure the top of the liner does not extend above the top of the valve body. The piston must work freely in the liner; if there is binding, the governor will not operate satisfactorily. Renew the controlling valve spring and the main valve spring if they are weak, broken, or corroded, or if they have taken a permanent set. Renew all diaphragms if necessary. If you use the old diaphragms, install them in their original position; do not reverse them.

Follow the instructions in the manufacturer's technical manual when you reassemble the governor. All clearances must be as designed if the governor is to operate satisfactorily. Check each moving part carefully to ensure freedom of movement.

When you have reassembled the governor, test it as soon as possible so that you can make any needed corrections.

Repairing Double-Seated Valves

On a double-seated valve, the extent of damage determines the kind of repairs you can do. Normally, you can lap it or weld-repair it and remachine it to fit the body. The normal seat angles are the same as those in globe valves, and the spotting-in procedure is the same. You can hold most valve disks on a spud or mount them on a mandrel and cut them the same way as a globe valve. In this case as in the others, it is best to consult local quality assurance directives and local procedures when you repair this type of valve. Also, in most cases the blueprints will show ND (no deviations) and must be closely adhered to, as far as type of weld and quality. In all cases, shop LPO's should be able to provide the necessary information.

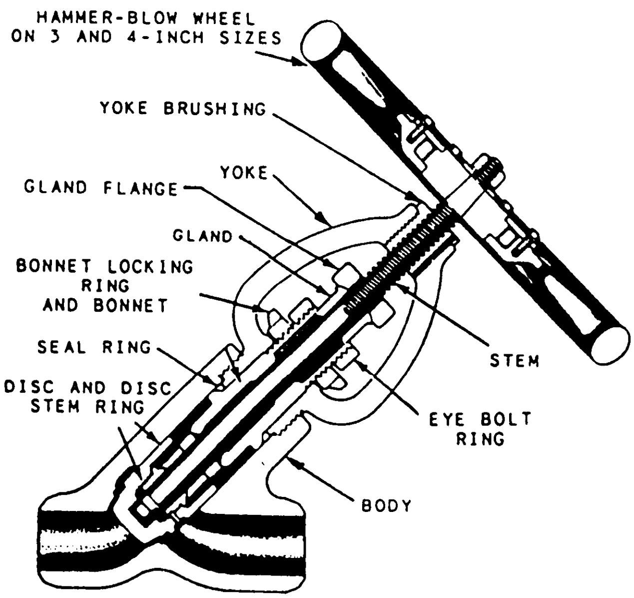


Figure 13-12.—1500-pound pressure seal bonnet globe valve.

Repairing Duplex Strainer Plug Valves

The most common reason to repair duplex strainers is scored or chipped O-ring grooves or scored or scratched liners. In some cases you may need to weld-repair the plug cock and machine it back to blueprint specifications. If you need to repair the strainer body, you will usually hone it, and in some cases you will use an oversized O-ring. Consult local type commander and QA procedures for the best method. Check with the shop's leading petty officer before you undertake any repair procedures.

Repairing Pressure Seal Bonnet Globe Valves

The repairs you may do on pressure seal bonnet globe valves (fig. 13-12) usually are limited to repair of the scat and disk and the manufacture of silver seals. Sometimes you may manufacture parts or be involved in a weld-repair. Always follow your controlled work package carefully.

REPAIRING PUMPS

Fireman, NAVEDTRA 12001, provides a description of the common types and uses of pumps aboard ship. You will do most of your pump repairs on centrifugal pumps, so we'll limit this discussion to that type.

Figure 13-13 shows the internal parts of a centrifugal pump. Look at the arrangement of the impeller,

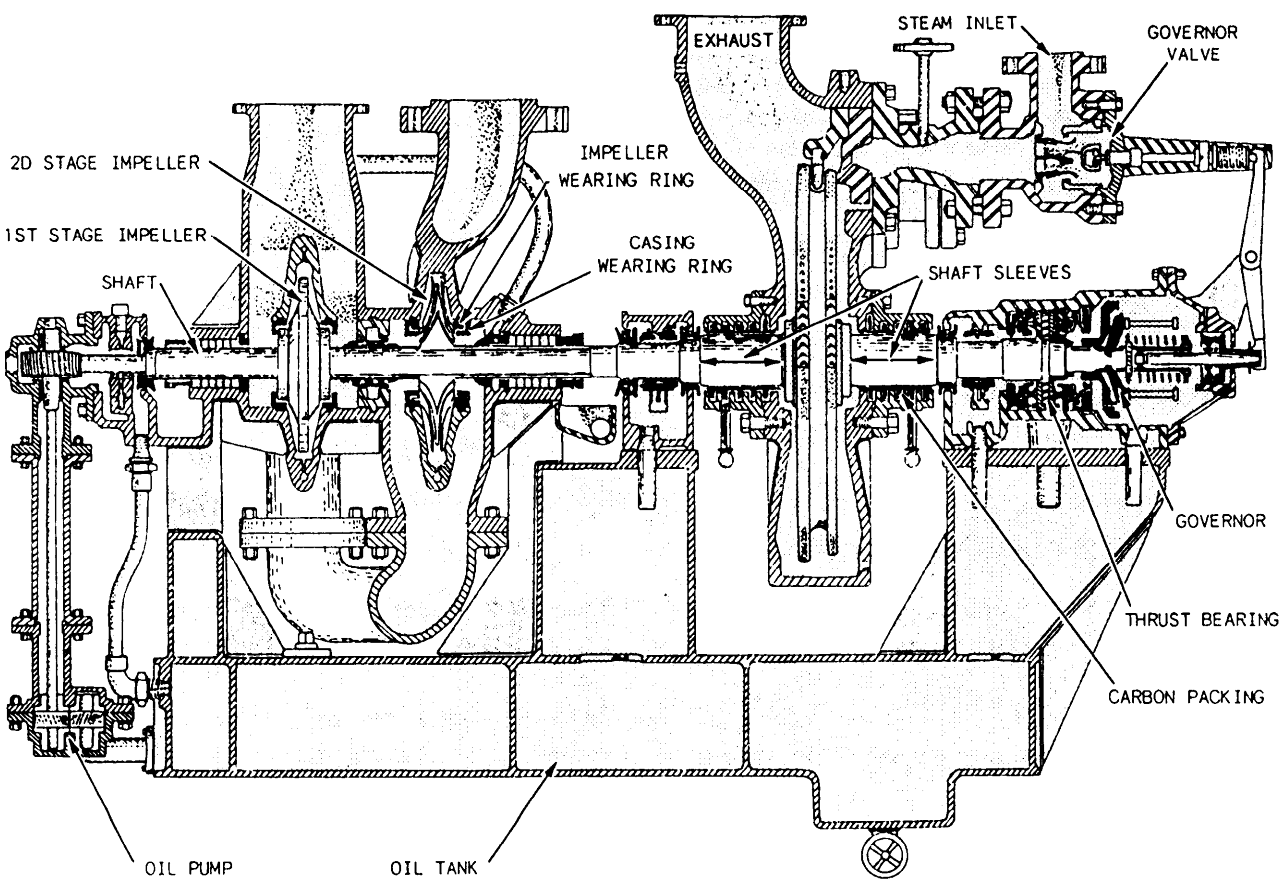


Figure 13-13.—Two-stage main feed pump.

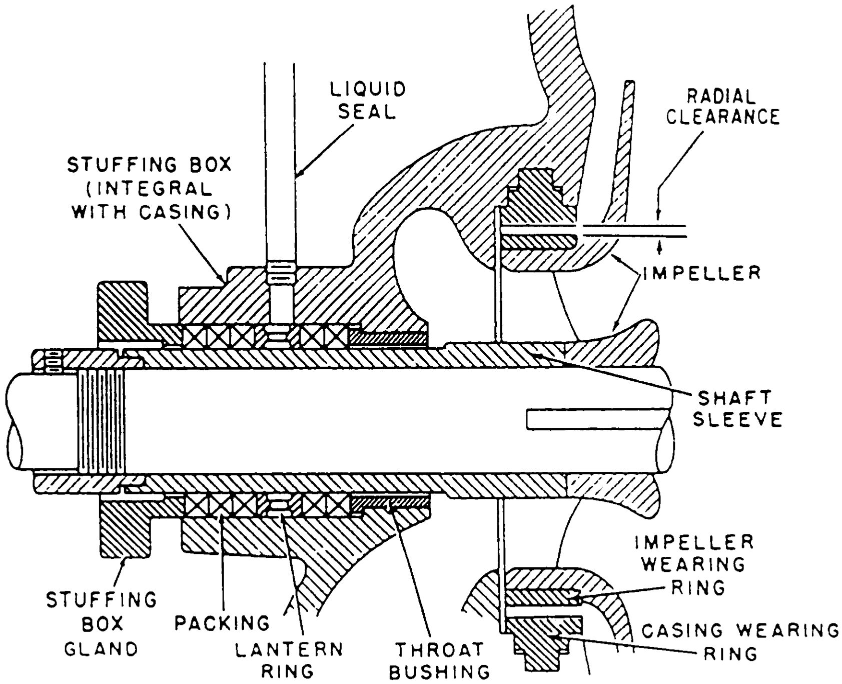


Figure 13-14.—Stuffhg box on a centrifugal pump.

casing wearing rings, impeller wearing rings, shaft, and shaft sleeves in particular.

The operation of a centrifugal pump wears away both the area of the shaft that goes through the packing gland or mechanical seal and the casing-impeller sealing areas. They must be renewed from time to time to maintain the efficiency of the pump.

The shaft, casing, and impeller in a centrifugal pump are designed so they can be renewed without replacing them. The shafts have tightly fitted renewable sleeves, while the casing and impeller have renewable surfaces called casing wearing rings and impeller wearing rings. You can see the arrangement clearly in figure 13-14.

When it is necessary to renew these parts, the rotor assembly, consisting of the pump shaft, the impeller and its wearing ring, and the casing rings, is usually brought into the shop. The following paragraphs explain the method you should use to replace these parts.

The repair parts generally are available from the ship's allowance, but you may need to manufacture them. Before you proceed with these repairs, consult the manufacturer's technical manual and the applicable blueprints to get the correct information on vital clearances and other data.

In some pumps, the shaft sleeve is pressed onto the shaft with a hydraulic press, and you must machine off the old sleeve in a lathe before you can install a new one. On centrifugal pumps, the shaft sleeve is a snug slip-on fit, butted up against a shoulder on the shaft and held securely in place with a nut. The centrifugal pump sleeve-shaft-shoulder joint is usually made up with a hard fiber washer. It prevents liquid from leaking through the joint and out of the pump between the sleeve and shaft.

The impeller wearing ring is usually lightly press-fitted to the hub of the impeller and keyed in with headless screws (also called Dutch keyed). To remove the worn ring, withdraw the headless screws or drill them out and then machine the ring off in a lathe.

The amount of diametrical running clearance between the casing rings and the impeller rings affects the efficiency of a centrifugal pump. Too much clearance will let too much liquid leak back from the discharge side to the suction side of the pump. Not enough clearance will cause the pump to "freeze." Before you install a new wearing ring on the impeller, measure the outside diameter of the impeller wearing ring, and the inside diameter of the casing ring. (See fig. 13-15.) If the measurements do not agree with the lit and clearance data you have on hand, ask your

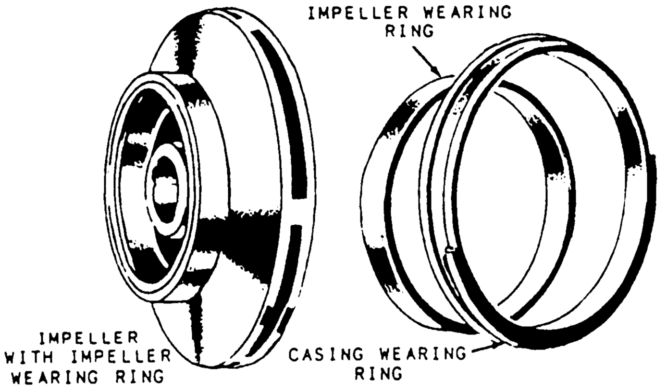


Figure 13-15.—Impeller, impeller wearing ring, and casing wearing ring for a centrifugal pump.

leading petty officer for instructions before you go any further. Sometimes it is necessary to take a light cut on the inside diameter of the impeller ring to get its correct press fit on the impeller hub. The difference between the outside diameter of the impeller wearing ring and the inside diameter of the casing wearing ring is the diametrical running clearance between the rings. If this clearance is too small, correct it by taking a cut on either the outside diameter of the impeller ring or the inside diameter of the casing ring. You also need to check the concentricity of the two rings. If they do not run true, machine their mating surfaces so they do run true. Be sure you keep the specified diametrical clearance.

When a pump like the one shown in figure 13-13 needs repairs, usually only the shaft assembly and casing wearing rings are brought to the shop. To renew the wearing rings and resurface the packing sleeves on this type of pump, take the following steps:

1. Clamp the casing wearing ring on a faceplate and align the circumference of the ring concentrically with the axis of the lathe spindle. (You can hold the casing rings in a 4-jaw chuck, but it may distort the ring.)

2. Take a light cut on the inside diameter of the casing ring to clean up the surface. Do this to all casing rings.

3. Mount the shaft assembly between centers or in a chuck and align its axis with the lathe axis.

4. Machine away the impeller wearing rings. Be careful not to cut into the impeller.

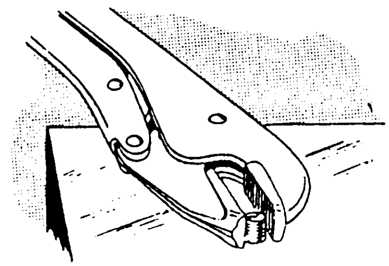


Figure 13-16.—Removing a broken stud with locking pliers.

5. Remove the shaft assembly from the lathe.

6. Make the impeller rings. The size of the inside diameter of the impeller rings should provide a press fit on the impeller. The outside diameter should be slightly larger than the inside diameter of the casing rings.

7. Press the impeller rings on the impeller and lock them in place with headless screws, if the blueprint specifies it.

8. Mount the shaft assembly back in the lathe and machine the diameter of the impeller rings to provide the proper clearance between impeller rings and casing rings. Blueprints and technical manuals list the clearance as either diametrical or radial clearance. Diametrical clearance is the total amount of clearance required. Radial clearance is one-half of the clearance required and must be doubled to get diametrical clearance.

REMOVING BROKEN BOLTS AND STUDS

When you must remove a broken bolt or stud, flood the part being worked on with penetrating oil or oil of wintergreen. Soak the area for several hours or overnight if you have time. A good soaking may loosen a bolt that will otherwise have to be drilled out.

If enough of the broken piece protrudes, take hold of it with locking pliers, as shown in figure 13-16, and carefully try to ease it out. If you cannot turn the bolt, soak it further with penetrating oil. If the oil doesn't loosen the bolt, jar it with light hammer blows on the top and around the sides. This may loosen the threads so that you can remove the bolt with the pliers.

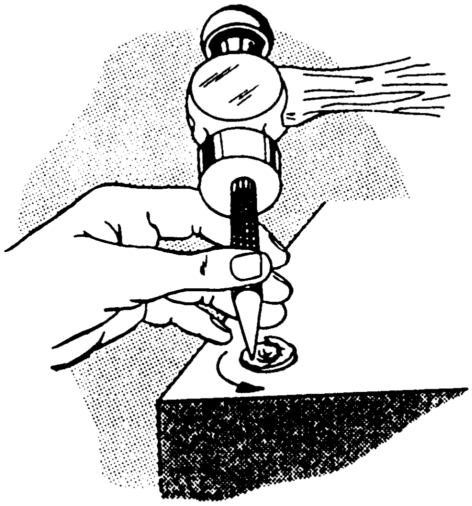


Figure 13-17.—Removing a broken bolt with a prick punch.

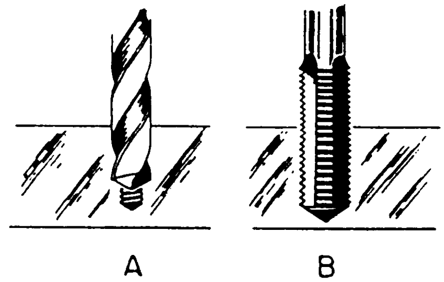


Figure 13-19.—Removing a broken bolt and retapping the hole to a larger size.

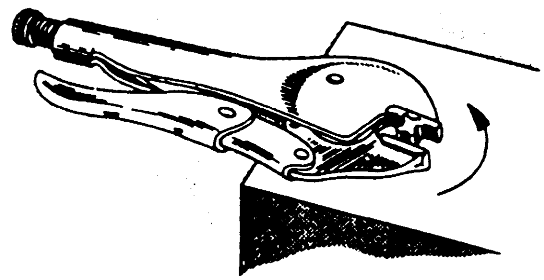


Figure 13-20.—Removing a broken tap with locking pliers.

If a bolt has been broken off flush with the surface, you may sometimes back it out with light blows on a prick punch or center punch, as shown in figure 13-17.

To drill out a broken bolt and retap the hole, file the bolt smooth, if necessary, and centerpunch it. Then select a twist drill that is a little smaller than the tap-drill size for the particular bolt that has been broken. As shown in figure 13-18, this drill will just about but not quite touch the crests of the threads in the threaded hole or the roots of the threads on the threaded bolt. Carefully start drilling at the center punch mark Crowd the drill one way or the other as necessary so that the hole will be drilled in the exact center of the bolt.

The drill in figure 13-18 has almost drilled the remaining part of the bolt away and will eventually break through the bottom of the bolt. When this happens, all that will remain of the bolt will be a threaded shell. With a prick punch or other suitable tool, chip out and remove the first two or three threads, if possible, at the top of the shell. Then carefully start a tapered tap into these clean threads and continue

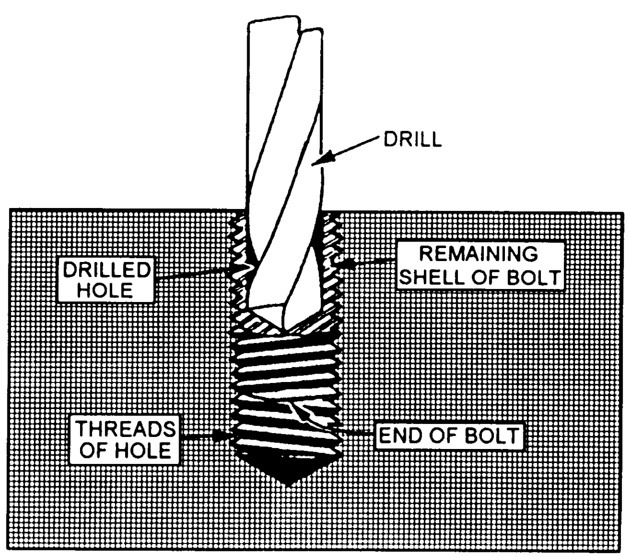


Figure 13-18.—Removing a broken bolt and retapping the hole to the same size.

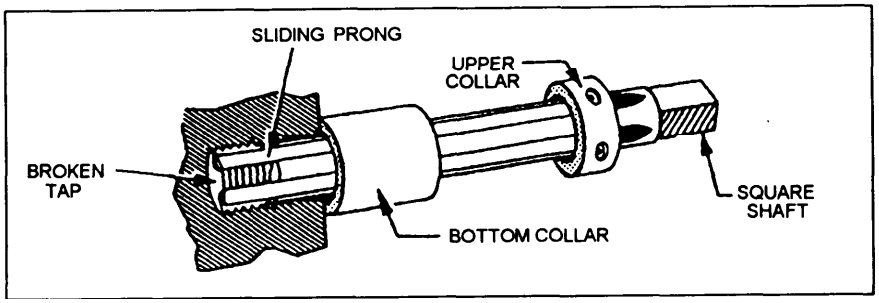


Figure 13-21.—Removing a broken tap with a tap extractor.

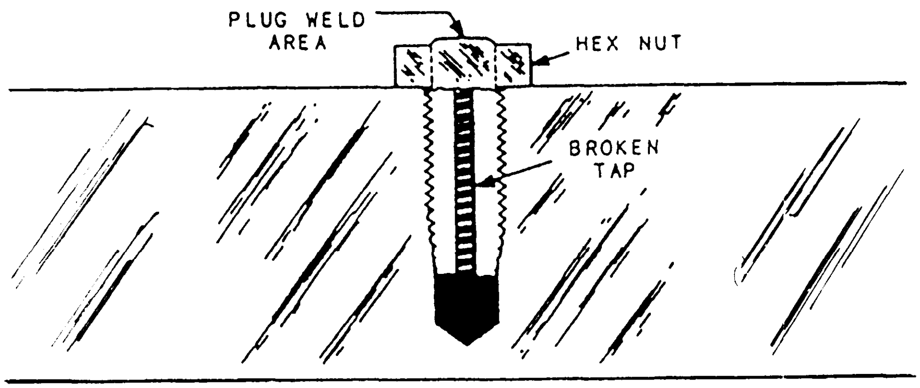


Figure 13-22.—Using a plug weld to remove a broken tap.

tapping until you have cut away the shell and restored the original threads.

In cases where it is not necessary to replace the capscrew or bolt with one of the same size, use a drill larger than the broken bolt to drill out the old bolt, as shown in figure 13-19, view A. Tap the hole first, and then finish it with a bottoming tap as shown in view B. Replace the original capscrew or stud with a larger size. Never do this without the concurrence of your QA office.

REMOVING A BROKEN TAP FROM A HOLE

To remove a broken tap that protrudes from a hole, generously apply penetrating oil to the tap, working it down through the four flutes into the hole. Then grasp the tap across the flats with locking pliers. Figure 13-20 shows this operation. Carefully ease the tap out of the hole, adding penetrating oil as necessary.

If the tap has broken off at or slightly below the surface of the work, you may be able to remove it with the tap extractor shown in figure 13-21. Again, apply a liberal amount of penetrating oil to the broken tap. Place the tap extractor over the broken tap and lower the upper collar to insert the four sliding prongs down into the four flutes of the tap. Then slide the bottom collar down to the surface of the work so it will hold the prongs tightly against the body of the extractor. Tighten the tap wrench on the square shank of the extractor and carefully work the extractor back and forth to loosen the tap. You may need to remove the extractor and strike a few sharp blows with a small hammer and pin punch to jar the tap loose. Then reinsert the tap remover and carefully try to back the tap out of the hole.

Each size of tap requires its own size of tap extractor. They come in the following sizes: 1/4, 5/16, 3/8, 7/16, 1/2, 9/16, 5/8, 3/4, 7/8 and 1 inch.

When a tap extractor will not remove a broken tap, you may be able to do it with the plug weld method shown in figure 13-22. Place a hex nut over the tap and

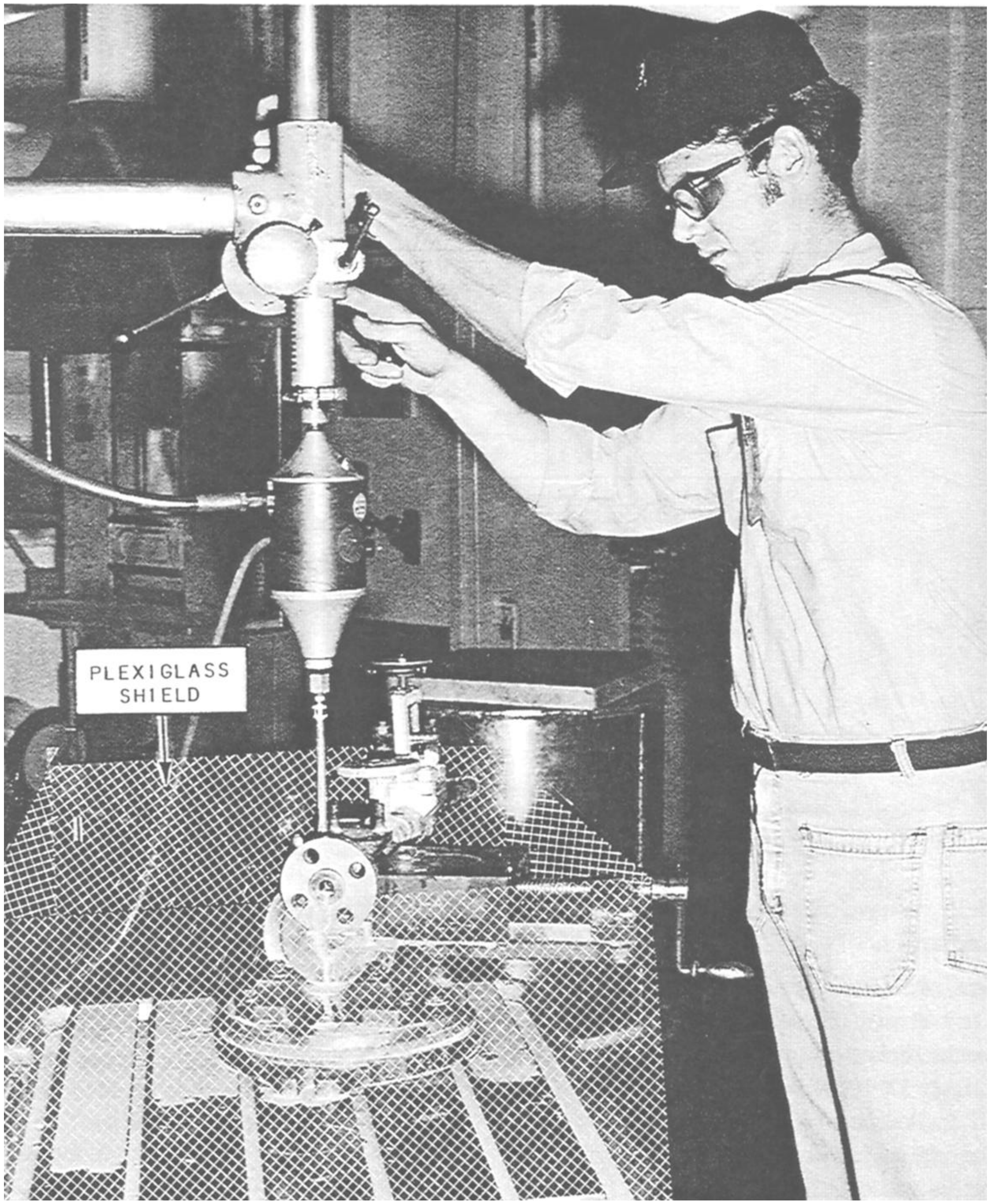


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Figure 13-23.—Metal disintegrator removing a broken stud.

have it welded to the tap. Use a nut with a hole somewhat smaller than the tap diameter to avoid welding the nut and the tap to the job itself. Allow the weld to cool before you try to remove the tap. When the nut, tap, and job have come to room temperature, it often is helpful to quickly heat the immediate area around the hole with an oxyacetylene torch. This quick heating expands the adjacent metal of the work and allows you to remove the tap more easily. If the heating is too slow, the tap will expand with the metal of the work and there will be no loosening effect.

METAL DISINTEGRATORS

Sometimes you cannot remove a broken tap or stud with the usual methods we explained earlier in this chapter. In those cases, you may use a metal disintegrator to remove such a piece without damaging the part. This machine uses an electrically charged electrode that vibrates as it is fed into the work and disintegrates a hole through the broken tap or stud. The part to be disintegrated and the mating part that it is screwed into must be made from a material that will conduct electricity. Figure 13-23 shows a disintegrator being used to remove a broken stud.

You can find the specific operating procedure for the metal disintegrator in the operators material furnished by the manufacturer. However, we will explain several steps in the setup for a disintegrating job that are common to most of the models of disintegrators found aboard Navy ships.

First set up the part to be disintegrated. Some disintegrator models have a built-in table with the disintegrating head mounted above it much like a drill press. On a machine such as this, you need only bolt the part securely to the table and be sure the part makes good contact to provide an electrical ground. Align the tap or stud to be removed square with the table so the electrode will follow the center of the hole correctly. If there is misalignment, the electrode may leave the tap or stud and damage the part. Use either a machinist's square laid on the table or a dial indicator mounted on the disintegrating head to help align the part. If the part will not make an electrical ground to the table, or if the model of machine you are using is designed as an attachment to be mounted in a drill press spindle, attach the disintegrator's auxiliary ground cable to the part.

The diameter and length of the part to be removed determines the selection of the electrode. As a general rule, the electrode should be large enough in diameter to equal the smallest diameter of a tap (the distance between the bottom of opposite flutes). If you plan to remove a stud, the electrode must not be so large that a slight misalignment can cause it to burn or damage the part. Use a scribe and a small magnet to remove any of the stud material not disintegrated.

A free-flowing supply of clean coolant is an essential part of the disintegrating operation. The coolant is pumped from a sump to the disintegrating head and then through the electrode, which is hollow, to the exact point of the disintegrating action.

Different machines have different controls that you must set. However, most have a control to start the disintegrating head vibrating and a selector switch for the heat or power setting. The position of this switch depends on the diameter of the electrode being used. Some models have an automatic feed control that regulates the speed that the electrode penetrates the part to be removed. Regardless of whether the feed is automatic or manual, do NOT advance so fast that it stops the disintegrating head and the electrode from vibrating. If this happens, the disintegrating action will stop and the electrode can be bent or broken.

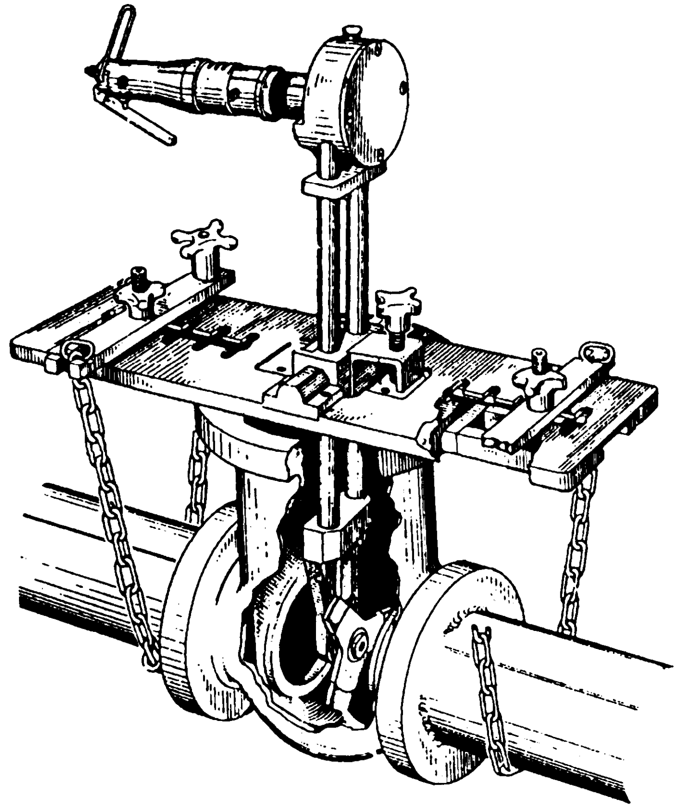

Figure 13-24.—Gate valve reseater.

IN PLACE MACHINING

There are times when a job cannot be brought to the shop and the MR must go and do the job in place. Some examples of in-place machining include the repair of globe and gate valves, the resurfacing of pipe and valve flanges, boring valve inlay areas, and general machine work.

There are a number of machines you can use on these jobs. For example, you can use the gate valve grinder shown in figure 13-24 to reseat gate valves.

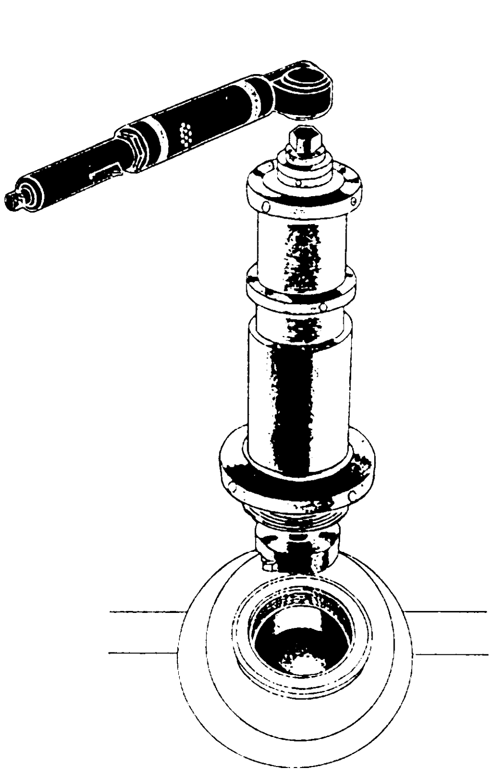

Figure 13-25.—Portable boring bar.

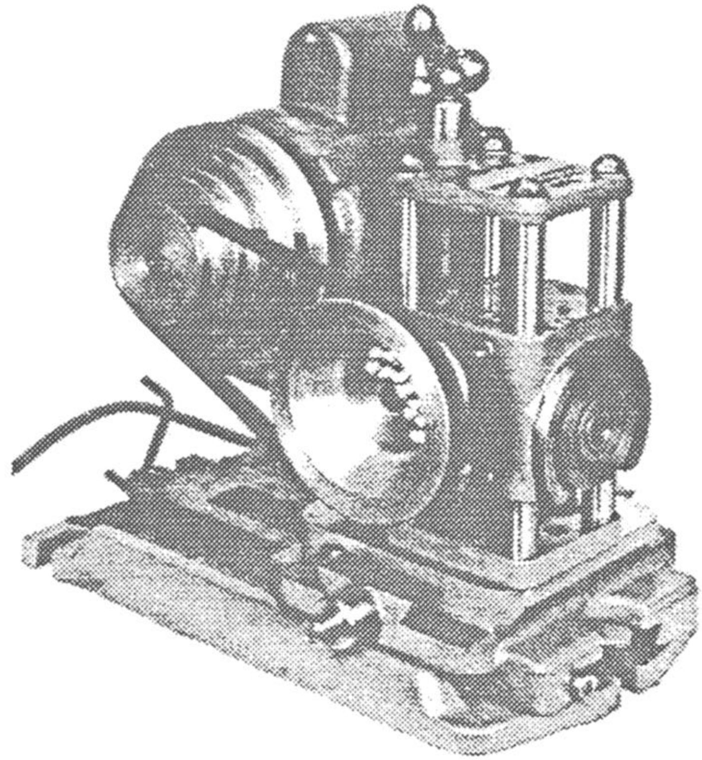

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Figure 13-26.—Versa-Mil.

Figure 13-25 shows a portable boring bar. You can use it to bore the inlay area of high-pressure steam valves.

Figure 13-26 shows a Versa-Mil. You can use it to mill, shape, grind, and drill in place. You can mount a feed table to the base of the Versa-Mil that allows you to hand feed the machine. Only your imagination limits the different setups you can make with the Versa-Mil.

There are a number of companies that build in-place machining equipment and it is not feasible to cover all of them. We have only given you a brief overview of the types of machines you might use. Refer to your machine operator's manual for specific operating instructions.