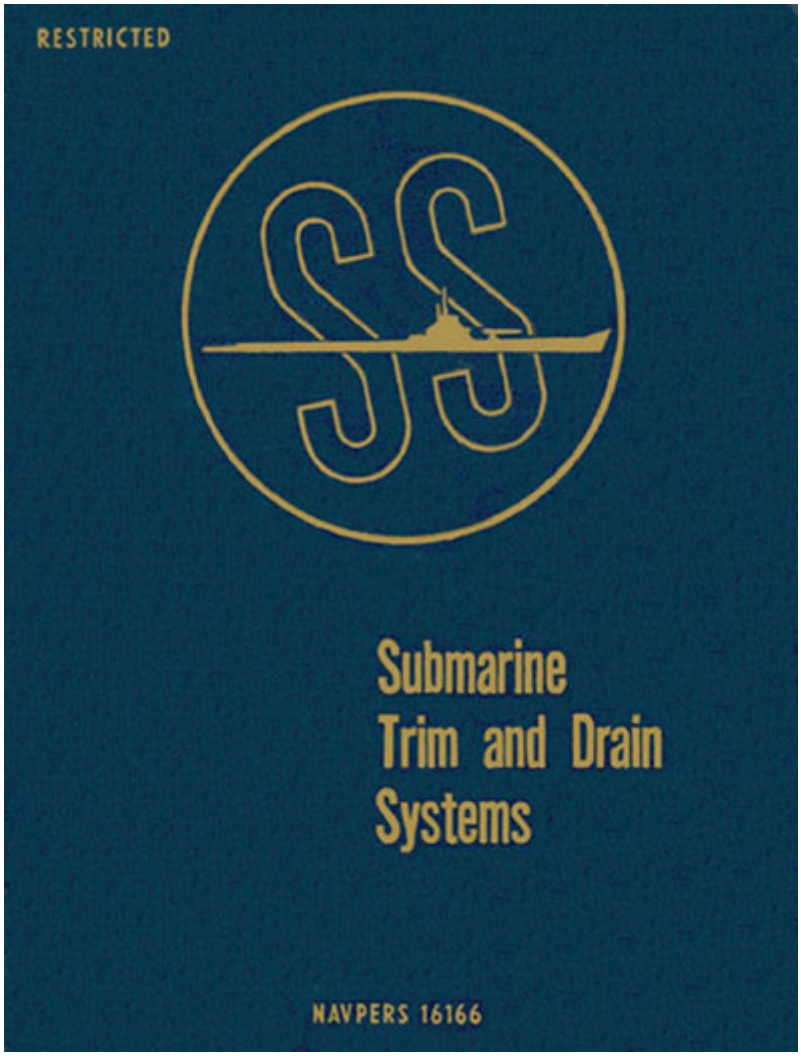
The Fleet Type Submarine Online Submarine Trim and Drain Systems



Folks,

Submarine Trim and Drain Systems, Navpers 16166, is one of a series of submarine training manuals that was completed just after WW II. The series describes the peak of WW II US submarine technology.

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Our thanks to Shelly Shelstad, creator of History on CD ROM for permitting us to use images he has scanned, particularly the oversized images that were meticulously pieced together. History on CD ROM sells a very nice CD or thumb drive version of this manual in PDF format for easy access off the web and for a printing. Thanks also to IKON Office Solutions (now Ricoh USA http://www.ricoh-usa.com) for scanning services.

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NavPers 16166

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1. The Fleet Type Submarine	NavPers 16160
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3.	Submarine Electrical Installations	NavPers 16162
4.	Submarine Refrigerating and Air-Conditioning Systems	NavPers 16163
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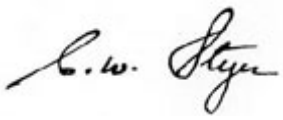
12.	Torpedo Tubes, 21-Inch submerged, Mks 32 to 39	O.P. 1085

PREFACE

The Submarine School, Submarine Base, New London, Connecticut and other activities of Submarines, Atlantic Fleet, have collaborated in the preparation of this manual. It is designed for use in both instruction and operations.

The text is prepared in two parts: the first three chapters cover the principles of operation and description of the trim and drain systems; detailed and specific operational instructions for each system are presented in Chapters 4 and 5. Free use has been made of sketches and flow diagrams in order to best serve the forces afloat as well as the students of the Submarine School.

It is recognized that equipment design is subject to change as new requirements are taken into account, and as recommendations from the forces afloat are acted upon. Consequently, the descriptions and discussions included must be considered as generally typical rather than final and specific in all details.



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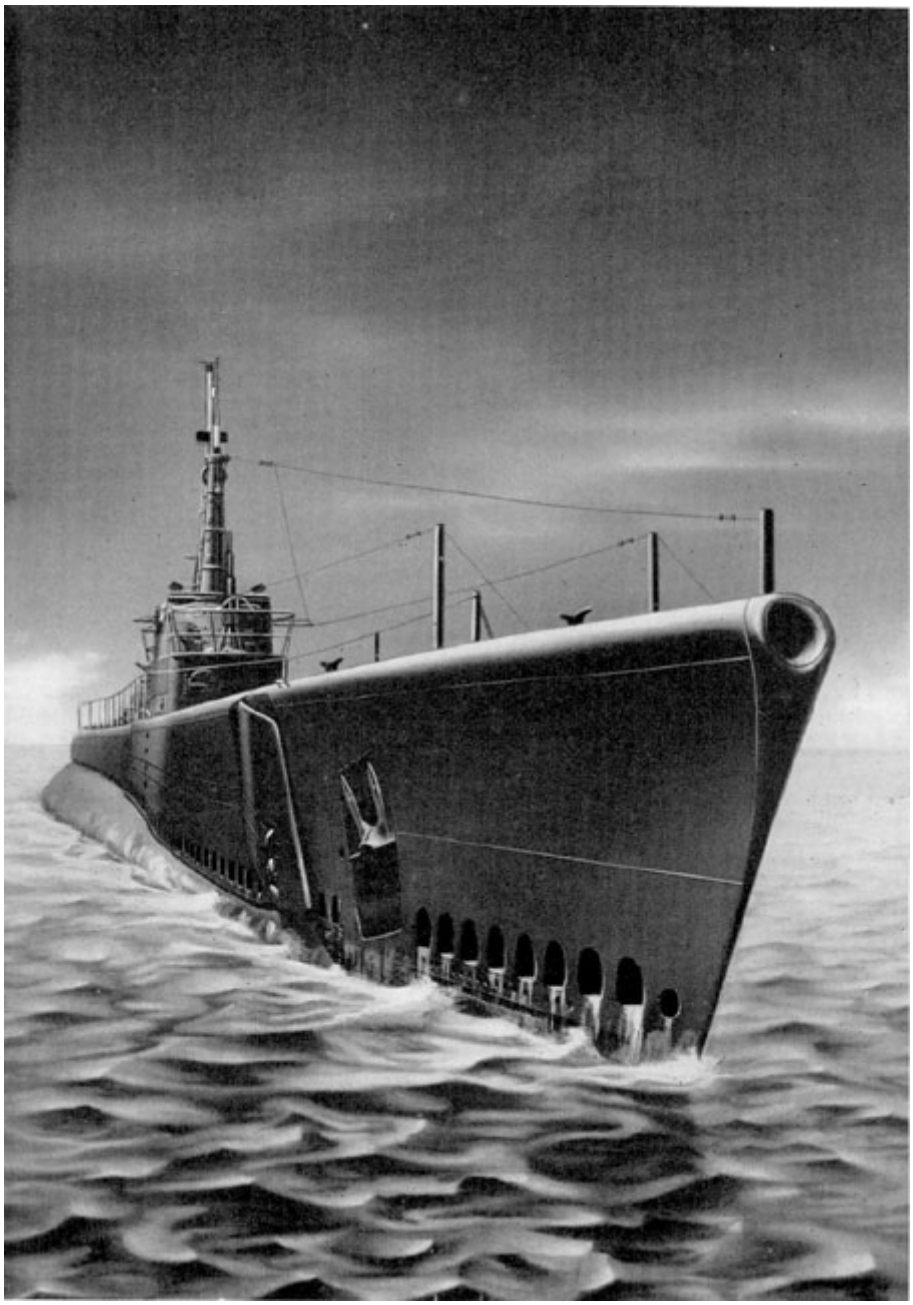

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1
INTRODUCTION

A. BASIC PRINCIPLES

1A1. Balance and stability. A modern submarine is designed to dive or surface rapidly under complete control. It must be able to proceed on the surface and to submerge at the desired rate of speed to the depths required. To do so quickly and efficiently, the submarine must maintain fore and aft balance, and athwartship stability. The chief function of the trim and drain system is to maintain this fore and aft balance by controlling the amount and distribution of water in the various tanks used for this purpose.

Before proceeding with the functional description of the trim and drain system, let us consider the factors affecting the balance and stability of the submarine. The balance and stability of the submarine are maintained by applications of the principles of buoyancy and the law of the lever.

1A2. Buoyancy. Buoyancy is the force which tends to keep an object afloat in water or any other liquid. When an object is immersed in a liquid, the liquid exerts pressure from all directions on the external surface of the object. The deeper the object is immersed in the liquid, the greater is the pressure against its top. If the immersed object weighs more than the liquid it displaces, it is said to have negative buoyancy. Such an object sinks. If the object weighs less than the liquid it displaces, the object is said to have positive buoyancy. Such an object floats, or if it is thrust under the surface of the liquid, it rises. When both the object and the liquid it displaces weigh the same, the object is said to have neutral buoyancy. If such an object is submerged, it remains submerged unless it is acted upon by an outside force.

1A3. Fore and aft balance. The conditions of positive, neutral, and negative buoyancy just described apply to submarine operations. However, these buoyancy conditions must always be considered with respect to the law of the lever, or the balancing of forces, on each side of the center of gravity of the boat. This is known as fore and aft balance. When a submarine is on the surface, or when it reaches a desired depth, the first objective is to attain perfect, or nearly perfect, trim, that is, a balancing of the forces. The trimming of the boat is accomplished by varying, or adjusting, the amount of water in the variable ballast tanks. The trim

exerted against its surface. Also, the upward pressure exerted by the liquid against the lower surface of the object is greater than the downward

system is the means by which this adjustment is made.

B. TRIM SYSTEM

1B1. Functions. The assumption is made in the next few paragraphs that the submarine is in diving trim on the surface. The submarine is so designed that when the main ballast tanks are empty, it has positive buoyancy and can cruise on the surface. When the main ballast tanks are flooded, the positive buoyancy is destroyed, and a state of neutral buoyancy exists. This enables the submarine to cruise underwater at any desired depth. Of course, diving, surfacing, and cruising submerged are further controlled by means of the bow and stern planes and rudder and speed adjustments.

However, the trim has been so carefully adjusted that by flooding the main ballast tanks and adding the required amount of water to the special ballast tanks, the submarine can be made to submerge at the desired rate.

In actual operation the condition of fore and aft balance assumed in the preceding paragraph is obtained by the use of the trim system. The trim system consists of a trim pump, a trim manifold, and the connecting piping leading to the variable ballast tanks. The trim system admits additional water

ballast to the variable ballast tanks to compensate for loss of weight, removes water ballast to reduce excessive weight, and distributes water ballast to the proper tanks to compensate for unequal distribution of weight aboard the submarine.

For example, if additional stores are stowed in the forward end of the boat, water is pumped out of the forward trim tank and auxiliary tanks in accordance with the compensating sheet, to compensate for this additional weight. The auxiliary ballast tanks, No. 1 and No. 2 amidships, generally are used to

water ballast so that athwartship stability is maintained. Either the port or the starboard tank may be used individually to correct listing of the ship.

The safety and negative tanks can be used as additional variable ballast tanks since they can be flooded and pumped by means of the trim manifold.

In addition, the trim system can be used to flood and pump the water round torpedo (WRT) tanks, both forward and aft. (See Chapter 2 for a detailed description of the trim system, and Chapter 4 for procedures for trim operations.).

compensate for over-all weight changes, and therefore water ballast must be taken into these tanks or discharged overboard as required.

Since the auxiliary tanks form a U outside the pressure hull and are separated at the keel, it follows that if a large amount of water ballast is added, it must be added equally on both the port and starboard sides in order to prevent listing. Again, as in maintaining fore and aft balance, the trim system is used in adjusting the distribution of this

1B2. Standby trim pump. Because of the importance of the functions of the trim system, it is necessary that a standby trim pump be provided to insure operation of the system in the event of failure of the trim pump. This standby equipment is provided by cross connecting the drain pump of the drain system with the trim manifold of the trim system. Thus each pump serves as a standby for the other, assuring operation of both systems.

C. DRAIN SYSTEM

1C1. Functions. The chief function of the drain system is to pump out the free water that accumulates in the wells, bilge sumps, and poppet valve drain tank. This water, which enters the ship from drains, overflow piping, gland leakage, and condensation, must be removed, for it may interfere with the operation of the vessel.

The drain system consists essentially of a pump and piping extending to the forward and after sections of the ship. A number of individually controlled branch suction lines extend to the bilge sumps and wells. The drain system is interconnected with the trim system through the trim manifold. This enables the trim system to operate through the drain pump and the drain system to operate through the trim pump, when necessary.

2
THE TRIM SYSTEM

A. FUNCTIONS

2A1. General description. As explained in Chapter 1, unequal distribution of weight in the submarine will upset its balance and stability. The trim system is employed chiefly to correct this condition by regulating the quantity of water in the variable tanks.

Figure 3-9 illustrates the general arrangement of the trim system of a submarine. It shows the trim pump manifold, the main flood and suction lines, the valves, and the connections to the various trim system tanks.

The trim manifold, located on the port side aft in the control room, is considered the center of control for the entire system since it directs the flow of water to the various tanks. It is a casting divided into two longitudinal compartments known as the suction and discharge sides. The discharge side of the manifold contains eight discharge control valves. One of these valves is the trim pump discharge valve which connects the discharge side of the manifold with the discharge side of the trim pump. The suction side of the manifold contains eight suction control valves and is connected to the suction side of the pump group. The remaining flood and suction lines are connected to the negative tank and the safety tank. These tanks are called the special ballast tanks.

Cross connection of the trim pump and the drain pump is made by two flanged connections on the after end of the longitudinal axis of the manifold. One connection is on the discharge side, the other on the suction side.

The trim pump, located in the after end of the pump room, provides pumping power for the system. It draws water into its suction side, through the suction side of the manifold, from the tank being pumped, and discharges it through its discharge side, into the discharge side of the manifold, which directs the water to the tank being flooded. When it is desired to pump water into one of the above tanks by means of the trim pump, the discharge valve on the trim pump manifold controlling this particular tank is opened. When water is to be removed from a tank by means of the trim pump, its valve on the suction side of the manifold is opened. Thus, the trim manifold control valves are the means of putting any part of the trim system on suction or discharge. For example, in pumping from forward trim tank

through the trim pump suction valve.

The remaining seven discharge and seven suction valves control the flood and suction from the following lines:

1. Trim pump suction from sea and overboard discharge line.

2. Trim line forward flood and suction.

3. Trim line aft flood and suction.

4. Auxiliary ballast tank No, 1 flood and suction.

5. Auxiliary ballast tank No. 2 flood and suction.

6. Negative tank flood and suction.

7. Safety tank flood and suction.

The trim lines forward and aft serve the two trim tanks and the two WRT tanks, while auxiliary ballast tanks No. 1 and No. 2 are served by their own flood and suction lines. These tanks make up the variable ballast tanks

to after trim tank, the water is drawn through lines from the forward trim tank through the suction side of the manifold and into the suction side of the trim pump. Then, by pump action, it is forced through the discharge side of the trim pump, through the discharge side of the trim manifold, and finally through lines into the after trim tank.

For a more detailed discussion of the trim pump and the trim pump manifold, see Sections 2B and 2C1.

The functions of the various parts of the trim system are discussed in the following paragraphs. The trim line forward is a three inch line extending from the trim manifold to the forward trim manifold in the forward

torpedo room. The forward trim manifold controls the flooding and pumping of the forward trim tank and the forward WRT tank.

The trim line aft is also a three-inch line, terminating in the after torpedo room at the after trim manifold which controls the flooding and pumping of the after trim tank and the after WRT tank.

from one variable tank to another, adding water to the variable tanks or discharging excess water from the tanks overboard. The water handled by the trim system is measured in pounds; and a gage, graduated in pounds to show the amount of water transferred by the trim pump, is located above the trim manifold where the operator can observe its readings.

Because the trim pump used on the fleet type submarine is of the

Auxiliary ballast tanks No. 1 and No. 2 are piped directly to their suction and discharge valves on the trim pump manifold. Flooding or pumping of these tanks can be accomplished only through the trim manifold. On the other hand, flooding and draining of the safety and the negative tanks can be accomplished in two ways, either by the use of their suction, and discharge valves on the trim manifold or directly from sea by use of their flood valves. In the latter case, the draining is accomplished by opening the flood valves and admitting compressed air into the tanks, thus forcing the water out. The tanks may be flooded by opening both the flood and the vent valves, allowing the sea to enter directly into the tanks.

The trim pump suction from sea and overboard discharge line, connecting the trim manifold with the sea, provides the trim system with an overboard discharge to, or direct flooding from, the sea. In addition to the suction and discharge valves on the trim manifold, this line has also a sea stop valve and a magazine flood valve. The sea stop valve is used to shut off the sea from the trim system and the magazine flood valve. The magazine flood valve guarantees, when the sea stop valve is open, an immediate source of sea water to the ammunition stowage and the pyrotechnic locker.

As stated before, the main function of the trim system is to shift and adjust the distribution of weight throughout the centrifugal type, it must be primed before beginning the operation. A priming pump is used for this purpose. It primes the trim pump by removing all air from the trim pump casing, the trim manifold, and the lines leading to it, thus allowing water to replace the air in this equipment and fill it completely. (See Section 2B2 on the priming pump for a more detailed discussion of its operation.)

NOTE: The previously installed reciprocating-type trim pump will be replaced by the centrifugal model on all fleet-type submarines. A number of vessels have a "Deepwell" type pump. This pump is similar to the centrifugal unit although the priming arrangement is different.

The trim system can also be used to supply or drain water from the torpedo tubes. Water for torpedo tube flooding is normally taken from the WRT tanks through the torpedo tube flood and drain lines. These lines are controlled by the torpedo tube flood and drain valves.

The trim line forward and the trim line aft are provided with hose connections, one in each compartment of the submarine. These connections can be used for fire fighting, or for bilge suctions in those compartments without bilge suction facilities. Of course, if the connections are used for bilge suction, the trim line must be on SUCTION, and if for fire fighting, the line must be on DISCHARGE.

submarine. This is done by transferring water ballast

B. TRIM PUMP

2B1. Source of power. The trim pump (see Figure 2-1), located on the port side of the pump room just forward of the after bulkhead, is driven by a 10-to-25-horsepower motor directly connected to the drive shaft of the trim pump by means of a flexible coupling.

The controller relay panel for the motor is mounted on the after bulkhead of the pump

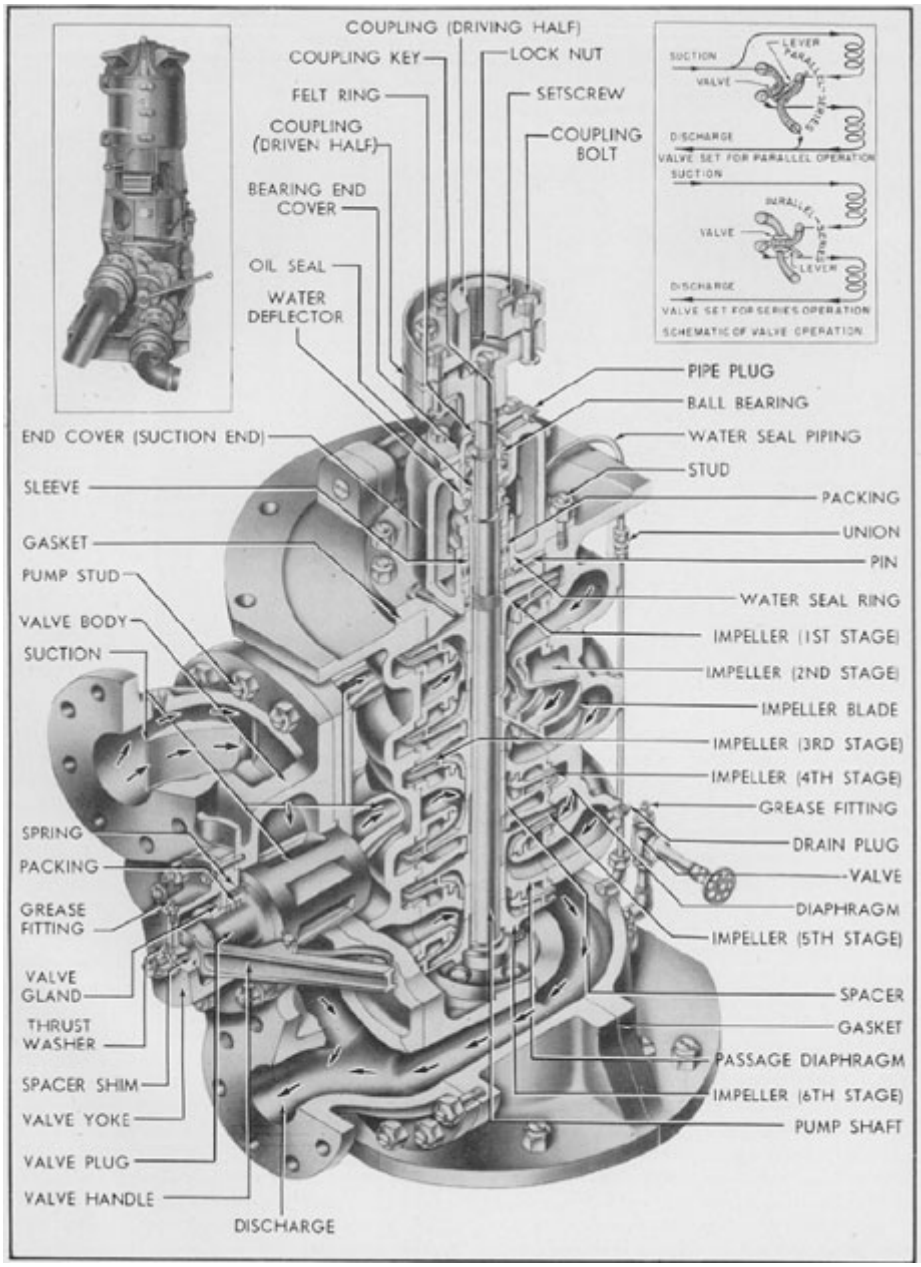

Figure 2-1. Trim pump.

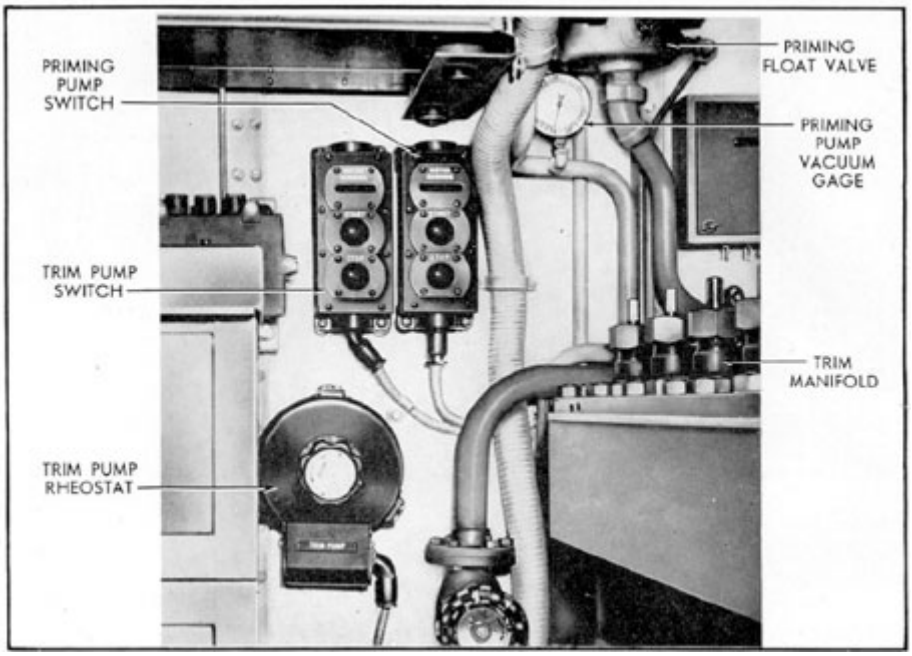

Figure 2-2. Trim pump controls.

room. However, the motor is started or stopped by push-button controls in the control room. Once started by these controls, the speed of the pump, and thereby the rate at which water is moved in the system, is regulated by a rheostat control also located in the control room just below the push-button switches (see Figure 2-2). Although the trim pump is driven by an electric motor, the starting of the motor does not guarantee that the trim pump will pump water, for since the trim pump is of the centrifugal type, it cannot pump air. Therefore, it cannot be operated until the system is free of air.

2B2. Priming pump. Freeing the system of air is the function of the priming pump, located outboard of the trim pump. Since any appreciable amount of air entering the inlet side of the trim pump will cause it to lose suction and thereafter run without pumping, it is necessary to use the priming pump to in the control room, provides a check on the satisfactory operation of the priming pump. If the trim pump is started and there is no indication of flow, the priming pump should be started at once to insure that the trim pump is fully primed, before other sources of trouble are investigated.

The priming pump, like the trim pump, is started or stopped by push-button controls in the control room. The priming pump is a vacuum pump with a float valve in the line running from the priming pump to the trim manifold and the trim casing. The valve consists of a float with a ball-ended stem. The purpose of the float is to permit the passage of air and to prevent the passage of sea water into the priming pump. As the water rises in the float valve, the upper part of the ball-ended stem is automatically forced against the valve seat, thus preventing sea water from entering the priming pump. When the float valve is filled with water, the vacuum gage

eliminate the air. A vacuum gage, mounted

will read about 20 inches of vacuum and the system is fully primed.

The priming pump is of the water-piston type and consists of three major parts 1) rotor, 2) lobe, and 3) port plate. The rotor is made up of a series of curved plates projecting radially from the hub. The lobe is elliptical in shape and forms the outer casing for the rotor. The port plate consists of-two inlet and two outlet ports corresponding to the inlet and outlet ports on the rotor. The pump is end-mounted on the direct driving electric motor as shown in Figure 2-3.

Before starting the priming pump, it is necessary first to provide sealing fresh water to it. This water is needed to fill the lobe partially and provide a water seal. Fresh water should be added until the seal water gage shows 2/3 full (see Figure 2-3). Serious damage may result if the pump is allowed to run in a dry condition. The motor is then started by the push-button control in the control room.

In operation, the rotor revolves in the lobe, which has been partially filled with water, at a speed high enough to throw the water out from the hub by centrifugal force. This results in a solid elliptical-shaped ring of water revolving at the same speed as the rotor. Referring to

The impeller consists of two parallel disks with curved vanes, or bulkheads, radiating from the hub and between the disks. One of these disks (upper or lower, depending upon where the water is brought in) has an inlet port, or circular opening, called the eye, which is concentric with the hub of the impeller. Actually then, one disk holds the impeller to the shaft while the other admits the water. The periphery of the impeller is open, as shown in Figure 2-1.

In operation, water enters the eye of the impeller, is picked up by the vanes and accelerated to a high velocity by the rotation of the impeller, and then discharged by centrifugal force into the casing and out the discharge port. When water is forced away from the eye of the impeller, pressure in this area is lowered ("suction" is created), and more water flows in. Consequently there is a constant flow of water through the pump. Considerable air in the inlet port of the pump will interrupt the action of the pump since, upon entering the impeller, it will break the suction which is dependent on the presence of water at the eye. For this reason, the pump casing and the system served by the pump must be completely filled with water before starting to pump.

The centrifugal pump just described has only one impeller and is known as a single-stage pump. A pump with four impellers may be known as a four-stage

Figure 2-3, it will be seen that a ring of water for a given rotor section, guided by the lobe, will move in and out from the hub, forming a liquid piston. As the rotor passes the inlet port, the water ring is farthest from the hub and air is permitted to enter. As the rotor advances to the discharge port, the air space becomes less and air is forced out the discharge port. This cycle is repeated twice for each revolution of the rotor.

2B3. Operation of the trim pump. A brief review of the general principles of the centrifugal pump will be helpful in understanding the operation of the trim pump. A centrifugal pump, as the name implies, employs centrifugal force to move a liquid from a lower to a higher level. In its simplest form, this type of pump consists of an impeller rotating in a watertight casing which is provided with inlet and outlet ports.

pump; with six impellers, a six-stage pump; and so forth. In actual practice, however, any pump with more than one stage is referred to as a multi-stage pump.

The mechanical details of the trim pump are shown in Figure 2-1. It will be seen that the pump is a six-stage centrifugal pump. The valve on the forward end permits either parallel or series operation and is manually operated. The schematic diagram in the upper right corner of the illustration shows the flow of the water being pumped, for both series and parallel operation. With the manually operated series-parallel valve in the SERIES position, the incoming water enters the first stage, proceeds through the second and third stages, and then back through the series-

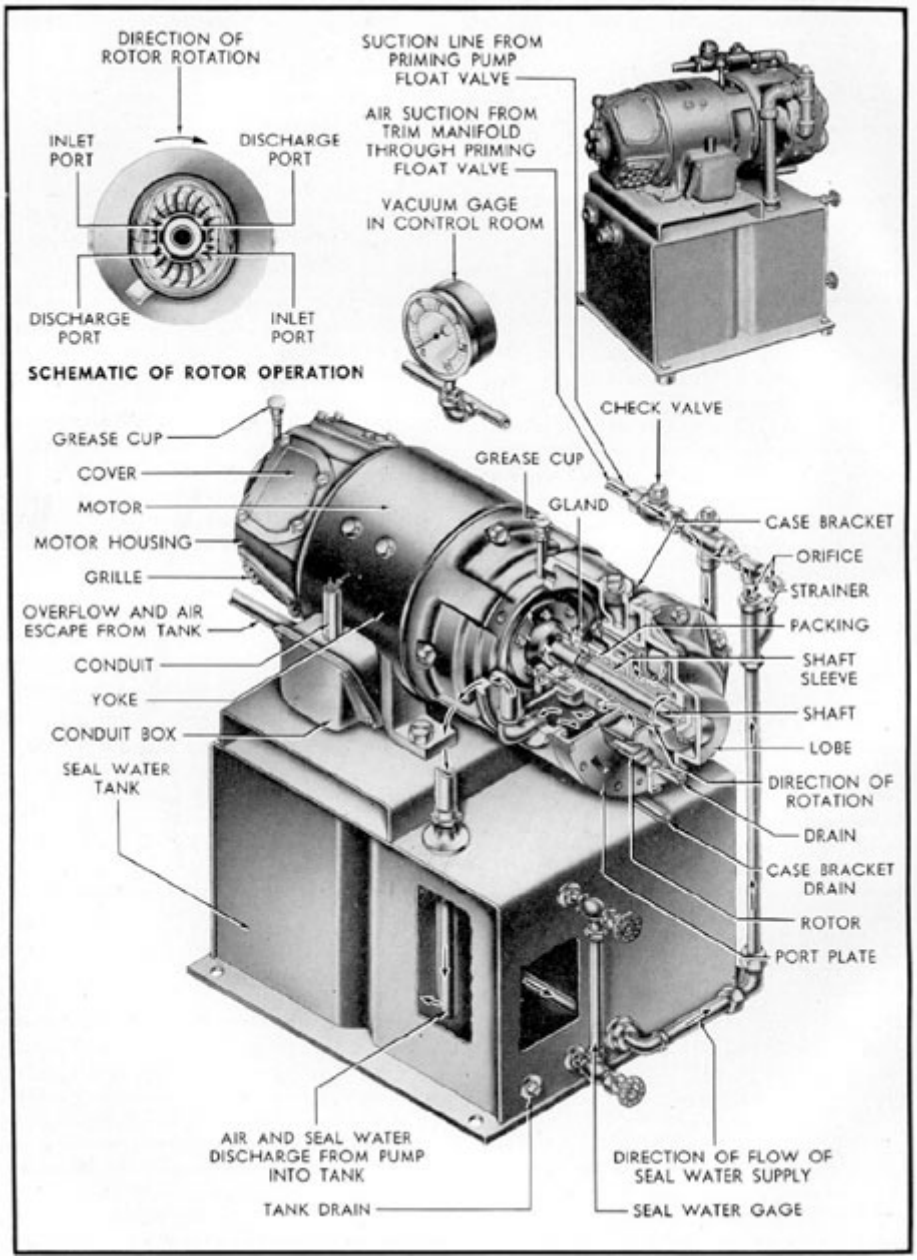

Figure 2-3. Priming pump.

parallel valve to the fourth, fifth, and sixth stages. With the series-parallel valve in the PARALLEL position, half of the inlet water proceeds through the first, second, and third stages, and is then discharged through the series-parallel valve. Simultaneously, the other half of the inlet water is directed by the series-parallel valve to the fourth, fifth, and sixth stages, and is then discharged directly. Series operation of the pump produces twice the discharge eliminate the air before restarting the trim pump.

The trim pump should not be operated at speeds greater than are necessary to produce the rate of flow specified for a given depth.

The following table lists the proper valve position and pump output in pounds of water per minute, recommended for different depths.

Depth	Pump Output	Valve Position

pressure, but only half the volume produced by parallel operation. The pump is operated in series only when the submarine is at a depth of approximately 250 feet or more and discharging to the sea; the higher pressure is necessary to overcome the greater sea pressure encountered at that depth.

In summary, it must be remembered that before starting the trim pump after installation or reassembly, it is necessary to make certain that the trim system lines and the pump casing are free of air. After the trim pump has been used, the casing should remain primed, because of the location of the pump in relation to the trim manifold. But if flow does not commence after starting the trim pump, the priming pump should be used to

On surface	1500-2500 lbs. per min.	Parallel
0-200 ft.	1500 lbs. per min.	Parallel
Trimming-tank to tank	1500 lbs. per min.	Parallel
200-250 ft.	1250 lbs. per min.	Parallel
250-400 ft.	1000 lbs. per min.	Series
400 ft. or more	1000 lbs. per min.	Series

The pump should not be operated at a motor speed greater than 2400 revolutions per minute. Excess speeds place an overload on the bearing and mechanical parts of the pump and motor and may cause breakdown.

C. MANIFOLDS

2C1. Trim manifold. In Section 2A, the trim manifold is referred to as the center of distribution for the trim system. It acts as a switchboard between the trim pump and the lines of the system, providing a centralized station to direct the flow of water to and from the variable tanks. Used in connection with the trim manifold, but connected to each variable tank, is a measuring gage, or liquidometer. These gages record the amount of water in each tank and provide the diving officer with an indication of the amount of water ballast being redistributed by the trim manifold through the manual. The manifold is a boxlike, two-piece casting, divided internally into two longitudinal compartments known respectively as the suction and discharge sides. The suction side contains eight suction control valves, while the discharge side has eight discharge, or flood, control valves. Each of these sixteen valves is of the disk and seat type, with rising stems and individual bolted-on bonnets. Name plates, attached to each bonnet, indicate the function of that particular valve.

Starting from the after end outboard of the manifold, the

trim system. The trim manifold is mounted hip-high on the port side of the control room just forward of the after bulkhead. The gage board is mounted directly above it.

Figure 2-4 shows the mechanical construction of the trim manifold, with the proper nomenclature of its parts, as used in this

valves control the functions indicated in the table on page 11.

The discharge valves are all on the starboard side of the manifold, with the corresponding suction valves opposite them on the port side. A special wrench for operating the valves is provided.

Flanged outlets are cast integral with the manifold to connect with the lines of the

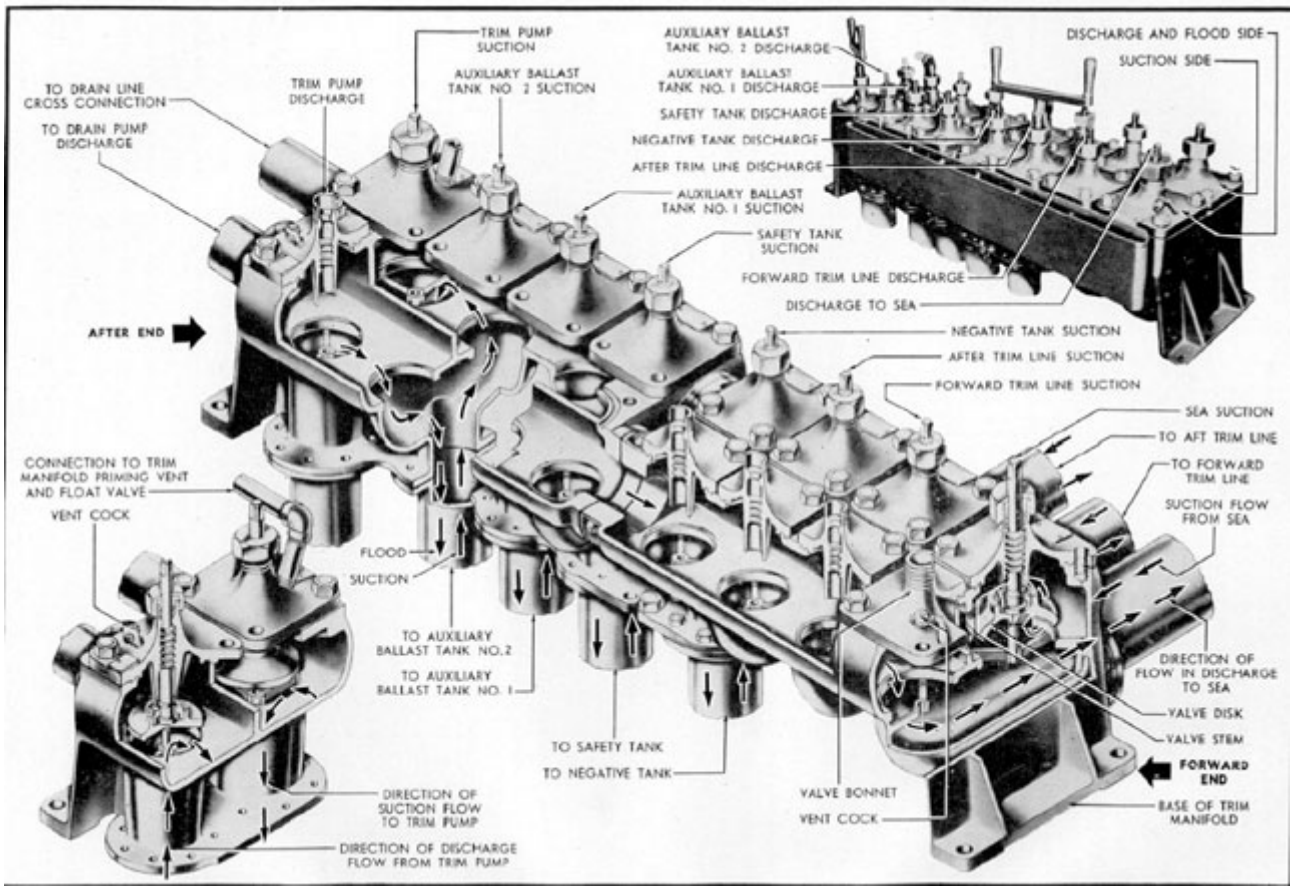

Figure 2-4. Trim manifold.

Outboard-Suction	**Inboard-Discharge**
1. Trim pump suction	9. Trim pump discharge
2. Auxiliary ballast tank No. 2 suction	10. Auxiliary ballast tank No. 2 discharge

side, aft of the torpedo tubes. The after trim manifold is located in the after torpedo room, port side, forward of the torpedo tubes (see Figure 3-9).

The forward and the after WRT and trim tank manifolds are

3. Auxiliary ballast tank No. 1 suction	11. Auxiliary ballast tank No. 1 discharge
4.Safety tank suction	12. Safety tank discharge
5.Negative tank suction	13. Negative tank discharge
6. After trim line suction	14. After trim line discharge
7. Forward trim line suction	15. Forward trim line discharge
8. Sea suction	16. Discharge to sea

system. Two outlets on the after end lead to the drain line cross connection and to the drain pump discharge, to permit emergency use of the drain pump for actuating the trim system.

In all pumping operations, the trim pump suction and the trim pump discharge valves on the manifold must be opened to permit flaw within the system. To flood a tank, the discharge valve for that tank must be opened at the trim manifold; to pump a tank, its suction valve must be opened. This should be done before the trim pump is started. All valves on the manifold should be shut immediately after the pumping operation is complete. Figure 2-4 shows the direction of flow when flooding or pumping auxiliary ballast tank No. 2.

Fully detailed instructions for specific trimming operations are given in Chapter 4. They explain the exact procedure to be followed in operating the trim manifold in conjunction with the other units of the trim system.

identical in operation and construction, differing only in the fact that they serve different tanks.

The body of each trim manifold is a two-chambered casting containing two valves which control flood and suction of the WRT tank and the trim tank, respectively. The after valve in the after torpedo room and the forward valve in the forward torpedo room control the trim tank. The valves are of the disk and seat type with bolted bonnets. The connecting passage between chambers of the integrally cast valve casting allows either valve to be operated independently. The handwheels carry name plates designating the uses of the individual valves.

When open, the manifold valve marked TRIM TANK FLOOD AND SUCTION permits the flooding or pumping of the trim tank from, or into, the trim system when the trim line is on service.

The other valve, marked WRT TANK FLOOD AND SUCTION, permits the flooding or pumping of the WRT tank from, or into, the trim system when the torpedo tube drain stop valve to the WRT tank is open.

2C3. Torpedo tube drain manifold. In Section 2A the flooding and draining of the torpedo tubes were mentioned as one of the functions of the trim system. This function is controlled by the torpedo tube drain manifolds. Two of these manifolds are located in the forward torpedo room, each servicing three torpedo tubes; two are located in the after torpedo room, each

2C2. Forward and after WRT and trim tank manifold. The WRT and trim tank manifolds are used in conjunction with the trim manifold to control the flooding and pumping of the WRT tanks and the trim tanks, both fore and aft.

The forward trim manifold (Figure 2-5) is located in the forward torpedo room, port servicing two torpedo tubes. Figure 3-9 shows the location of these manifolds (the forward manifold servicing the three starboard tubes is not shown in the illustration). In each case, the control levers are adjacent to the manifold.

The body of the torpedo tube drain manifold is a three-chambered casting, housing three cam-actuated plunger-type valves, and provided with flanged outlets for connection to the trim system and to the torpedo tube

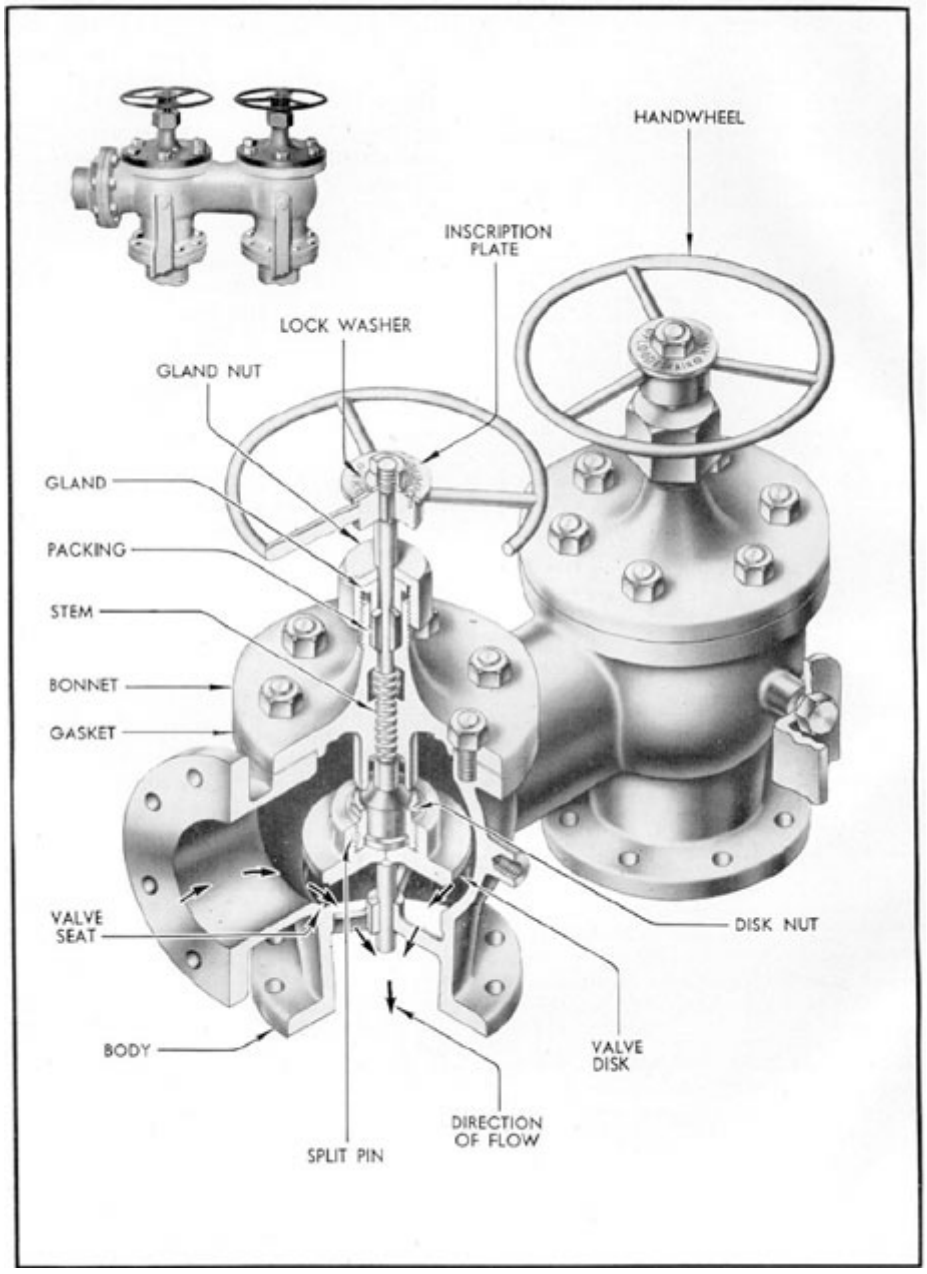

Figure 2-5. Forward WRT and trim tank manifold.

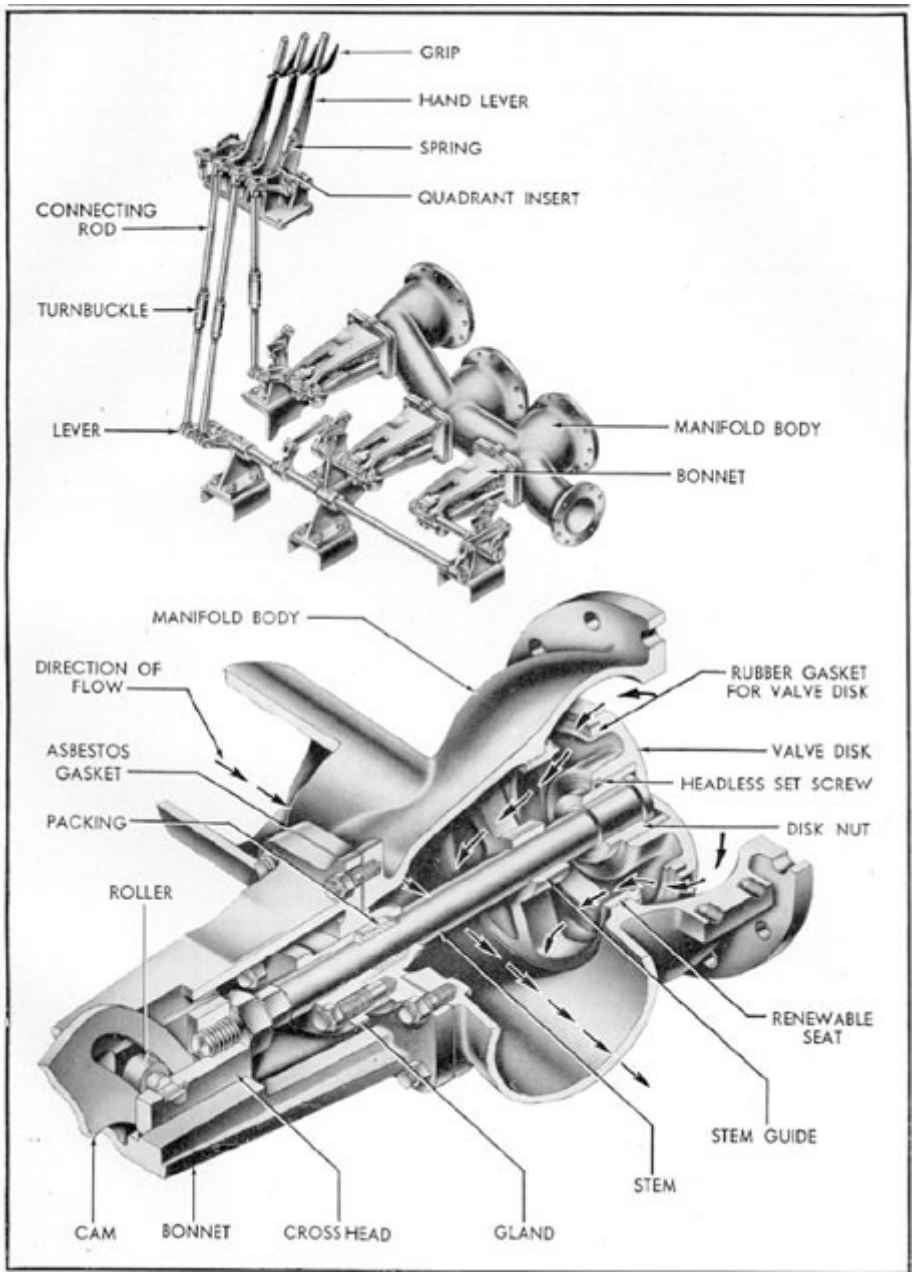

Figure 2-6. Torpedo tube drain manifold.

drains. The cam mechanisms are attached to the back of the casting. Separate control levers and connections are provided for each of the valves (see Figure 2-6).

Each hand lever operates one cam, through the action of its connecting rod and cam lever. In the open position, permitting water to flow to or from the torpedo tube drains. In draining or flooding the tubes, the manifold valves are used in conjunction with the torpedo tube drain stop valve to the WRT tank, which must be open when draining from the tubes to that tank.

Figure 2-6 the cam and valve are shown in

D. VALVES

2D1. Trim pump sea stop valve. In discharging water ballast from any part of the trim system to sea, the trim pump sea stop valve must be opened, thus providing a passage from the trim manifold through the pressure and outer hulls to the sea. The same line is used to permit water to enter the system from the sea when additional water ballast is to be added. This valve is located on the port side of the control room, directly below the trim manifold (see Figure 3-9).

The sea stop valve is of the rising stern disk and seat type, with a bolted bonnet. Flanged connections are provided to the sea discharge line, the trim manifold, and the magazine flood line. A guide which extends below the valve disk serves to center and seat the valve disk. The mechanical construction is shown in Figure 2-7.

The connection to the pressure hull is a flange, cast integral with the valve body below the valve seat to insure a pressure-tight connection to the pressure hull. The lower part of the valve body, with the screwed flange, projects through the pressure hull and connects to the line overboard.

Turning the handwheel counterclockwise to the OPEN position raises the, valve disk and permits the suction of sea water into the trim system, the stem position, thereby providing a means of supplying water to flood the magazine and the trim system simultaneously.

2D2. Torpedo tube drain stop valve to the WRT tank. The torpedo tube drain stop valve to the WRT tank serves as a stop valve between that tank and the individual torpedo tube drain valves.

There is a torpedo tube drain stop valve to the WRT tank in both the forward and the after torpedo rooms (see Figure 3-9). Both of these valves are identical in function and construction (see Figure 2-8).

The torpedo tube drain stop valve to the WRT tank is a globe-type valve with a bolted yoke-type bonnet and a rising stem. The mechanical construction is shown in Figure 2-8. The inscription plate carries the valve designation. In the OPEN position, the valve permits water to be blown into the torpedo tubes from the WRT tank, or to be drained back into the tank from the torpedo tubes, provided the individual torpedo tube drain valves are open. The valve is also opened to flood or drain the WRT tank by the trim line. All flow of water to and from that tank is cut off by closing the valve.

2D3. Magazine flood valve and testing casting. The magazine flood valve and testing casting (see Figure 2-9) provide an emergency method of flooding

direct flooding of the magazine, or the overboard discharge of water from the trim system.

Turning the handwheel clockwise seats the valve disk and cuts off the suction from, or discharge to, the sea. In Figure 2-7 it will be seen that the handwheel controls only the up-and-down movement of the stem; therefore, only the suction from, or discharge to, sea is affected by this handwheel. The side outlets remain open irrespective of the valve

the magazine compartment. This is another secondary function of the trim system.

The magazine flood valve is used to control this emergency flooding system. The testing casting is used in checking the magazine flood valve to make certain that it is ready for immediate use. Both the magazine flood valve and the testing casting are located in the control room on the magazine flood line

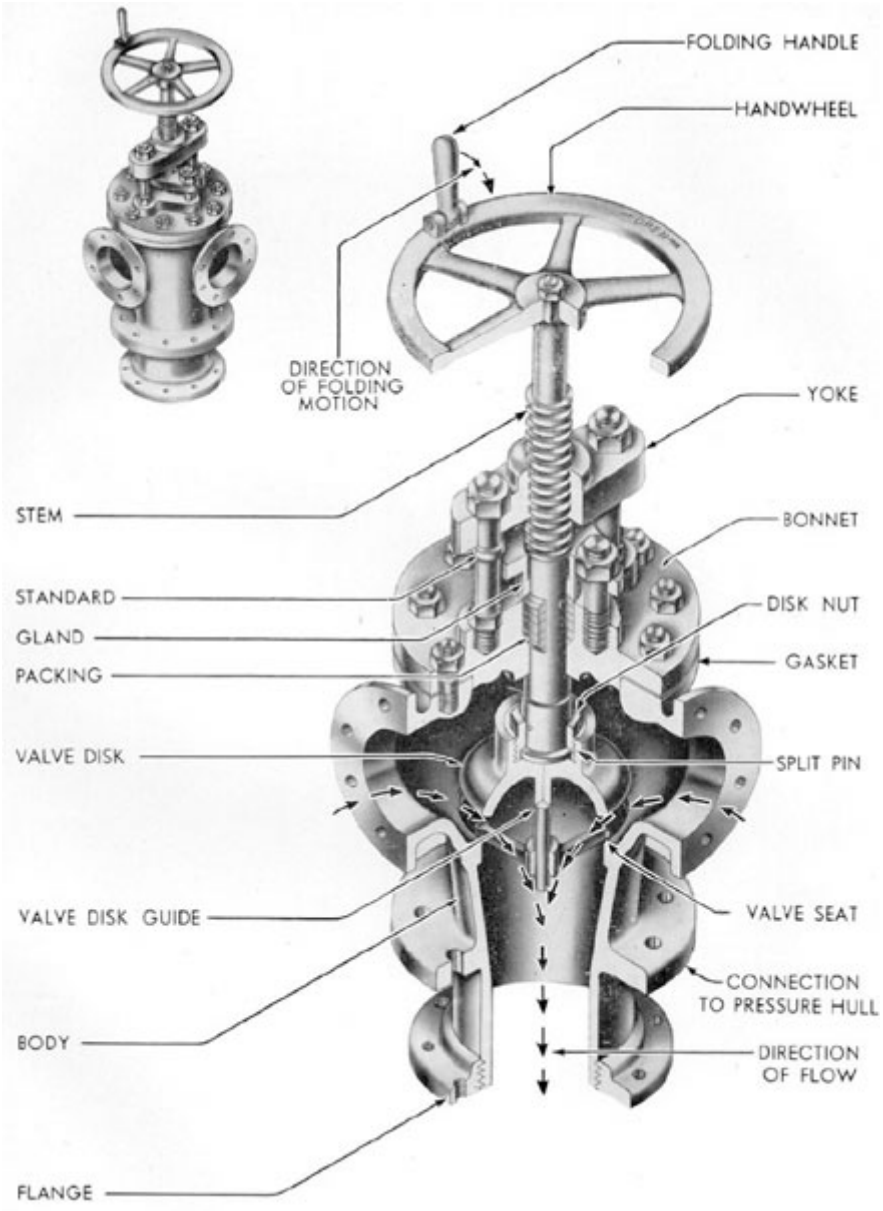

Figure 2-7. Trim pump sea stop valve.

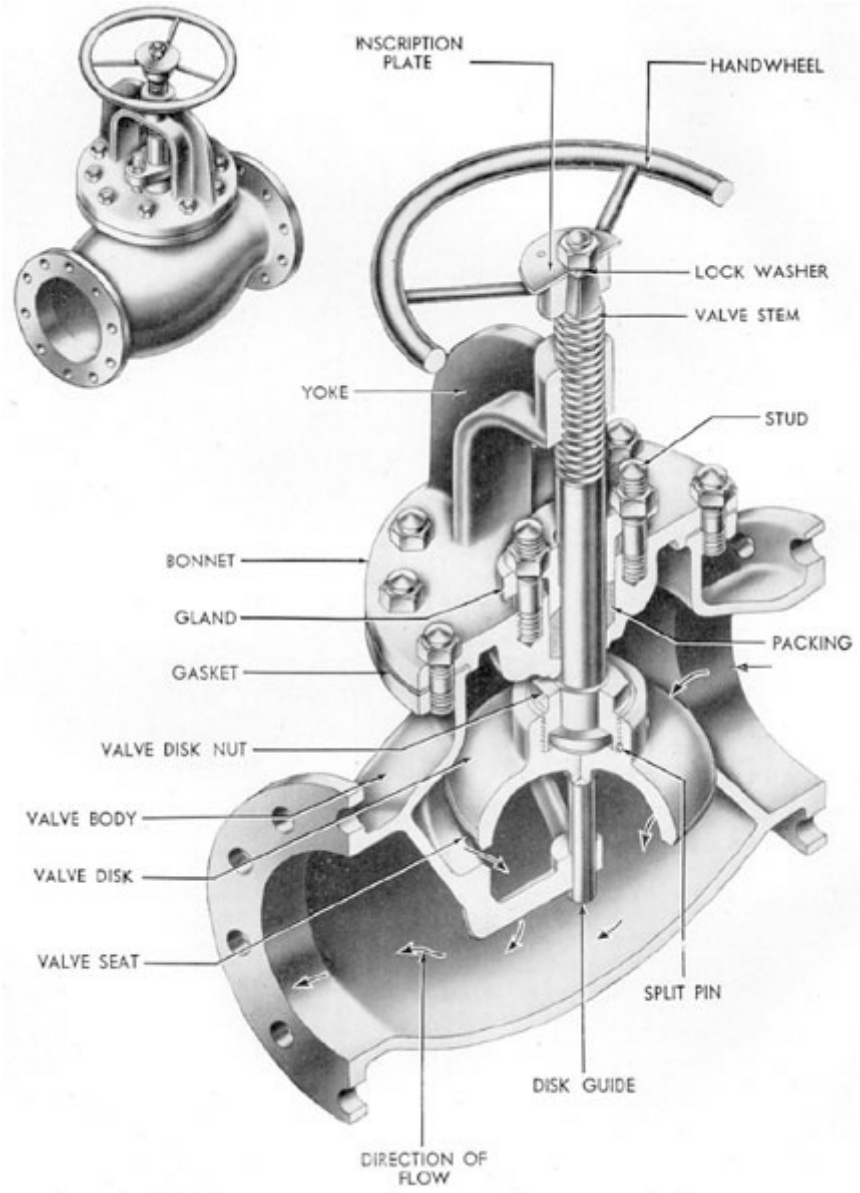

Figure 2-8. Torpedo tube drain stop valve to WRT tank.

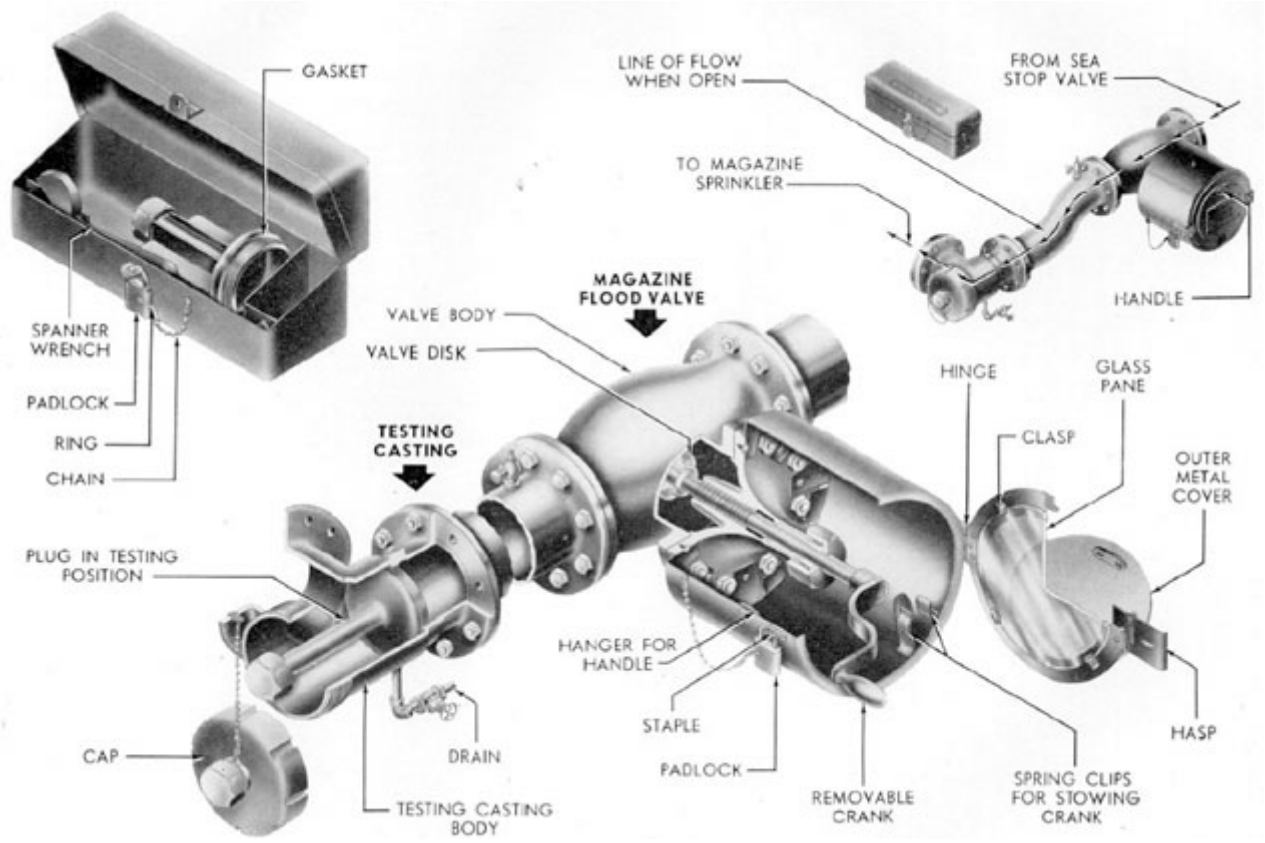

Figure 2-9. Magazine flood valve and testing casting.

of the trim system. The accessory box containing the operating plug and wrench is mounted directly above the testing casting.

The magazine flood valve is a disk and seat type globe stop valve with a bolted bonnet, rising stem, and flanges for connection to the testing casting and the sea stop valve. A cylindrical box bolted to the bonnet encloses the stem. The end of the protecting box has a hinged glass door equipped with a hasp-and-chain padlock. Protecting the glass cover, is a smaller, hinged metal cover. Inside the box is a crank that fits the valve stem.

The magazine flood valve is used only in emergency to flood the magazine compartment. The outer metal cover and the glass

The testing casting is used for periodic testing of the magazine flood valve to make certain that the flood valve is in operating condition and ready for use when needed.

The testing casting is T-shaped, with the long leg and one arm flanged for connection to the magazine flood line and the flood valve. The other arm is threaded to receive the protecting cap. The operating plug, in the accessory box, fits the inside threads in the testing casting. The wrench fits the cap and the plug.

In testing the magazine flood valve, the cap is removed from the testing casting and the plug is screwed in tightly. After the valve is opened, the vent in the magazine line is opened to see if the line contains water. If the valve is operating correctly, the line will

door are unlocked and opened during periods of possible emergency or when testing. In cases of emergency, the glass door should be broken. The valve is opened, using the crank, to flood the magazine.

contain water. The flood valve is closed and the line through the testing casting drain is drained before the plug is removed. Next, the plug is removed and the cap replaced, making

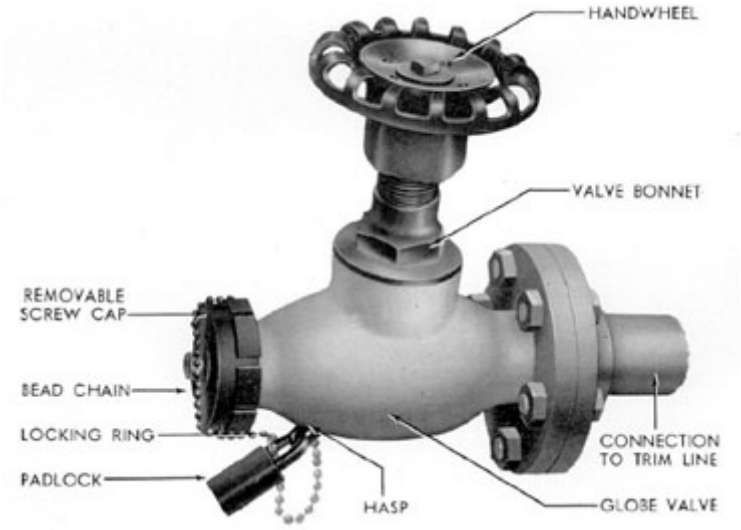

Figure 2-10. Trim line hose connection.

the testing connection watertight. The plug and wrench are then replaced in the box, and the door to the valve stem enclosure is locked.

2D4. Trim line hose connection. The trim line hose connections (Figure 2-10) may be used as fire main outlets or as additional bilge suction. They may be used in pumping a compartment, or any area not covered by the drain system, when there is suction in the trim lines.

The forward trim line has three hose connections; one in the forward torpedo room, one in the forward battery compartment, and one in the control room. The after trim line has five hose connections: one each in the after battery compartment, the forward

The hose connection is a globe valve with a rising stem. It has one end flanged for connection to the trim line and the other end threaded for a hose coupling. A locking cap attached to the valve body by a chain, and secured with a padlock, fits onto the hose coupling end.

In using the hose connection either for flooding or pumping, the cover is unlocked and removed. The hose is attached by coupling to the threaded end of the connection. The valve is opened by turning the handwheel counterclockwise, thus providing suction or flooding as required. When sufficient water has been obtained or removed, the valve is shut, the hose removed, and the cover replaced and locked. When not in use, the valve should be

engine room, the after engine room, the maneuvering room, and the after torpedo room.

kept shut and the cover locked to prevent possible leakage.

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3
THE DRAIN SYSTEM

A. FUNCTIONS

3A1. General. In submarines as in all ships, a certain amount of water from various sources accumulates inside the hull. The most important of these sources include:

1. Leakage at-glands around the propeller shafts, pitometer log, sound gear, periscopes, and similar equipment.

2. Draining of air flasks, manifold drain pans, conning tower deck, gun access trunk, and escape trunk.

3. Condensation from air-conditioning cooling coils.

This water drains off into the bilges and wells where a number of bilge sumps with strainers are provided from which the bilge water can be pumped.

The bilge sumps and wells are pumped periodically to prevent the excess free water from overflowing the bilges and interfering with the operation of the submarine. This water is pumped out by the drain system which consists essentially of the drain pump and the piping connecting the pump with the sumps and other drainage points in the submarine. Reference to the general arrangement shown in Figure 3-9 will be helpful in

line forward extends to the forward torpedo room and provides pumping connections for the two bilges and the pitometer log well in the after section of the torpedo room. The drain line terminates at the forward bilge manifold, with two valves controlling the suction from the poppet valve drain tank and the forward bilge.

The escape trunk drain opens into the forward torpedo room; the water drains directly onto the deck and eventually empties into the bilges.

There are no drain line connections in the forward battery compartment.

The drain line aft extends to the after torpedo room and contains pumping connections to the sumps in the compartments in the after section of the submarine. There are no drain line connections in the after battery compartment. The forward engine room has two bilge sumps connecting with the drain line aft through two individual lines. The after engine room also has two bilge sumps which connect to the drain line by means of two separate lines. In addition to the bilge sump pumping connections, the drain line aft contains also a

understanding the functional description which follows.

3A2. Functional description.
The drain pump, located in the pump room, provides suction for the drain system. The pump is started and stopped by means of an electric push-button switch located nearby in the pump room. The drain pump has a suction and a discharge connection. A suction line equipped with a strainer and a sight glass connects the suction side of the pump with the main forward and after drain lines, usually called the drain line forward and the drain line aft. The drain line forward and the drain line aft can be cut off by shutting their respective stop valves, located in the pump room.

In Figure 3-9, proceeding forward from the pump room, it an be seen that the drain suction line to the collecting tank, making it possible for water from the collecting tank to be pumped out through the drain system.

There is one bilge sump in the motor room.

The drain line aft terminates in the after bilge manifold in the after torpedo room. Here too, the manifold contains two valves, controlling suction from the forward and after bilge sumps.

Returning now to the pump room, the drain pump suction line carries a branch connection to the pump room bilge manifold. This manifold contains three valves controlling suction from the three pump room bilge sumps.

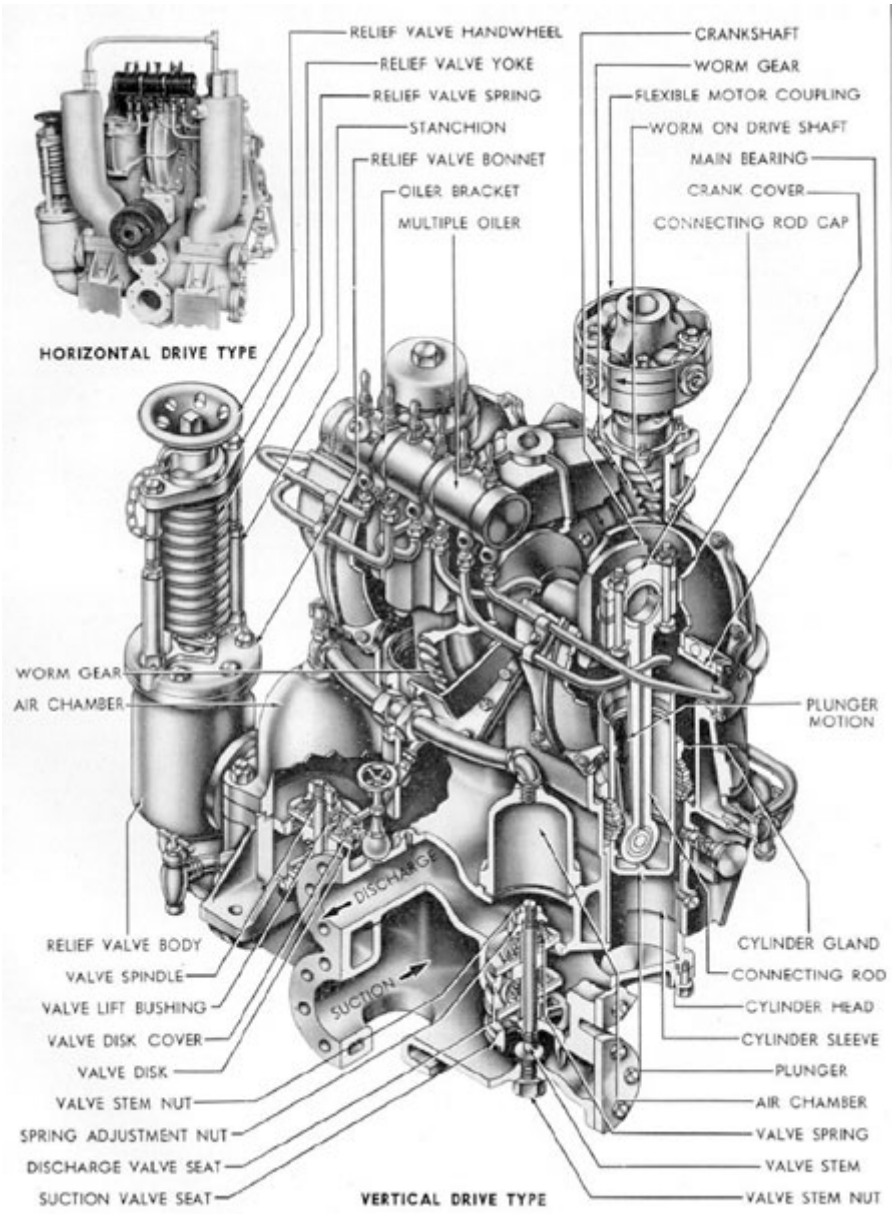

Figure 3-1. Drain pump.

The drain water from the gun access trunk, the cable trunk, the periscopes, and the antenna wells empties into the pump room bilge and collects in the sumps from which it is pumped when required.

The drain pump has three points to which it may discharge: 1) the overboard discharge; 2) the compensating water main; and 3) the trim system. In addition, the drain pump is so interconnected with the trim manifold that it can discharge water into the trim system instead of into its own upon the conditions. Then the drain pump is started and the pumping begins. When the pumping is completed, the pump is stopped, and the valves to the various lines used in the operation are shut.

The drain system can discharge the bilge water directly overboard, into the expansion tank through the compensating water main, or into the trim system through the trim manifold.

Bilge water should not be discharged directly overboard if

piping. This interconnection permits the use of either the drain pump or the trim pump with either the trim or the drain system, in the event that one of the two pumps is not in operating condition.

Every branch suction line to the bilge sumps has its own bilge stop valve. When it is desired to pump out certain bilge sumps, or wells, the valves leading from them to the drain line and the pump are opened. The required discharge valves are then opened to the overboard discharge, the compensating water main, or the trim system, depending

there is danger of detection by the enemy, because the oil in it will rise to the surface, indicating the presence of the submarine. Instead, bilge water should be pumped into the expansion tank, where the water separates from the oil before being discharged overboard.

If the trim system is used to receive the bilge drainage, it is possible to pump this water into the variable ballast tanks. But this may be a hazard to security, because discharging variable tanks to sea during trimming operations will allow bilge oil to rise to the surface, leaving the telltale oil slick.

B. DRAIN PUMP

3B1. Source of power. An electric motor, rated at 10 horsepower and 1150 revolutions per minute, is used to drive the drain pump through-a worm and worm gear assembly as shown in Figure 3-1. The two types of pumps in use are shown in this illustration. One has a vertically mounted motor and is shown in the large cutaway view; the other has the "motor mounted horizontally and is shown in the upper left-hand corner of Figure 3-1. The cutaway view shows the mechanical construction of the pump.

3B2. Description. The drain pump is a single acting duplex reciprocating pump with the cylinders mounted vertically. The two plungers are connected to the crankshaft by connecting rods, so that one plunger "draws" water into the cylinder through the valves from the inlet, or suction, port. When the plunger reaches the top of its stroke and starts its downward travel, the water forces the suction valve down, closing the inlet port, opening the discharge valve, and allowing the water to flow out of the discharge port. At the same time, the second plunger is performing the reverse operation, taking a suction while the first plunger is discharging. This results in a continuous flow of water through the pump.

An air chamber is provided for each cylinder to smooth out the flow and quiet the pump operation by cushioning the discharge. Air in the chamber is compressed during discharge. When the plunger reaches the end of its stroke, expansion of this air

completes its downward travel at the moment the other plunger completes its upward travel. As a plunger moves upward in the cylinder, it creates vacuum, or suction. This lowered pressure tends to keep the water flowing until the reverse stroke begins.

A connection is provided to the 225-pound air system for recharging the chambers.

Indicator lights show when the chambers need charging or venting.

3B3. Lubrication. Lubrication of the main bearings and the connecting rod bearings is accomplished by the multiple oiler mounted on the pump casing. Oil reaches the bearings through holes drilled through the crankshaft and connecting rods. The worm gear drive runs in oil which is cooled by sea water circulating through a coil installed in the worm drive housing.

3B4. Relief Valve. The relief valve, set at 225 pounds per square inch, is mounted on the pump body and protects the pump from excess pressure in case a valve is shut on the discharge line when the pump is operating.

A drain cock is provided to allow the draining of all water from the pump.

3B5. The drain pump controls. The electrical controls for the drain pump consist of the motor switch, the air chamber pressure indicators, and the control panel. All are mounted on the port side of the pump room.

The motor switch is equipped with a push-button for starting, a push-button for stopping, and a signal light which is ON when the motor is running.

The drain pump control panel is housed in a ventilated panel box with a removable door. This panel supports the contactors, relays, fuses, and overload relays of the control circuit.

The air chamber pressure indicator consists of two lights which show the conditions existing in the pump air chambers. They are controlled by a limit switch mounted in the air chamber. If too much water is in the chambers, both lights will be ON. In this case air should be blown into the chambers until one light goes OUT. If both lights are OUT, insufficient water is in the chambers, and they must be vented until one light goes ON.

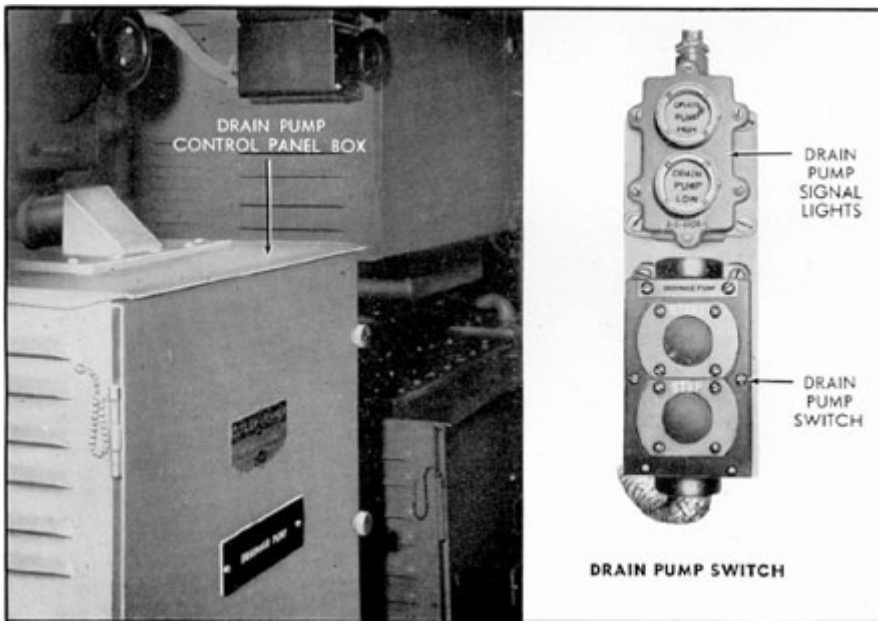

Figure 3-2. Drain pump controls.

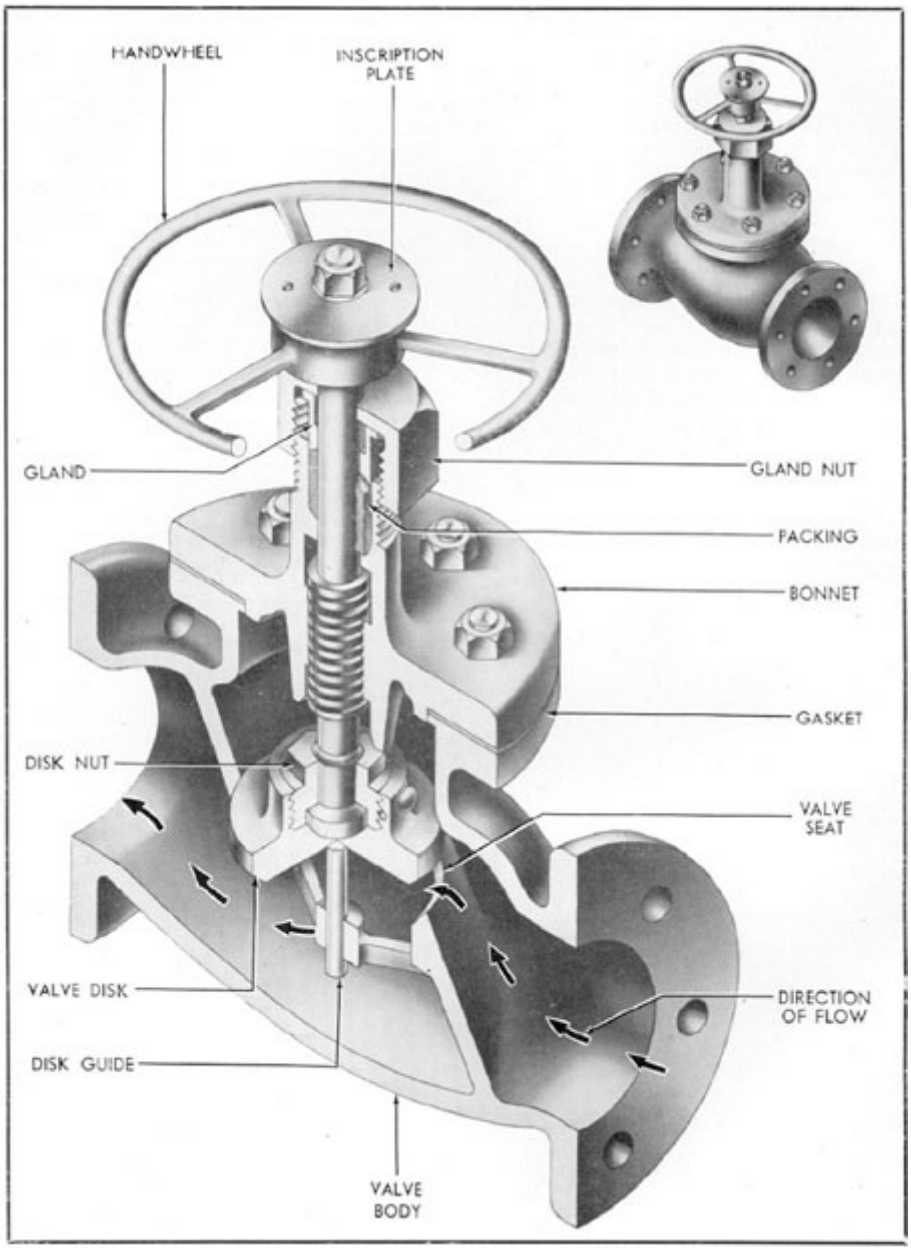

Figure 3-3. Drain line stop valve.

C. VALVES AND FITTINGS

3C1. Drain line stop valves. In Section 3A it was explained that the suction of the drain pump could be applied to either the forward or the after drain line. The drain system is provided with two valves, known as the forward and the after drain line stop valves, respectively. These valves will put either drain line on SERVICE, depending on which section of the boat is to be serviced. These two valves are located on the port side of the pump room, forming the connection between the line leading to the suction side of the drain pump and the forward and after drain lines (see Figure 3-9).

The forward drain line stop valve is an angle valve of the disk and seat type, with a bolted bonnet, a rising stem, and flanges for connection to the lines. The after drain line stop valve is a globe valve, the construction of which is shown in Figure 3-3.

Opening the forward drain line stop valve by its manually operated handwheel places the forward drain line on SERVICE and permits the use of the forward section of the drain system. Similarly, the after drain line stop valve is used to place the after drain line on or off SERVICE.

3C2. Drain pump overboard discharge valve. When the water collected from the bilges by the drain system is to be discharged the inboard leg of the valve is connected to the stop check valve on the line leading to the drain pump discharge. The bolted bonnet gives access to the disk and seat valve for inspection and repair. The adjustable packing gland prevents leakage around the rising stem when the valve is subjected to depth pressure.

When discharging from the drain pump to sea, the manually operated overboard discharge valve must be opened. It is shut immediately after the discharging operation is completed.

3C3. Bilge strainer. Although the purpose of the bilges is to collect excess water, solid material such as flakes of paint and bits of metal inevitably finds its way into the bilges. If this solid matter were to enter the lines of the drain system, it might clog or damage the drain pump. As a precaution, each bilge sump is equipped with a bilge strainer (Figure 3-5) which-screens the bilge water before it enters the drain system lines, and holds back any large particles.

The three bilge sumps in the forward torpedo room, the three in the pump room, the two in each engine room, the one in the motor room, and the two in the after torpedo room are equipped with bilge strainers of the general type shown in the illustration. The only exception is the after bilge sump in the after torpedo room which is equipped with a Macomb strainer.

directly to the sea, two valves must be opened to provide a passage for the drain water.

The inboard valve is a stop check valve; the second valve is outboard of the first and is known as the drain pump overboard discharge valve (see Figure 3-4). Both are located on the port side forward in the pump room, and are mounted in tandem so that the stop check valve acts as a sea stop for the discharge valve.

The mechanical details of the drain pump overboard discharge valve are shown in Figure 3-4. The valve is mounted with the outboard leg extending through the pressure hull; the midway flange is bolted and gasketed to the hull to insure a pressure-tight connection. The threaded flange is connected to the pipe leading overboard. The flange on

The size and shape of the strainers vary somewhat to suit the individual bilge sumps.

The strainer consists of an open-bottom mesh cylinder set in the bilge sump. The mesh is held in place by clips screwed to chocks which are welded to the pressure hull. The top cover is split and has hinged sides. It is held tightly closed around the bilge suction pipe by a holding spring.

The bilge water enters the strainer through the screen, which holds back all large particles of solid material; the water drops into the well and is sucked into the drain system through the drain pipe. To remove foreign matter which may collect in the well,

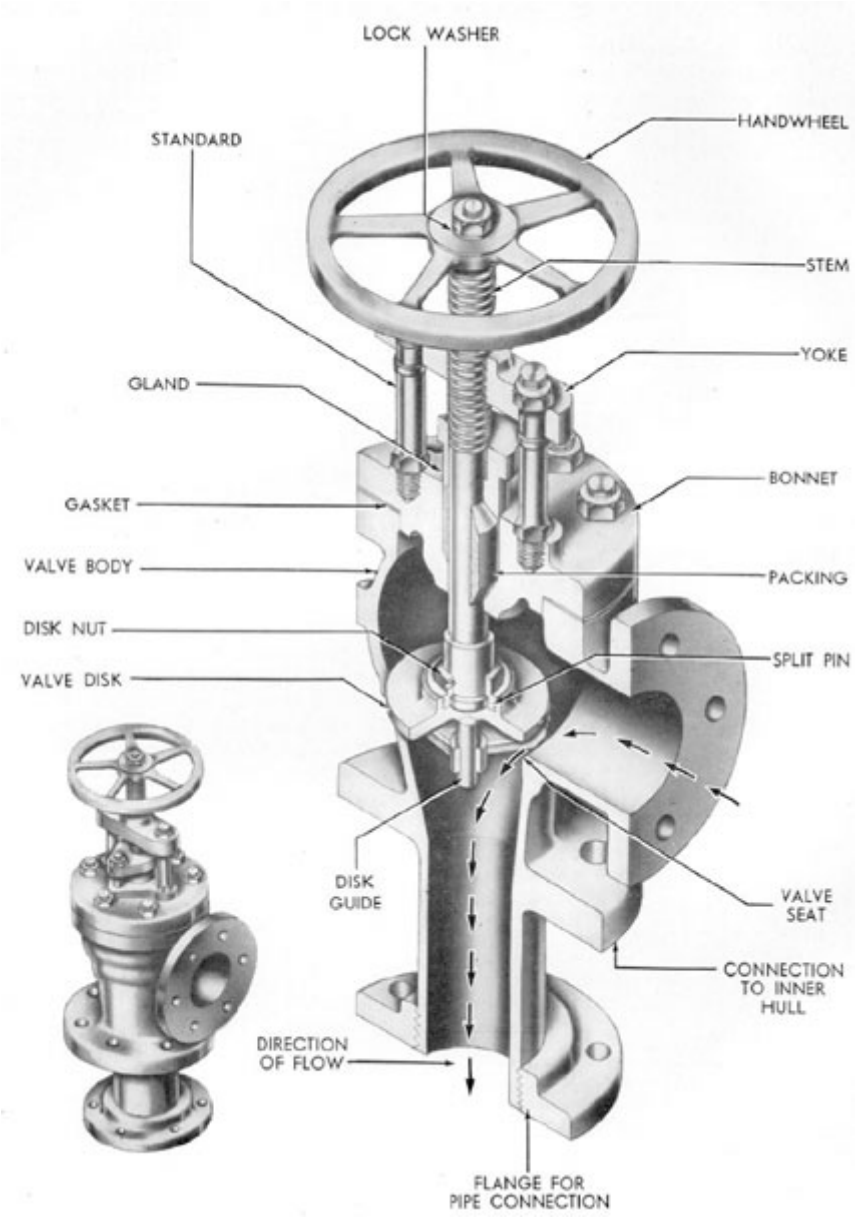

Figure 3-4. Drain pump overboard discharge valve.

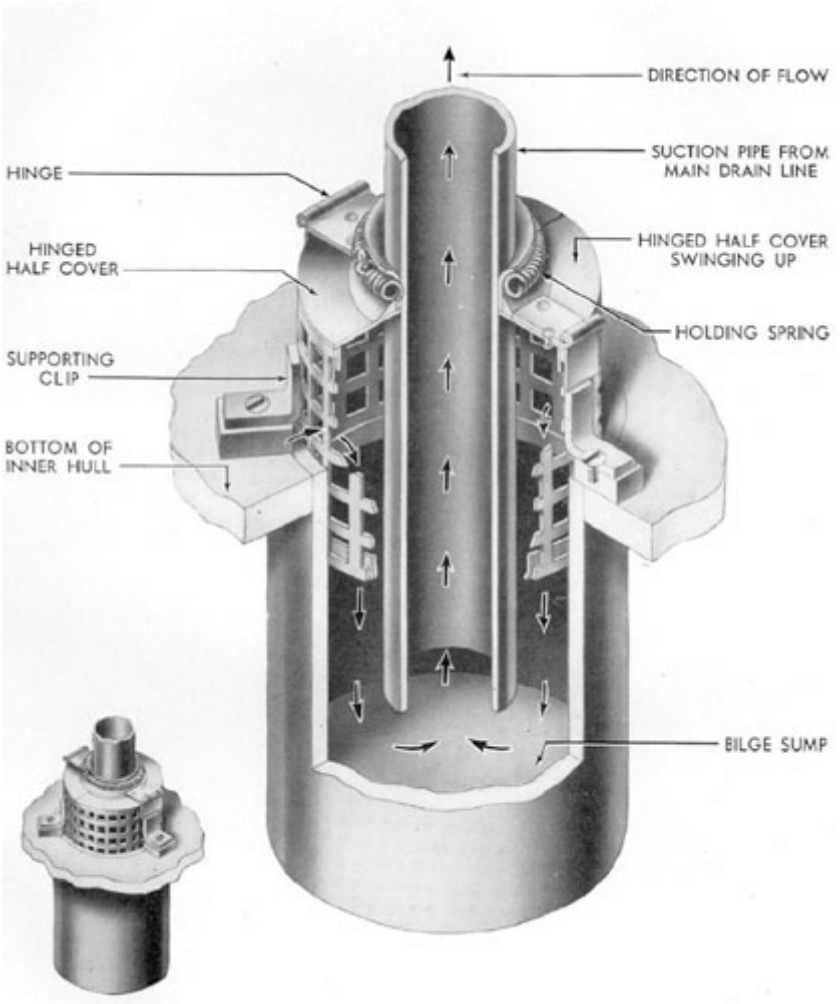

Figure 3-5. Bilge strainer.

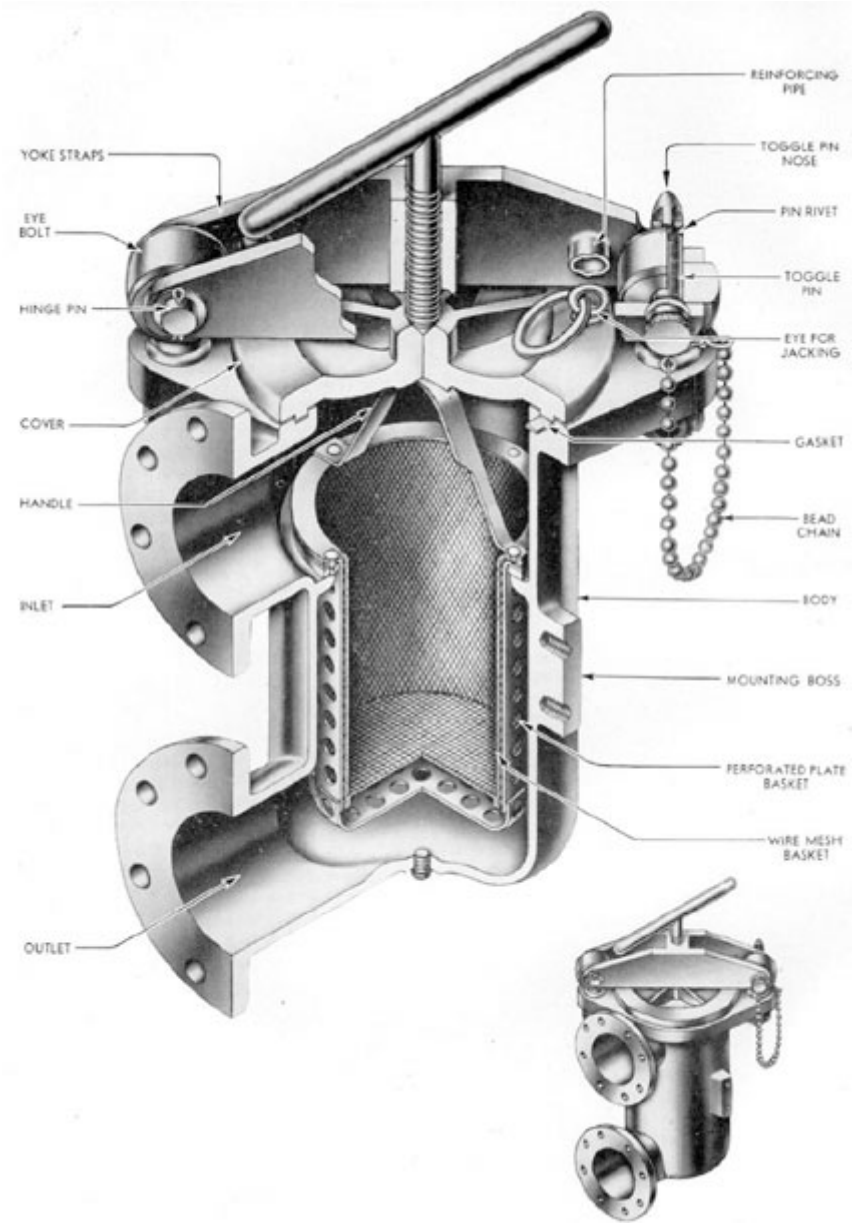

Figure 3-6. Malcomb strainer.

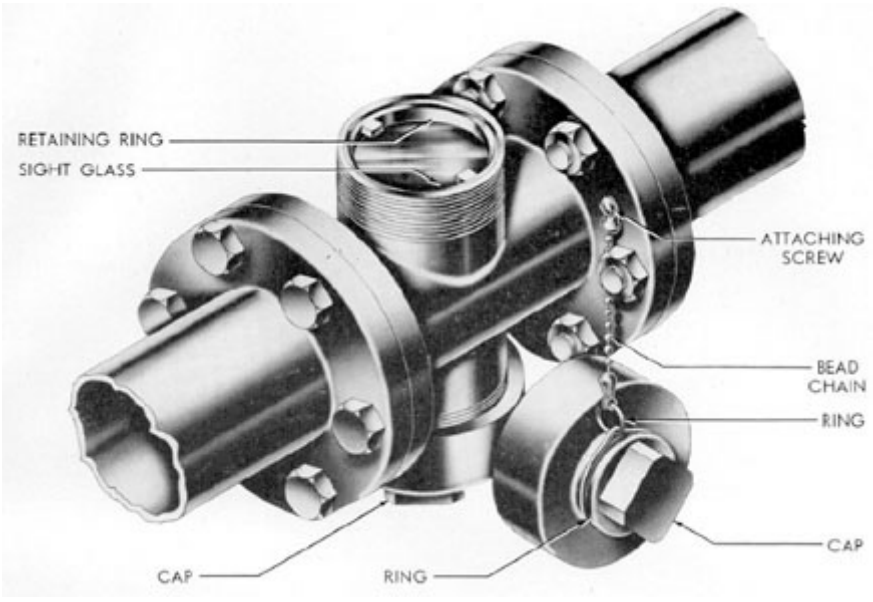

Figure 3-7. Drain line sight glass.

the hinged covers may be The wire mesh basket permits

opened by slipping off the holding spring.

3C4. Macomb strainer.
Although the bilge strainers will prevent pieces of solid material larger than a half-inch from entering the drain system, it is necessary to screen the water again to remove any smaller particles of debris that might clog or damage the drain pump. Such material is filtered out of the drain system by the Macomb strainers.

Figure 3-6 illustrates the construction of a typical Macomb strainer. The shape of the body and the position of the inlet and outlet ports vary somewhat in individual cases to suit conditions of space or use.

The strainer is connected into the drain suction line in such a manner that bilge water flowing therein will enter the inlet port and pass through the wire mesh basket before leaving by the outlet port to continue on to the drain pump.

water to flow freely from inlet to outlet but traps and retains all solid matter larger than the holes in the wire mesh. The perforated plate basket serves to support and protect the wire mesh basket to which it is attached. The entire basket assembly can be removed for cleaning. The basket handle is used both for lifting and for holding the basket securely in place against the shoulder inside the body.

To clean the strainer, it is necessary to loosen the handle bolt, withdraw the self-locking toggle pin, and swing back the hinged yoke. The cover can then be lifted off using the ring provided, and the basket lifted out and cleaned. The reverse procedure is used in replacing and closing the strainer. After the yoke has been secured, the handle bolt is screwed down tightly to provide a leak-proof fit between the body and the cover. A plug is provided at the bottom of the body for draining.

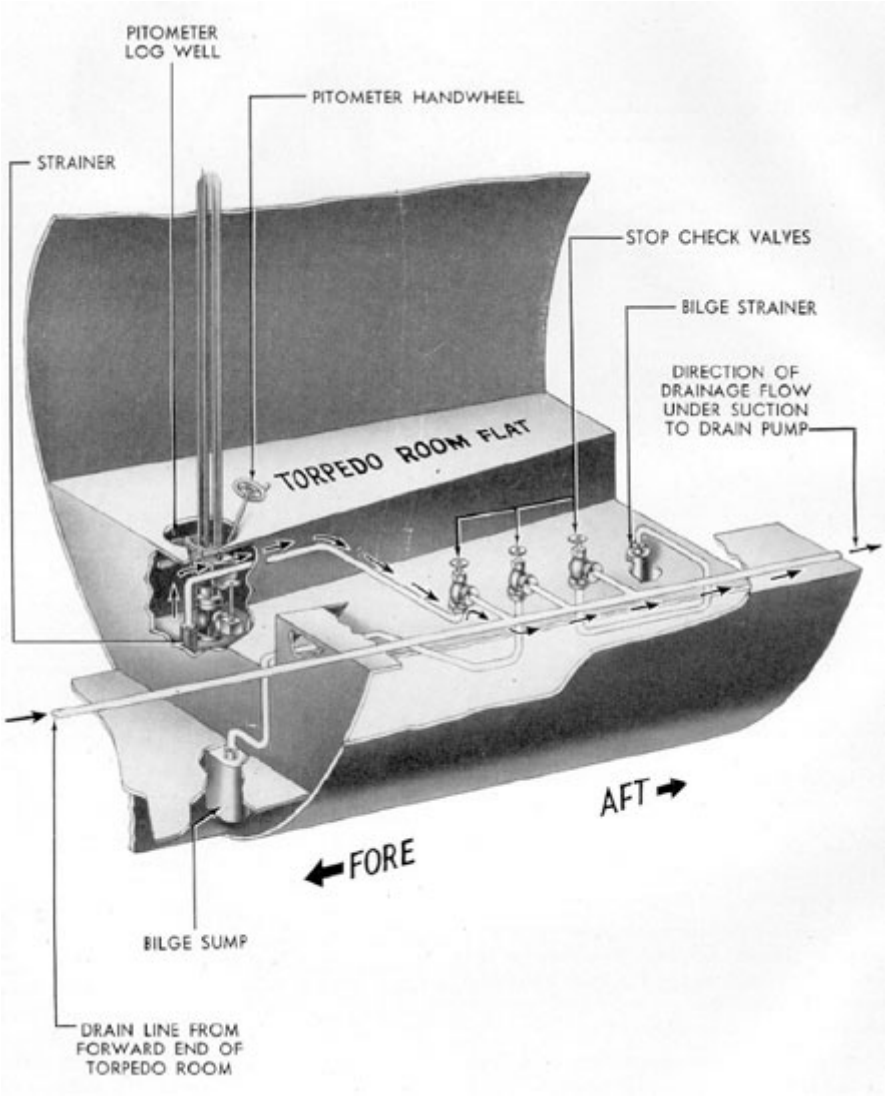

Figure 3-8. Pitometer log well suction line and sump.

There are three Macomb strainers in the drain system: one is connected into the drain pump suction line in the pump room; an other is connected into the collecting tank drain line in the after engine room; and the third is in the after torpedo room on the drain line running from the bilge to the after bilge manifold.

A fourth Macomb strainer is used in the trim system. It is located on the trim pump suction line in the pump room and is used to protect the trim pump from debris in the water ballast.

and are provided with squared heads to fit the wrench used in removing them.

In use the cap is removed and the fluid in the drain line is visible through the sight glass. If more light is needed, the cap on the other side of the drain line may be removed and an external light flashed through the fluid in the line to the sight side.

There are two drain line sight glasses, one on the suction line near the drain pump strainer in the pump room, and the other in the after engine room on the collecting tank drain line.

3C5. Drain line sight glass. The drain line sight glass (Figure 3-7) provides a means of determining visually the amount of oil or solid matter in the bilge water as it flows through the lines of the drain system. It consists of a cross-shaped casting, two ends of which are flanged and connected to the drain lines. The other arms are fitted with glass plates to allow inspection of the water in the drain line.

The glass windows are protected by caps which screw onto the body of the fitting, protecting the glass from damage. The covers are attached to the fitting by bead chains

3C6. Pitometer log well suction line and sump. The water which collects in the pitometer log well is pumped out by the pitometer log well suction line. This line extends from the main drain line and runs athwartship along the after bulkhead of the forward torpedo room to the pitometer log well.

It is equipped with a bilge strainer which is fitted into the well. A stop check valve mounted in the line between the well and the forward drain line (see Figure 3-8), is opened to pump the pitometer log well.

Figure 3-9. TRIM AND DRAIN SYSTEMS.

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Figure 3-9. TRIM AND DRAIN SYSTEMS.

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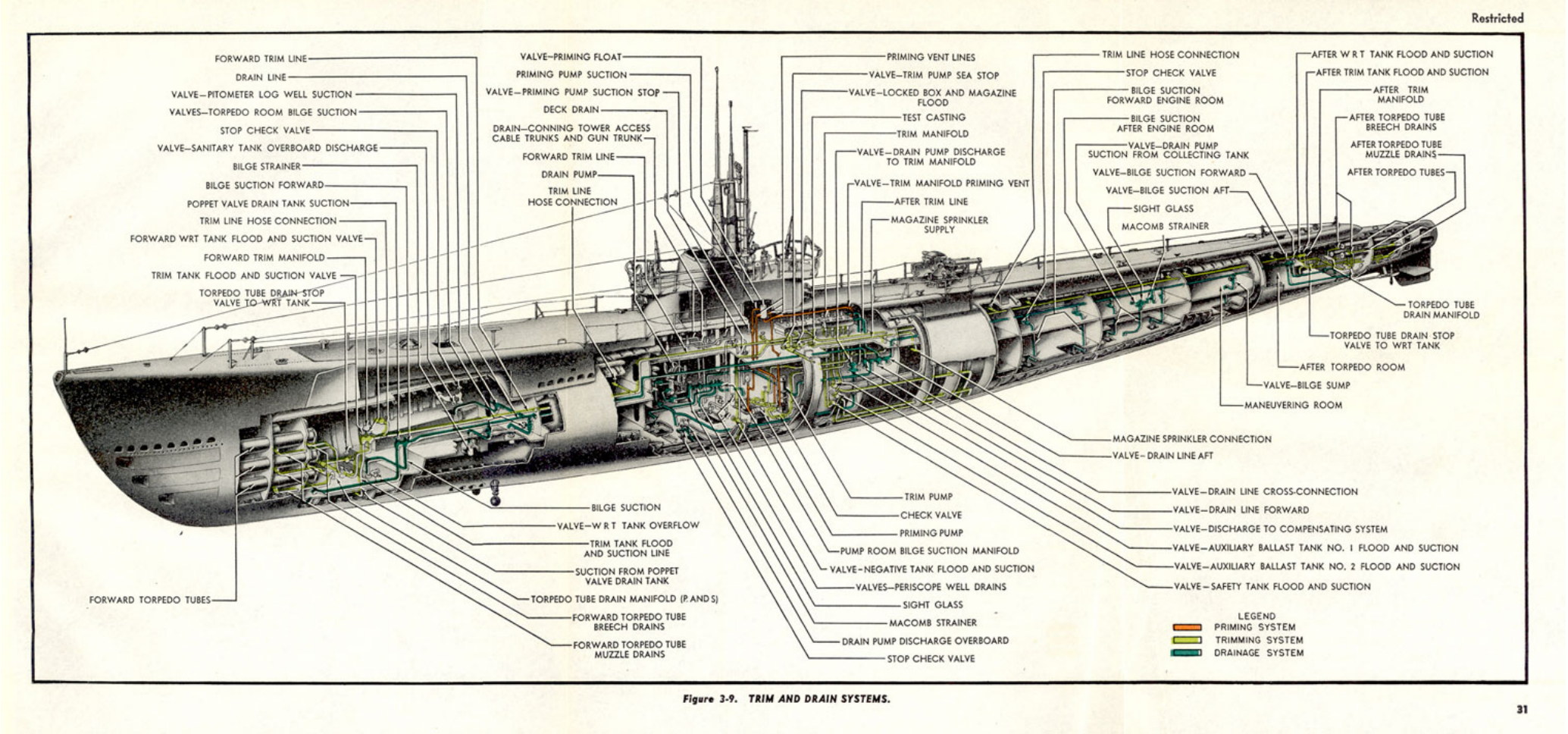

Figure 3-9. TRIM AND DRAIN SYSTEMS.

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4
TRIM OPERATIONS

(For Vessels Having a Centrifugal Trim Pump and a Priming Pump)

A. PUMP FROM FORWARD TRIM TANK TO SEA WITH TRIM PUMP

1. Open the forward trim tank flood and suction valve on the forward trim manifold, in the forward torpedo room.

2. Open the forward trim line suction valve on the trim manifold in the control room.

3. Open the trim pump suction valve on the trim manifold.

4. Open the trim pump discharge valve on the trim manifold.

5. Open the discharge to sea valve on the trim manifold.

6. Open the trim pump sea stop valve in the control room.

7. Open the forward trim tank vent valve on the 225-pound service air manifold in the control room. (When pumping to or from a tank, the tank must be vented.)

8. Open the priming pump suction stop valve at the priming float valves

9. Open the trim manifold priming vent valve leading to the priming float valve.

10. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim

12. Shut the trim manifold priming vent valve.

13. Shut the priming pump suction stop valve. (Operations 8 to 13 inclusive may be omitted if the trim system is filled with water from previous use.)

14. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain desired rate of pumping. (Effective pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

15. Stop the trim pump when the trim meter indicates that the required weight of water has been discharged.

16. Shut the trim pump suction valve on the trim manifold.

17. Shut the trim pump discharge valve on the trim manifold.

18. Shut the discharge to sea valve on the trim manifold.

19. Shut the trim pump sea stop valve.

pump is not fully primed since this vacuum reading indicates the float valve is not filled with water. (The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

11. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

20. Shut the forward trim line suction valve on the trim manifold.

21. Shut the forward trim tank flood and suction valve on the forward trim manifold, in the forward torpedo room.

22. Shut the forward trim tank vent valve on the 225-pound service air manifold.

Figure 4-1. PUMP FROM THE FORWARD TRIM TANK TO SEA WITH THE TRIM PUMP.

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B. PUMP FROM AFTER TRIM TANK TO FORWARD TRIM TANK WITH TRIM PUMP

1. Open the after trim tank flood and suction valve on the after trim manifold, in the after torpedo room.

2. Open the after trim line suction valve on the trim manifold in the control room.

3. Open the trim pump suction valve on the trim manifold.

4. Open the trim pump discharge valve on the trim manifold.

5. Open the forward trim line discharge valve on the trim manifold.

6. Open the forward trim tank flood and suction valve on the forward trim manifold, in the forward torpedo room.

7. Open the after trim tank vent valve on the 225-pound service air manifold in the control room.

13. Shut the trim manifold priming vent valve.

14. Shut the priming pump suction stop valve. (Operations 9 to 14 inclusive may be omitted if the trim system is filled with water from previous use.)

15. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain desired rate of pumping. (Effective pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

16. Stop the trim pump when the trim meter indicates that the required weight of water has been discharged.

8. Open the forward trim tank vent valve on the 225-pound service air manifold. (When pumping to or from a tank, the tank must be vented.)

9. Open the priming pump suction stop valve at the priming float valve.

10. Open the trim manifold priming vent valve leading to the priming float valve.

11. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim pump is not fully primed since this vacuum reading indicates the float valve is not filled with water. (The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

12. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

17. Shut the trim pump suction valve on the trim manifold.

18. Shut the trim pump discharge valve on the trim manifold.

19. Shut the forward trim line discharge valve on the trim manifold.

20. Shut the forward trim tank flood and suction valve on the forward trim manifold in the forward torpedo room.

21. Shut the after trim line suction valve on the trim manifold.

22. Shut the after trim tank flood and suction valve on the after trim manifold, in the after torpedo room.

23. Shut the forward trim tank vent valve on the 225-pound service air manifold.

24. Shut the after trim tank valve on the 225-pound service air manifold.

Figure 4-2. PUMP FROM THE AFTER TRIM TANK TO THE FORWARD TRIM TANK WITH THE TRIM PUMP

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C. PUMP FROM FORWARD WRT TANK TO SEA WITH TRIM PUMP

1. Open the forward torpedo tube drain stop valve to the WRT tank in the forward torpedo room.

2. Open the WRT tank flood and suction valve on the forward trim manifold, in the forward torpedo room.

14. Shut the priming pump suction stop valve. (Operations 9 to 14 inclusive may be omitted if the trim system is filled with water from previous use.)

15. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain

3. Open the forward trim line suction valve on the trim manifold.

4. Open the trim pump suction valve on the trim manifold.

5. Open the trim pump discharge valve on the trim manifold.

6. Open the discharge to sea valve on the trim manifold.

7. Open the trim pump sea stop valve.

8. Open the WRT tank vent valve on the forward torpedo tube blow and vent manifold. (When pumping to or from a tank, the tank must be vented.)

9. Open the priming pump suction stop valve at the priming float valve.

10. Open the trim manifold priming vent valve leading to the priming float valve.

11. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim pump is not fully primed since this vacuum reading indicates the float valve is not filled with water. The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

12. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

13. Shut the trim manifold priming vent valve.

desired rate of pumping. (Effective pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

16. Stop the trim pump when the trim meter indicates that the required weight of water has been discharged.

17. Shut the trim pump suction valve on the trim manifold.

18. Shut the trim pump discharge valve on the trim manifold.

19. Shut the discharge to sea valve on the trim manifold.

20. Shut the trim pump sea stop valve.

21. Shut the forward trim line suction valve on the manifold.

22. Shut the WRT tank flood and suction valve on the forward trim manifold, in the forward torpedo room.

23. Shut the forward torpedo tube drain stop valve to the WRT tank in the forward torpedo room.

24. Shut the WRT tank vent valve on the forward torpedo tube blow and vent manifold, in the forward torpedo room.

Figure 4-3. PUMP FROM FORWARD WRT TANK TO SEA WITH TRIM PUMP.

D. PUMP FROM AUXILIARY BALLAST TANK NO. 1 TO FORWARD TRIM TANK WITH TRIM PUMP

1. Open the auxiliary ballast tank No. 1 flood and suction valve in the pump room.

2. Open the auxiliary ballast tank No. 1 suction valve on the trim manifold in the control room.

3. Open the trim pump suction valve on the trim manifold.

4. Open the trim pump discharge valve on the trim manifold.

5. Open the forward trim line discharge valve on the trim manifold.

6. Open the forward trim tank flood and suction valve on the forward trim manifold in the forward torpedo room.

7. Open the auxiliary ballast tank No. 1 blow and vent stop valve at the starboard side of the crew's mess room.

8. Open the auxiliary ballast tank No. 1 vent valve on the 225-pound service air manifold in the control room.

9. Open the forward trim tank vent valve on the 225-pound service air manifold. (When pumping to or from a tank, the tank must be vented.)

10. Open the priming pump suction stop valve at the priming float valve.

14. Shut the trim manifold priming vent valve.

15. Shut the priming pump suction stop valve. (Operations 10 to 15 inclusive may be omitted if the trim system is filled with water from previous use.)

16. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain desired rate of pumping. (Effective pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

17. Stop the trim pump when the trim meter indicates that the required weight of water has been discharged.

18. Shut the trim pump suction valve on the trim manifold.

19. Shut the trim pump discharge valve on the trim manifold.

20. Shut the forward trim line discharge valve on the trim manifold in the control room.

21. Shut the forward trim tank flood and suction valve on the forward trim manifold, in the forward torpedo room.

11. Open the trim manifold priming vent valve leading to the priming float valve.

12. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim pump is not fully primed since this vacuum reading indicates the float valve is not filled with water. (The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

13. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

22. Shut the auxiliary ballast tank No. 1 suction valve on the trim manifold.

23. Shut the auxiliary ballast tank No. 1 flood and suction valve in the pump room.

24. Shut the forward trim tank vent valve on the 225-pound service air manifold.

25. Shut the auxiliary ballast tank No. 1 vent valve on the 225-pound service air manifold.

26. Shut the auxiliary ballast tank No. 1 blow and vent stop valve.

Figure 4-4. PUMP FROM AUXILIARY BALLAST TANK NO. 1 TO FORWARD TRIM TANK WITH TRIM PUMP.

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E. PUMP FROM SAFETY TANK TO SEA WITH TRIM PUMP

1. Open the safety tank flood and suction valve in the pump room. 2. Open the safety tank suction valve on the trim manifold in the control room.

3. Open the trim pump suction valve on the trim manifold.

4. Open the trim pump discharge valve on the trim manifold.

5. Open the discharge to sea valve on the trim manifold.

6. Open the trim pump sea stop valve in the control room.

7. Vent the safety tank outboard at the hydraulic vent manifold.

14. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain desired rate of pumping. (Effective pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

15. Stop the trim pump when the trim meter indicates that the required weight of water has been discharged.

(See note below.) (When pumping to or from a tank, the tank must be vented.)

8. Open the priming pump suction stop valve leading to the priming float valve.

9. Open the trim manifold priming vent valve leading to the priming float valve.

10. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim pump is not fully primed since this vacuum reading indicates the float valve is not filled with water. (The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

11. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

12. Shut the trim manifold priming vent valve.

13. Shut the priming pump suction stop valve. (Operations 8 to 13 inclusive may be omitted if the trim system is filled with water from previous use.)

16. Shut the trim pump suction valve on the trim manifold.

17. Shut the trim pump discharge valve on the trim manifold.

18. Shut the discharge to sea valve on the trim manifold.

19. Shut the trim pump sea stop valve in the control room.

20. Shut the safety tank suction valve on the trim manifold.

21. Shut the safety tank flood and suction valve in the pump room.

22. Shut the safety tank vent at the hydraulic vent manifold.

NOTE: Since the safety tank is being vented outboard, this operation is possible only while the submarine is on the surface. If the safety tank is vented inboard, pumping may be done while submerged.

Figure 4-5. PUMP FROM SAFETY TANK TO SEA WITH TRIM PUMP.

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F. PUMP FROM NEGATIVE TANK TO SEA WITH TRIM PUMP

1. Open the negative tank flood and suction valve in the pump room.

13. Shut the trim manifold priming vent valve.

2. Open the negative tank suction valve on the trim manifold in the control room.

3. Open the trim pump suction valve on the trim manifold.

4. Open the trim pump discharge valve on the trim manifold.

5. Open the discharge to sea valve on the trim manifold.

6. Open the trim pump sea stop valve in the control room.

7. Open the negative tank vent stop valves in the pump room. (When pumping to or from a tank, the tank must be vented. Negative tank vents inboard only.)

8. Open the negative tank vent valve at the forward port corner of the control room.

9. Open the priming pump suction stop valve at the priming float valve.

10. Open the trim manifold priming vent valve leading to the priming float valve.

11. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim pump is not fully primed since this vacuum reading indicates the float valve is not filled with water. (The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

12. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

14. Shut the priming pump suction stop valve. (Operations 9 to 14 inclusive may be omitted if the tram system is filled with water from previous use.)

15. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain desired rate of pumping. (Effective pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

16. Stop the trim pump when the trim meter indicates that the required weight of water has been discharged.

17. Shut the trim pump suction valve on the trim manifold.

18. Shut the trim pump discharge valve on the trim manifold.

19. Shut the discharge to sea valve on the trim manifold.

20. Shut the trim pump sea stop valve in the control room.

21. Shut the negative tank suction valve on the trim manifold.

22. Shut the negative tank flood and suction valve in the pump room.

23. Shut the negative tank vent valve in the control room.

24. Shut the negative tank vent stop valves in the pump room.

Figure 4-6. PUMP FROM NEGATIVE TANK TO SEA WITH TRIM PUMP.

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G. PUMP FROM NEGATIVE TANK TO AUXILIARY BALLAST TANK NO. 2 WITH TRIM PUMP

1. Open the negative tank flood and suction valve in the pump room.

2. Open the negative tank suction valve on the trim manifold in the control room.

3. Open the trim pump suction valve on the trim manifold.

4. Open the trim pump discharge valve on the trim manifold.

5. Open the auxiliary ballast tank No. 2 discharge valve on the trim manifold.

6. Open the auxiliary ballast tank No. 2 flood and suction valve in the pump room.

7. Open both negative tank vent stop valves in the pump room.

8. Open the auxiliary ballast tank No. 2 blow and vent stop valve at the port side of the crew's mess room.

9. Open the negative tank vent valve at the forward port corner of the control room.

10. Open the auxiliary ballast tank No. 2 vent valve on the 225-pound service air manifold. (When pumping to or from a tank, the tank must be vented.)

11. Open the priming pump suction stop valve at the priming

16. Shut the priming pump suction stop valve. (Operations 11 to 16 inclusive may be omitted if the trim system is filled with water from previous use.)

17. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain desired rate of pumping. (Effective pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

18. Stop the trim pump when the trim meter indicates that the required weight of water has been discharged.

19. Shut the trim pump suction valve on the trim manifold.

20. Shut the trim pump discharge valve on the trim manifold.

21. Shut the auxiliary ballast tank No. 2 discharge valve on the trim manifold.

22. Shut the auxiliary ballast tank No. 2 flood and suction valve in the pump room.

23. Shut the negative tank suction valve on the trim manifold.

float valve.

12. Open the trim manifold priming vent valve leading to the priming float valve.

13. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim pump is not fully primed since this vacuum reading indicates the float valve is not filled with water. (The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

14. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

15. Shut the trim manifold priming vent valve.

24. Shut the negative tank flood and suction valve in the pump room.

25. Shut the negative tank vent stop valves in the pump room.

26. Shut the auxiliary ballast tank No. 2 blow and vent stop valve in the crew's mess. room.

27. Shut the auxiliary ballast tank No. 2 vent stop valve on the 225-pound service air manifold.

28. Shut the negative tank vent valve in the port corner of the control room.

Figure 4-7. PUMP FROM NEGATIVE TANK TO AUXILIARY BALLAST TANK NO. 2 WITH TRIM PUMP.

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H. PUMP FROM SEA TO HOSE CONNECTION IN FORWARD ENGINE ROOM WITH DRAIN PUMP

1. Remove the cap from and connect a hose to the trim line hose connection in the forward engine room.

2. Open the trim pump sea stop valve in the control room.

3. Open the sea suction valve on the trim manifold.

4. Open the after trim line discharge valve on the trim manifold.

When both lights are ON, the water level is too high. Admit additional air into the air chambers by means of the 225-pound air connection to the drain pump.

When both lights are OUT, the water level is too low. Expel some air from the air chambers by means of the vent valve on the drain pump.

11. Stop the drain pump when water is no longer required at the

5. Open the drain pump cross connection valve.

6. Open the drain pump suction valve.

7. Open the drain pump discharge valve to the trim manifold.

8. Open the trim line hose connection valve in the forward engine room.

9. Start the drain pump.

10. Observe the drain pump indicator lamps to determine whether the water in the drain pump air chambers is at the proper level (see Sections 3B2 and 3BS).

The water is at the proper level when only the lower light marked DRAIN PUMP LOW is ON.

hose.

12. Shut the sea suction valve on the trim manifold.

13. Shut the trim pump sea stop valve in the control room.

14. Shut the trim line hose connection valve.

15. Remove the hose from the trim line hose connection and replace the cap.

16. Shut the drain pump discharge valve to the trim manifold.

17. Shut the drain pump suction valve.

18. Shut the drain pump cross connection valve.

19. Shut the after trim line discharge valve on the trim manifold.

Figure 4-8. PUMP FROM SEA TO HOSE CONNECTION IN FORWARD ENGINE ROOM WITH DRAIN PUMP.

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I. PUMP FROM NO. 1 TO NO. 2 AUXILIARY BALLAST TANK WITH TRIM PUMP

1. Open the auxiliary ballast tank No. 1 flood and suction valve in the pump room.

2. Open the auxiliary ballast tank No. 1 suction valve on the trim manifold in the control room.

3. Open the trim pump suction valve on the trim manifold.

16. Shut the priming pump suction stop valve. (Operations 11 to 16 inclusive may be omitted if the trim system is filled with water from previous use.)

17. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain desired rate of pumping. (Effective

4. Open the trim pump discharge valve on the trim manifold.

5. Open the auxiliary ballast tank No. 2 discharge valve on the trim manifold.

6. Open the auxiliary ballast tank No. 2 flood and suction valve in the pump room.

7. Open the auxiliary ballast tank No. 1 blow and vent stop valve at the starboard side of the crew's mess room.

8. Open the auxiliary ballast tank No. 2 blow and vent stop valve at the port side of the crew's mess room.

9. Open the auxiliary ballast tank No. 1 vent valve on the 225-pound service air manifold.

10. Open the auxiliary ballast tank No. 2 vent valve on the 225-pound service air manifold. (When pumping to or from a tank, the tank must be vented.)

11. Open the priming pump suction stop valve at the priming float valve.

12. Open the trim manifold priming vent valve leading to the priming float valve.

13. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim pump is not fully primed since this vacuum reading indicates the float valve is not filled with water. (The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

18. Stop the trim pump when the trim meter indicates that the required weight of water has been discharged.

19. Shut the trim pump suction valve on the trim manifold.

20. Shut the trim pump discharge valve on the trim manifold.

21. Shut the auxiliary ballast tank No. 2 discharge valve on the trim manifold.

22. Shut the auxiliary ballast tank No. 1 suction valve on the trim manifold.

23. Shut the auxiliary ballast tank No. 2 flood and suction valve in the pump room.

24. Shut the auxiliary ballast tank No. 1 flood and suction valve in the pump room.

25. Shut the auxiliary ballast tank No. 2 vent valve on the 225-pound service air manifold.

26. Shut the auxiliary ballast tank No.1 vent valve on the 225-pound service air manifold. 27. Shut the auxiliary ballast tank No. 2 blow and vent stop valve on the port side of the crew's mess room.

28. Shut the auxiliary ballast tank No. 1 blow and vent stop valve on the starboard side of the crew's mess room.

14. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

15. Shut the trim manifold priming vent valve.

Figure 4-9. PUMP FROM NO. 1 TO NO. 2 AUXILIARY BALLAST TANK WITH TRIM PUMP.

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Figure 4-1. PUMP FROM THE FORWARD TRIM TANK TO SEA WITH THE TRIM PUMP.

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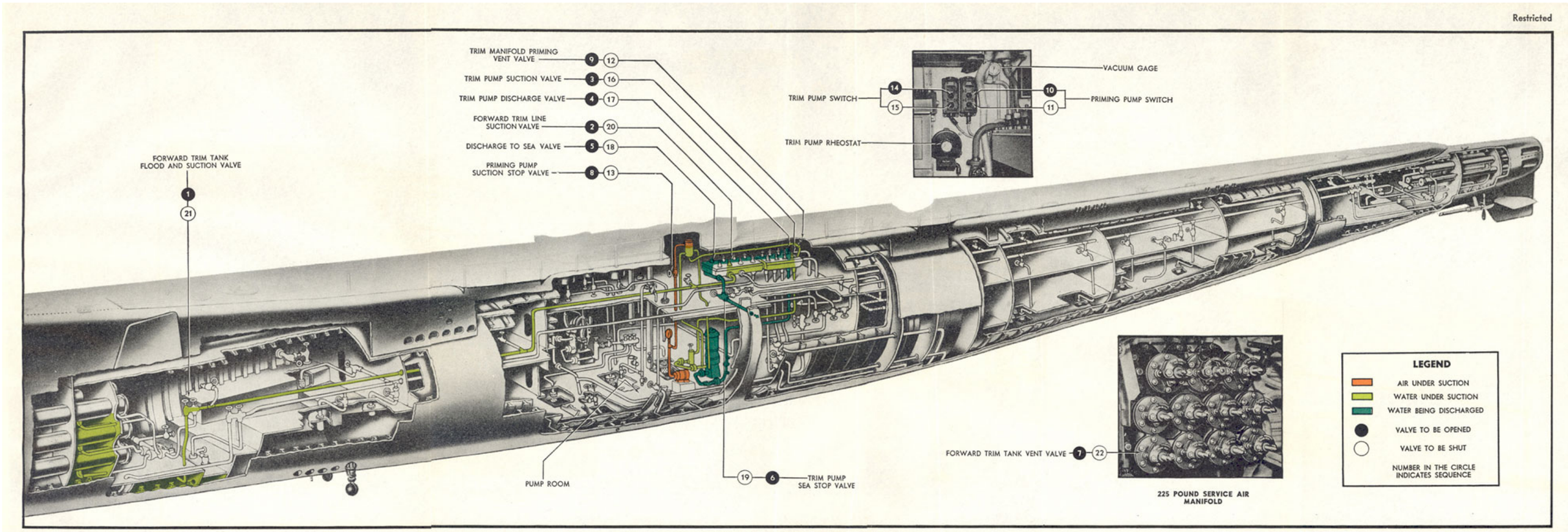

Figure 4-1. PUMP FROM THE FORWARD TRIM TANK TO SEA WITH THE TRIM PUMP.

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Figure 4-2. PUMP FROM THE AFTER TRIM TANK TO THE FORWARD TRIM TANK WITH THE TRIM PUMP.

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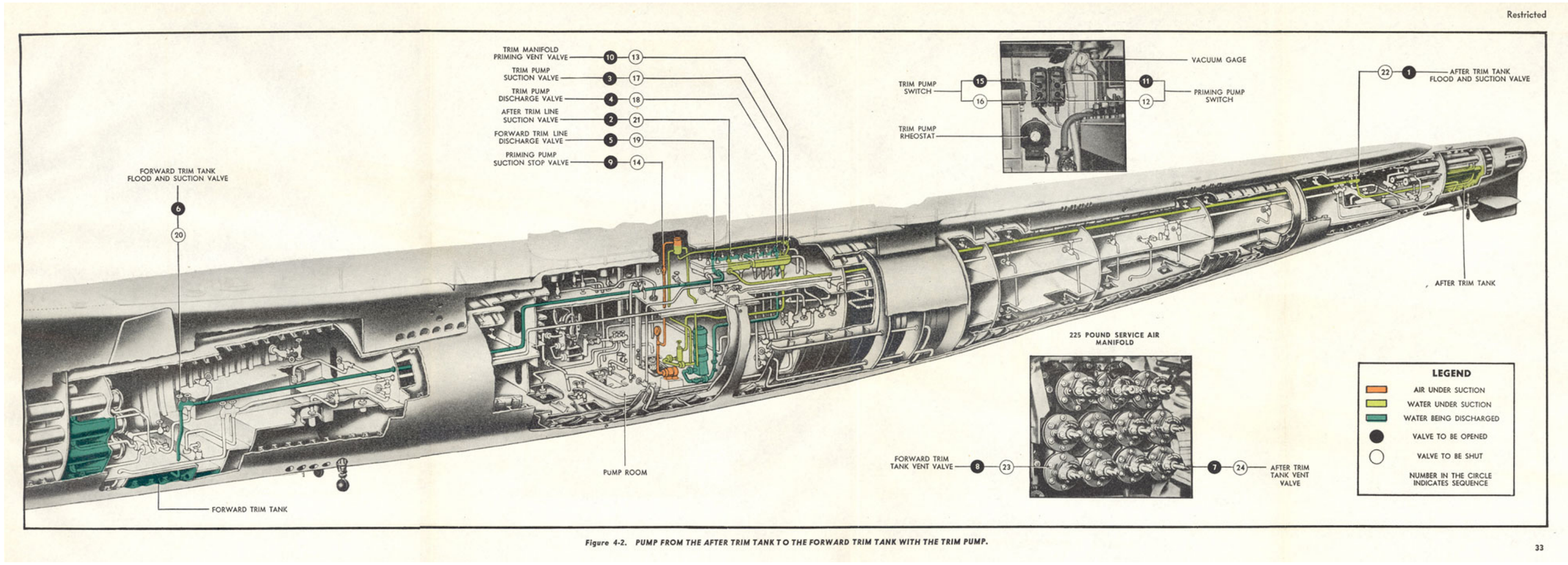

Figure 4-2. PUMP FROM THE AFTER TRIM TANK TO THE FORWARD TRIM TANK WITH THE TRIM PUMP.

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Figure 4-3. PUMP FROM FORWARD WRT TANK TO SEA WITH TRIM PUMP.

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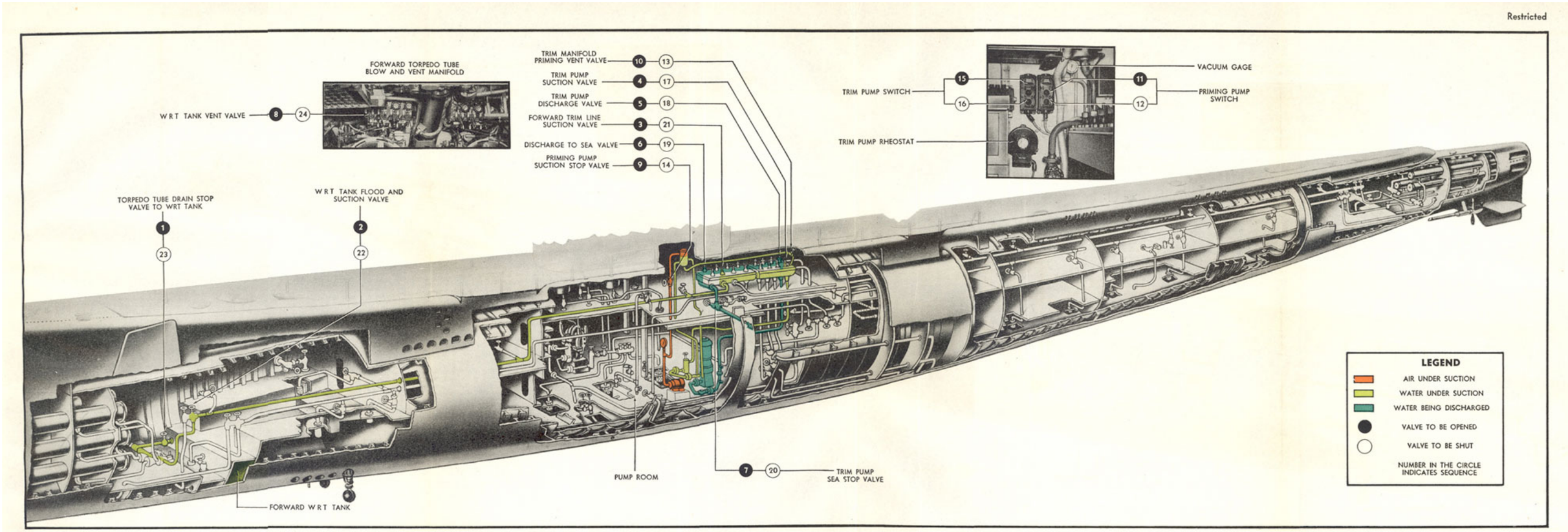

Figure 4-3. PUMP FROM THE FORWARD WRT TANK TO SEA WITH THE TRIM PUMP.

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Figure 4-4. PUMP FROM AUXILIARY BALLAST TANK NO. 1 TO FORWARD TRIM TANK WITH TRIM PUMP.

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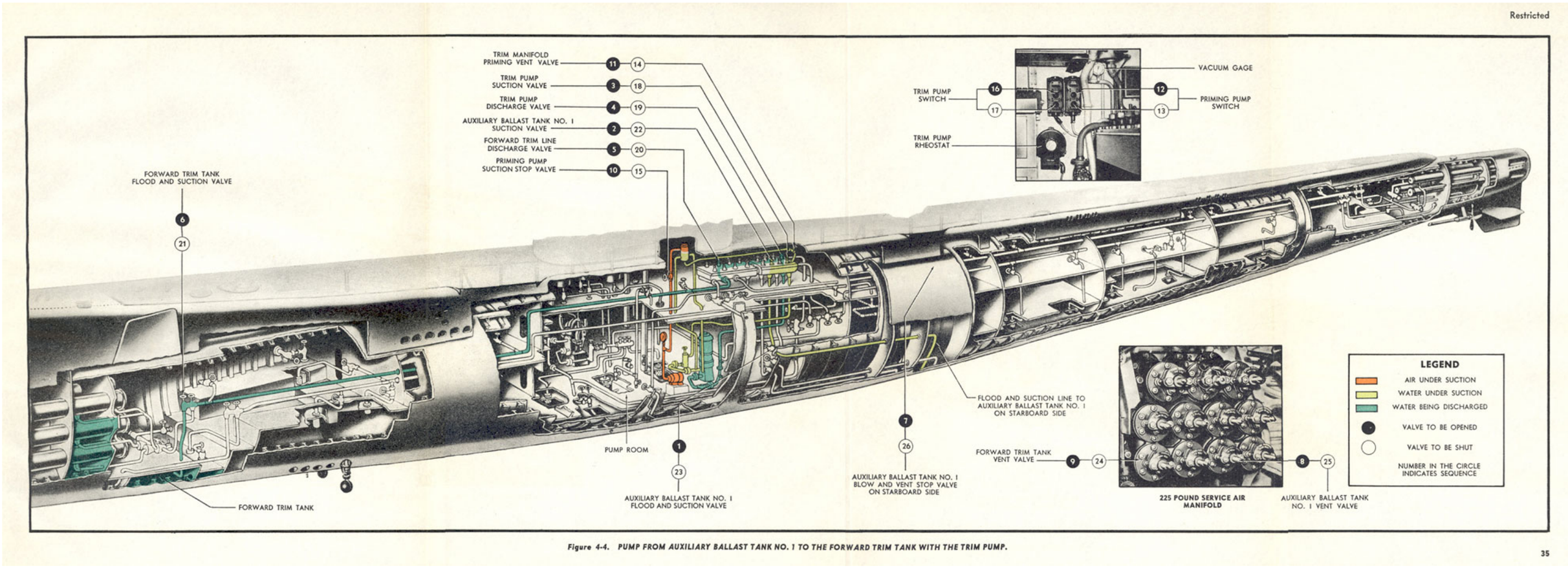

Figure 4-4. PUMP FROM AUXILIARY BALLAST TANK NO. 1 TO THE FORWARD TRIM TANK WITH THE TRIM PUMP.

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Figure 4-5. PUMP FROM SAFETY TANK TO SEA WITH TRIM PUMP.

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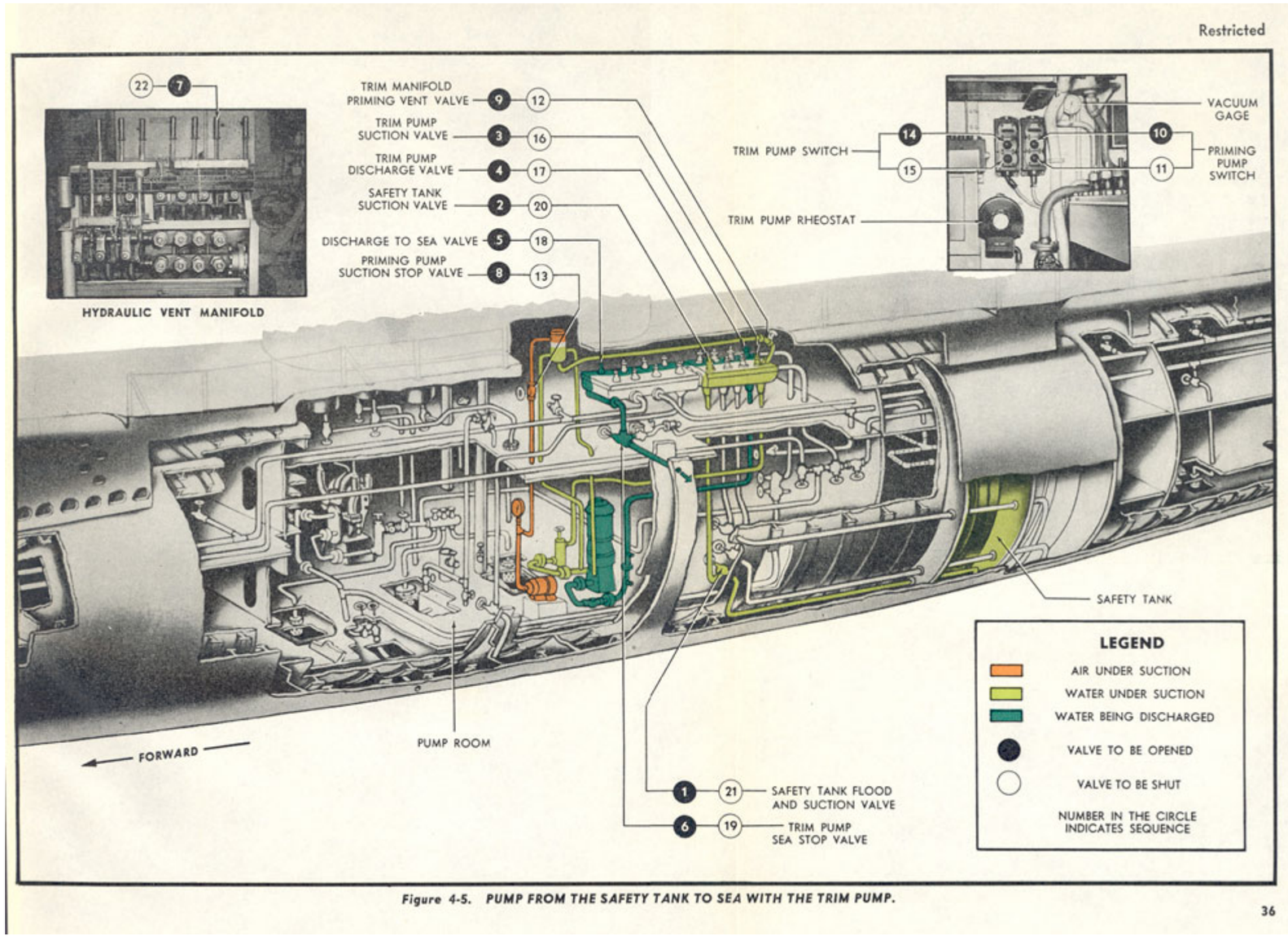

Figure 4-5. PUMP FROM THE SAFETY TANK TO SEA WITH THE TRIM PUMP.

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Figure 4-6. PUMP FROM NEGATIVE TANK TO SEA WITH TRIM PUMP.

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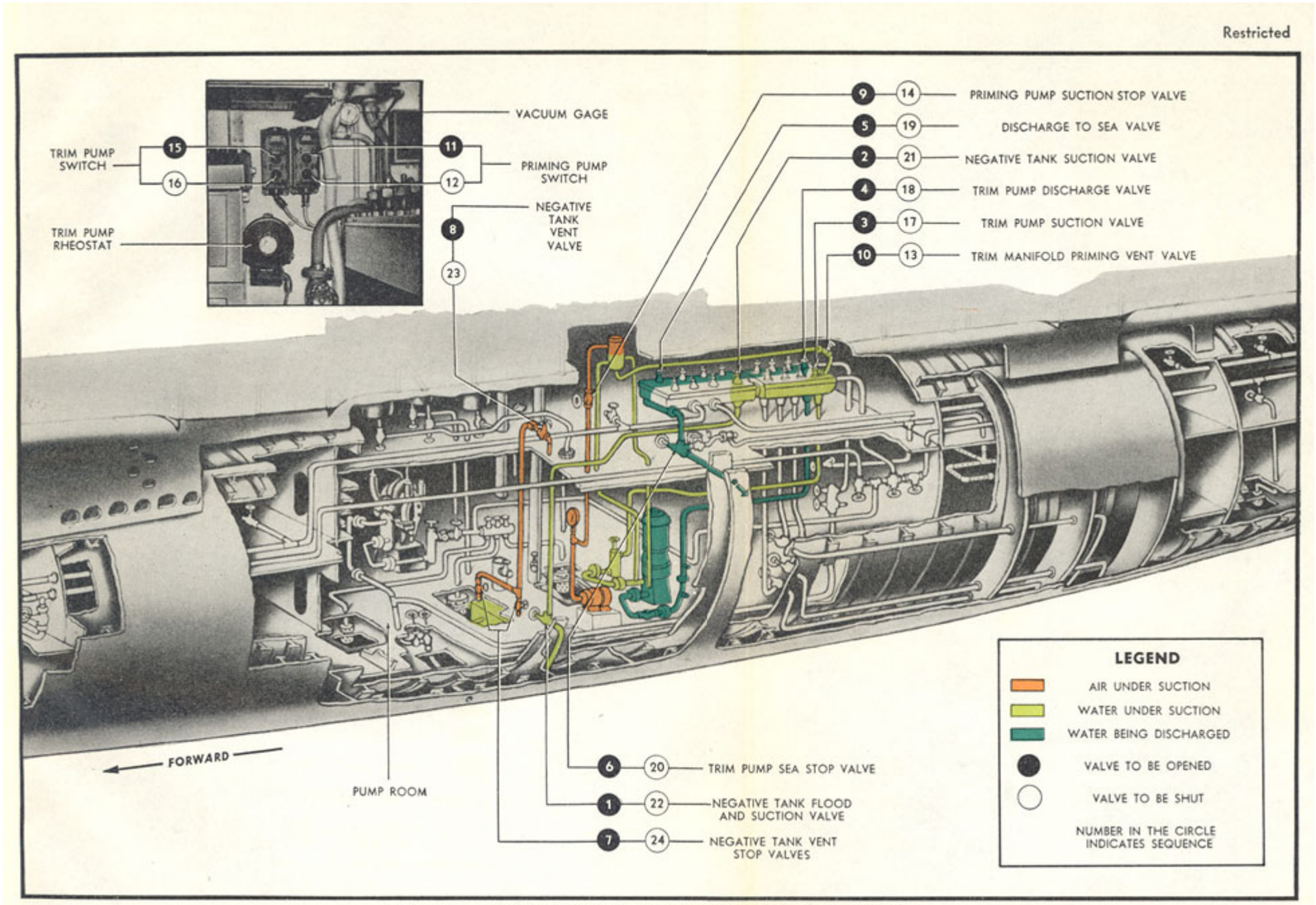

Figure 4-6. PUMP FROM THE NEGATIVE TANK TO SEA WITH THE TRIM PUMP.

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Figure 4-7. PUMP FROM NEGATIVE TANK TO AUXILIARY BALLAST TANK NO. 2 WITH TRIM PUMP.

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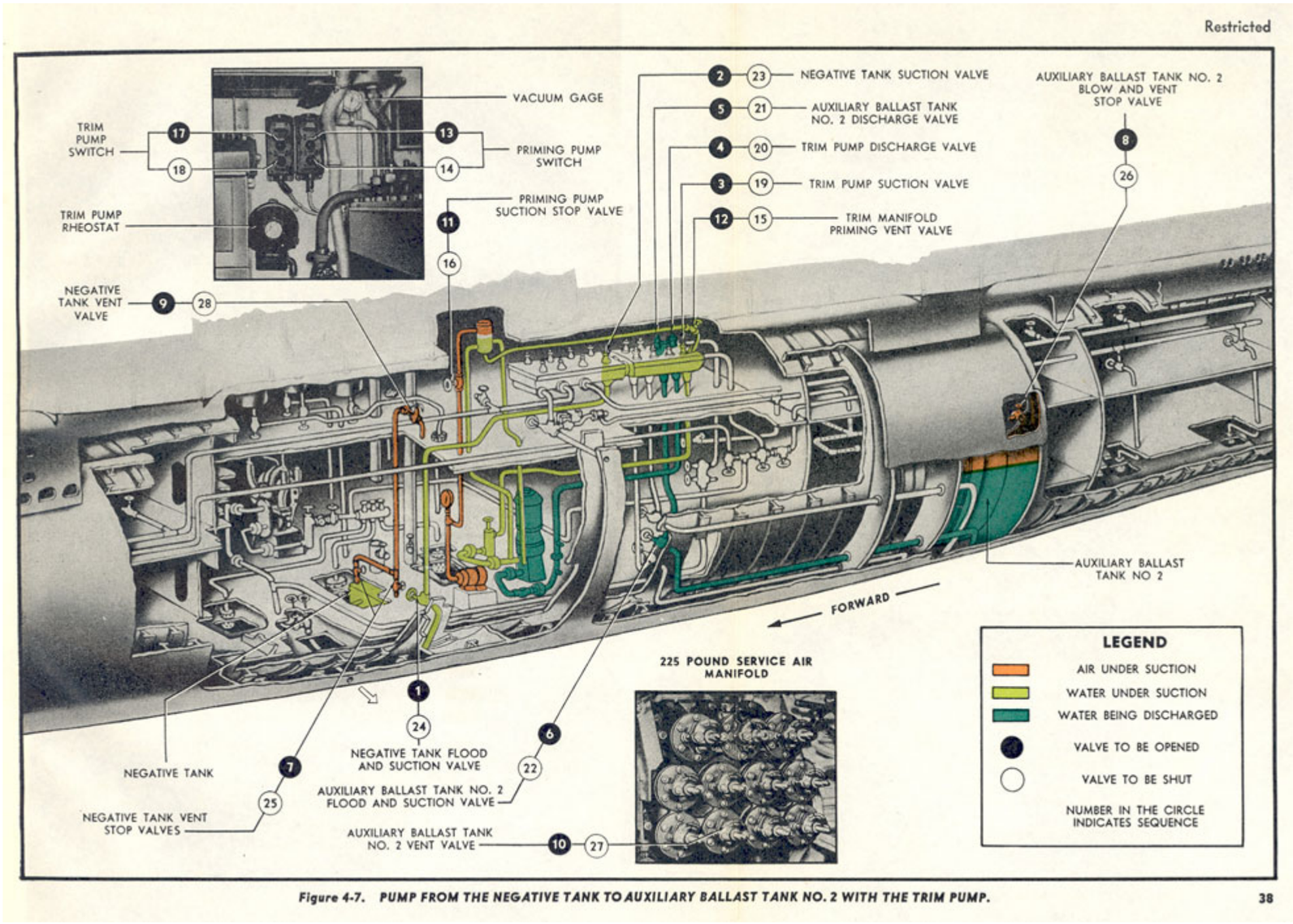

Figure 4-8. PUMP FROM SEA TO HOSE CONNECTION IN FORWARD ENGINE ROOM WITH DRAIN PUMP.

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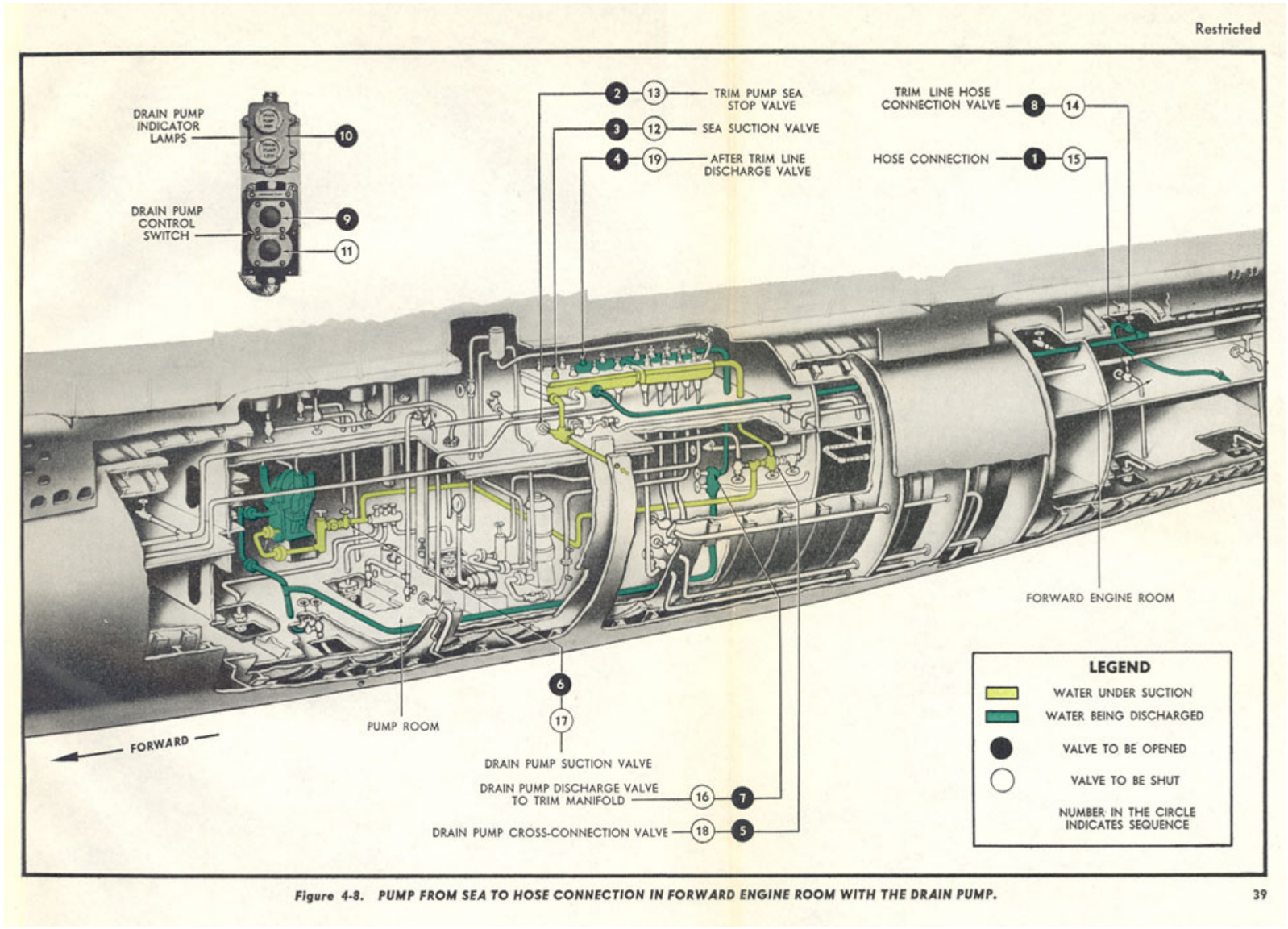

Figure 4-8. PUMP FROM SEA TO HOSE CONNECTION IN FORWARD ENGINE ROOM WITH THE DRAIN PUMP. 39

Figure 4-9. PUMP FROM NO. 1 TO NO. 2 AUXILIARY BALLAST TANK WITH TRIM PUMP.

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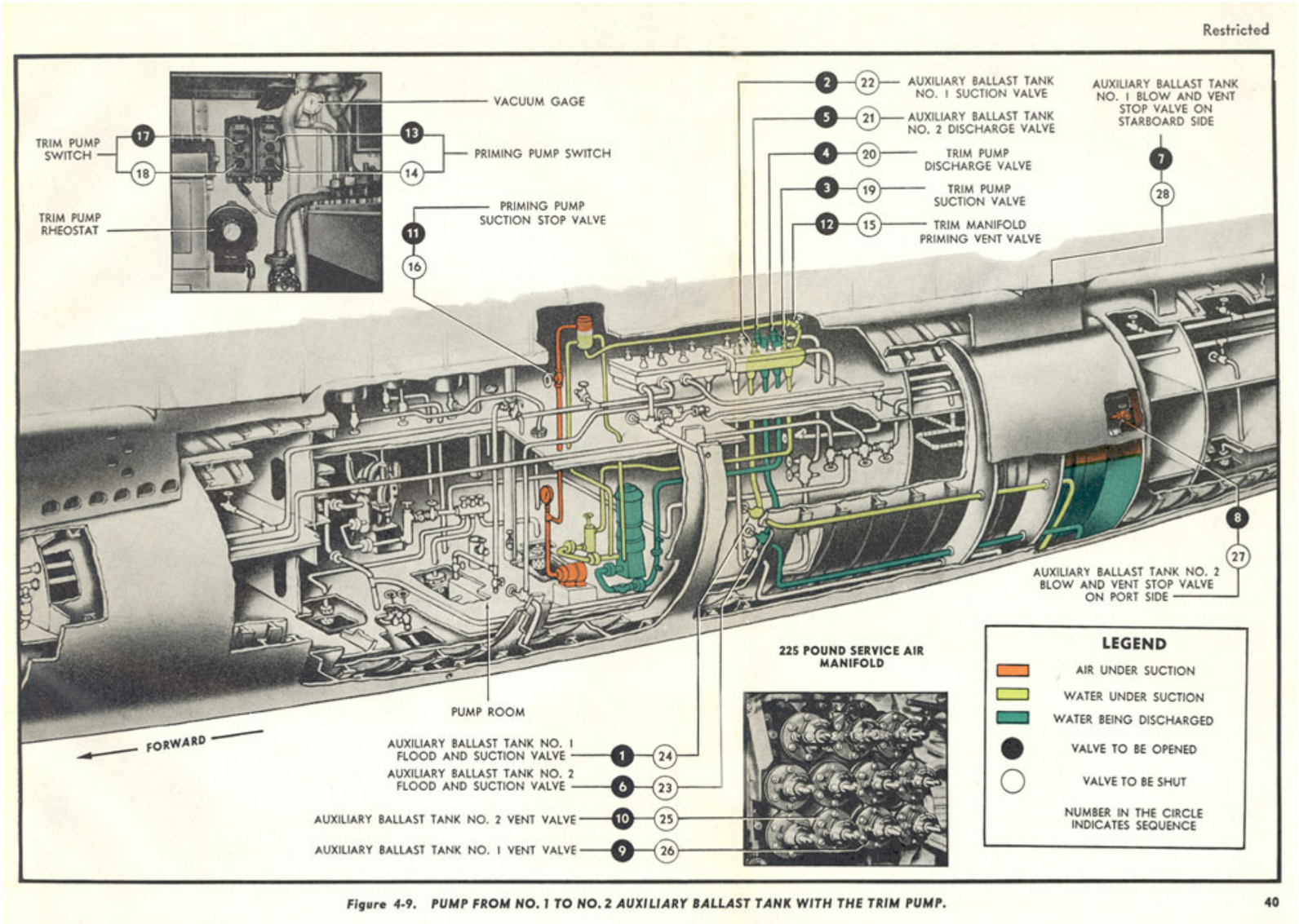

Figure 4-9. PUMP FROM NO. 1 TO NO. 2 AUXILIARY BALLAST TANK WITH THE TRIM PUMP. 40

5
DRAIN OPERATIONS

A. PUMP FROM FORWARD TORPEDO ROOM BILGES TO EXPANSION TANK WITH DRAIN PUMP

1. Open the forward bilge sump suction valve in the forward torpedo room.

2. Open the drain line forward stop valve in the pump room.

3. Open the drain pump suction valve.

4. Open the drain pump discharge valve to the compensating system. (The compensating water main leads to the top of the expansion tank through valves normally locked OPEN as shown in Figure 5-1.)

5. Start the drain pump.

6. Observe the drain pump indicator lamps to determine whether the water in the drain pump air chambers is at the proper level (see Sections 3B2 and 3B5).

The water is at the proper level when only the lower light marked DRAIN PUMP. LOW is ON.

When both lights are ON, the water level is too high. Admit additional air into the air chambers by means of the 225-pound air connection to the drain pump.

When both lights are OUT, the water level is too low. Expel some air from the air chambers by means of the vent valve on the drain pump.

7. After the forward bilge has been emptied, open the middle bilge sump suction valve at the after end of the torpedo room.

8. Shut the forward bilge sump suction valve in the forward torpedo room.

9. After the middle bilge has been emptied, open the after bilge sump suction valve at the after end of the torpedo room.

10. Shut the middle bilge sump suction valve.

11. Stop the drain pump when the after bilge has been emptied.

12. Shut the drain pump suction valve.

13. Shut the drain pump discharge valve to the compensating system.

14. Shut the drain line forward stop valve.

15. Shut the after bilge sump suction valve at the after end of the torpedo room.

Figure 5-1. PUMP FROM FORWARD TORPEDO ROOM BILGES TO EXPANSION TANK WITH DRAIN PUMP

B. PUMP FROM PUMP ROOM BILGES TO SEA WITH DRAIN PUMP

1. Open the forward bilge sump suction valve in the pump room.

2. Open the drain pump suction valve.

3. Open the stop check valve and sea valve on the drain pump overboard discharge line.

4. Start the drain pump.

5. Observe the drain pump indicator lamps to determine whether the water in the drain pump air chambers is at the proper level (see Sections 3B2 and 3B5).

The water is at the proper level when only the lower light marked DRAIN PUMP LOW is ON.

When both lights are ON, the water level is too high. Admit additional air into the air chambers by means of the 225-pound air connection to the drain pump.

When both lights are OUT, the water level is too low. Expel some air from the air chambers by means of the vent valve on the drain pump.

6. When the forward bilge has been emptied, open the middle bilge sump suction valve in the pump room.

7. Shut the forward bilge sump suction valve.

8. When the middle bilge has been emptied, open the after bilge sump suction valve in the pump room.

9. Shut the middle bilge sump suction valve.

10. Stop the drain pump when the after bilge has been emptied.

11. Shut the drain pump suction valve.

12. Shut the stop check valve and sea valve on the drain pump overboard discharge line.

13. Shut the after bilge sump suction valve in the pump room.

Figure 5-2. PUMP FROM PUMP ROOM BILGES TO SEA WITH DRAIN PUMP.

C. PUMP FROM FORWARD TORPEDO ROOM BILGES TO SEA WITH DRAIN PUMP

1. Open the forward bilge sump suction valve in the forward torpedo room.

2. Open the drain line forward stop valve in the pump room.

3. Open the drain pump suction valve.

4. Open the stop check valve and sea valve on the drain pump overboard discharge line.

5. Start the drain pump.

6. Observe the drain pump indicator lamps to determine whether the water in the drain pump air chambers is at the proper level (see Sections 3B2 and 3B5).

The water is at the proper level when only the lower light marked DRAIN PUMP LOW is ON.

When both lights are ON, the water level is too high. Admit additional air into the air chambers by means of the 225-pound air connection to the drain pump.

When both lights are OUT, the water level is too low. Expel some air from the air chambers by means of the vent valve on the drain pump.

7. After the forward bilge has been emptied, open the middle bilge sump suction valve at the after end of the torpedo room.

8. Shut the forward bilge sump suction valve in the forward torpedo room.

9. After the middle bilge has been emptied, open the after bilge sump suction valve at the after end of the torpedo room.

10. Shut the middle bilge sump suction valve.

11. Stop the drain pump when the after bilge has been emptied.

12. Shut the drain pump suction valve.

13. Shut the stop check valve and sea valve on the drain pump overboard discharge line.

14. Shut the drain line forward stop valve.

15. Shut the after bilge sump suction valve at the after end of the torpedo room.

Figure 5-3. PUMP FROM FORWARD TORPEDO ROOM BILGES TO SEA WITH DRAIN PUMP.

D. PUMP WATER FROM COLLECTING TANK TO EXPANSION TANK WITH DRAIN PUMP

1. Unlock and open the drain pump suction valve from the collecting tank located in the after engine room. This valve normally is locked SHUT.

2. Open the drain suction stop check valve from the collecting tank.

3. Open the drain line aft stop valve in the pump room.

4. Open the drain pump suction valve.

5. Open the drain pump discharge valve to the compensating system. (The compensating water main leads to the top of the expansion tank through valves normally locked OPEN as shown in Figure 5-4.)

6. Start the drain pump.

7. Observe the drain pump indicator lamps to determine whether the water in the drain pump air chambers is at the proper level (see Sections 3B2 and 3B5).

The water is at the proper level when only the lower light marked DRAIN PUMP LOW is ON.

When both lights are ON, the water level is too high. Admit additional air into the air chambers by means of the 225-pound air connection to the drain pump.

When both lights are OUT, the water level is too low. Expel some air from the air chambers by means of the vent valve on the drain pump.

8. When the water has been transferred, stop the drain pump. When all water has been pumped out, the liquidometer gage-will show the collecting tank filled with fuel.

9. Shut the drain pump suction valve.

10. Shut the drain pump discharge valve to the compensating system.

11. Shut the drain line aft stop valve in the pump room.

12. Shut the drain suction stop check valve from the collecting tank in the after engine room.

13. Shut and lock the drain pump suction valve from the collecting tank.

Figure 5-4. PUMP WATER FROM COLLECTING TANK TO EXPANSION TANK WITH DRAIN PUMP.

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E. PUMP WATER FROM COLLECTING TANK TO EXPANSION TANK WITH TRIM PUMP

1. Unlock and open the drain pump suction valve from the collecting tank located in the after engine room. (This valve normally is locked SHUT.)

2. Open the drain suction stop check valve from the collecting tank.

3. Open the drain line aft stop valve in the pump room.

4. Open the drain pump cross connection valve.

5. Open the trim pump suction valve on the trim manifold.

6. Open the trim pump discharge valve on the trim manifold.

7. Open the drain pump discharge valve to the trim manifold.

8. Open the drain pump discharge valve to the compensating system. (The compensating water main leads to the top of the expansion tank through valves normally locked OPEN as shown in Figure 5-5.)

9. Open the priming pump suction stop valve at the priming float valve.

10. Open the trim manifold priming vent valve leading to the priming float valve.

11. Start the priming pump. Observe the priming pump vacuum gage. If the gage reads below about 20 inches, the trim pump is not fully primed since this vacuum reading indicates the float valve is not filled with

12. Stop the priming pump when the gage reads about 20 inches, indicating high vacuum.

13. Shut the trim manifold priming vent valve.

14. Shut the priming pump suction stop valve. (Operations 9 to 14 inclusive may be omitted if the trim system is filled with water from previous use.)

15. Turn the trim pump control rheostat to the slowest speed position. Start and operate the trim pump. Adjust speed to obtain desired rate of pumping. (Effective pumping is indicated by air flow which can be felt when holding the hand over the vent on the 225-pound service air manifold and a discharge reading of the trim meter which measures flow in pounds. If there is no flow, repeat priming operation.)

16. When the water has been transferred, stop the trim pump.

17. Shut the trim pump suction valve on the trim manifold.

18. Shut the trim pump discharge valve on the trim manifold.

19. Shut the drain pump discharge valve on the trim manifold.

20. Shut the drain pump discharge valve to the compensating system.

21. Shut the drain pump cross connection valve.

22. Shut the drain line aft stop valve.

water. (The sealing water tank gage must register at least two-thirds full for effective operation of the priming pump.)

23. Shut the drain suction stop check valve from the collecting tank.

24. Shut and lock the drain pump suction valve from the collecting tank.

Figure 5-5. PUMP WATER FROM COLLECTING TANK TO EXPANSION TANK WITH TRIM PUMP.

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F. PUMP FROM POPPET VALVE DRAIN TANK TO SEA WITH DRAIN PUMP

1. Open the poppet valve drain tank suction valve on the drain manifold in the forward torpedo room.

2. Open the drain line forward stop valve in the pump room.

3. Open the drain pump suction valve.

4. Open the stop check valve and sea valve on the drain pump overboard discharge line.

5. Start the drain pump.

6. Observe the drain pump indicator lamps to determine whether the water in the drain pump air chambers is at the proper level (see Sections 3B2 and 3B5).

The water is at the proper level when only the lower light marked DRAIN PUMP LOW is ON.

When both lights are ON, the water level is too high. Admit additional air into the air chambers by means of the 225-pound air connection to the drain pump.

When both lights are OUT, the water level is too low. Expel some air from the air chambers by means of the vent valve on the drain pump.

7. Stop the drain pump when the poppet valve tank has been emptied.

8. Shut the drain pump suction valve.

9. Shut the stop check valve and sea valve on the drain pump overboard discharge line.

10. Shut the drain line forward stop valve in the pump room.

11. Shut the poppet valve drain tank suction valve.

Figure 5-6. PUMP FROM POPPET VALVE DRAIN TANK TO SEA WITH DRAIN PUMP.

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Figure 5-1. PUMP FROM FORWARD TORPEDO ROOM BILGES TO EXPANSION TANK WITH DRAIN PUMP

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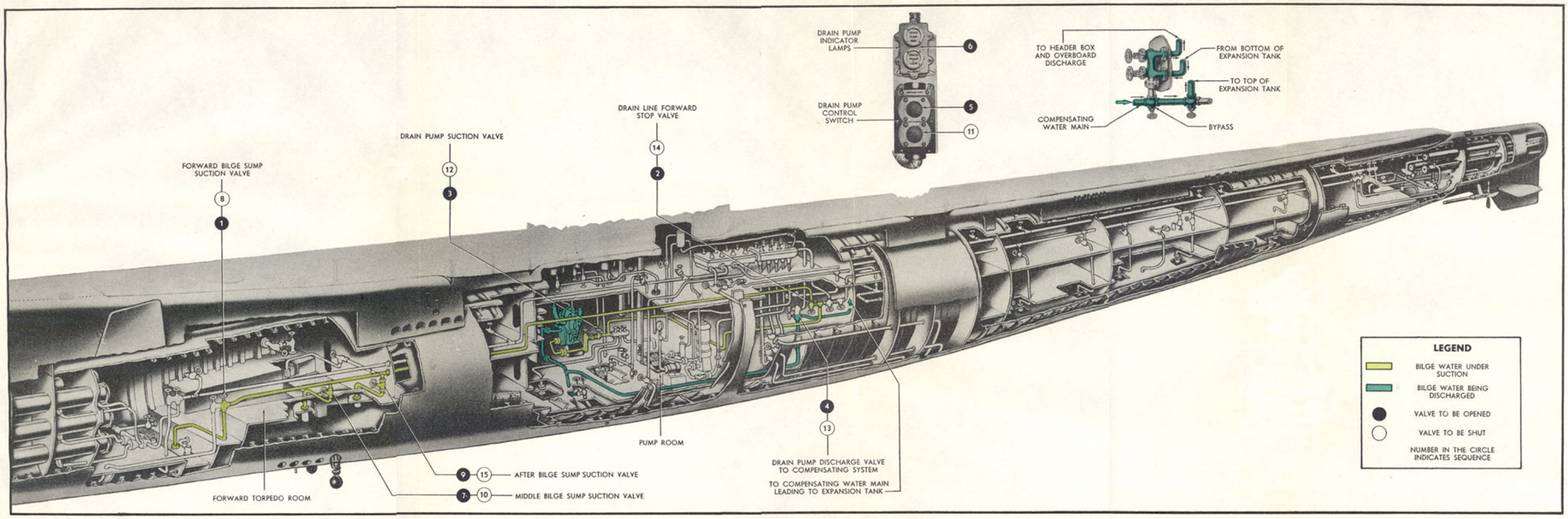

Figure 5-1. PUMP FROM THE FORWARD TORPEDO ROOM BILGES TO THE EXPANSION TANK WITH THE DRAIN PUMP.

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Figure 5-2. PUMP FROM PUMP ROOM BILGES TO SEA WITH DRAIN PUMP.

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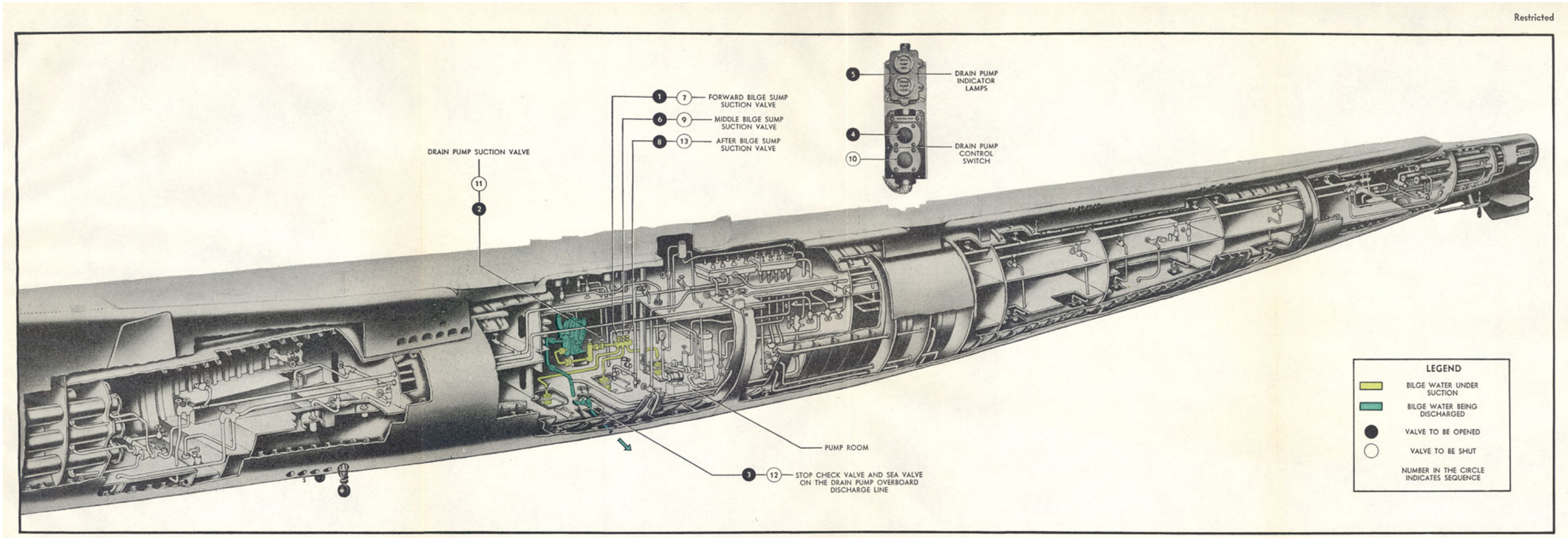

Figure 5-2. PUMP FROM THE PUMP ROOM BILGES TO SEA WITH THE DRAIN PUMP.

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Figure 5-3. PUMP FROM FORWARD TORPEDO ROOM BILGES TO SEA WITH DRAIN PUMP.

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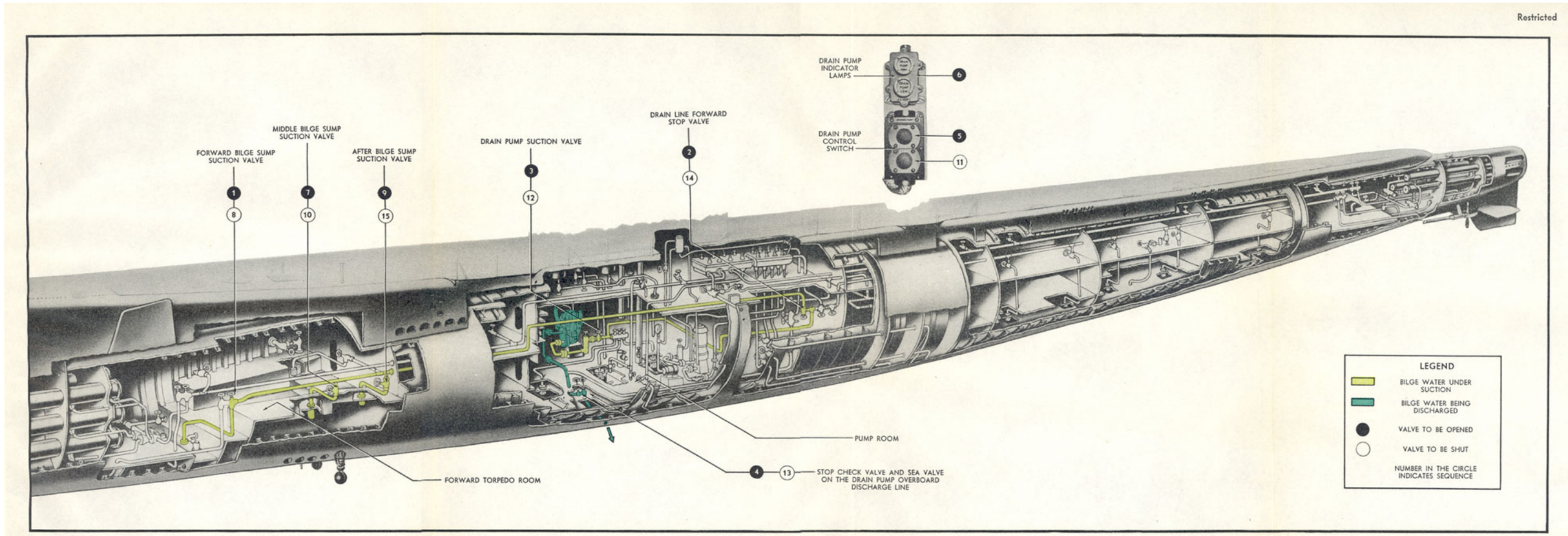

Figure 5-3. PUMP FROM THE FORWARD TORPEDO ROOM BILGES TO SEA WITH THE DRAIN PUMP.

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Figure 5-4. PUMP WATER FROM COLLECTING TANK TO EXPANSION TANK WITH DRAIN PUMP.

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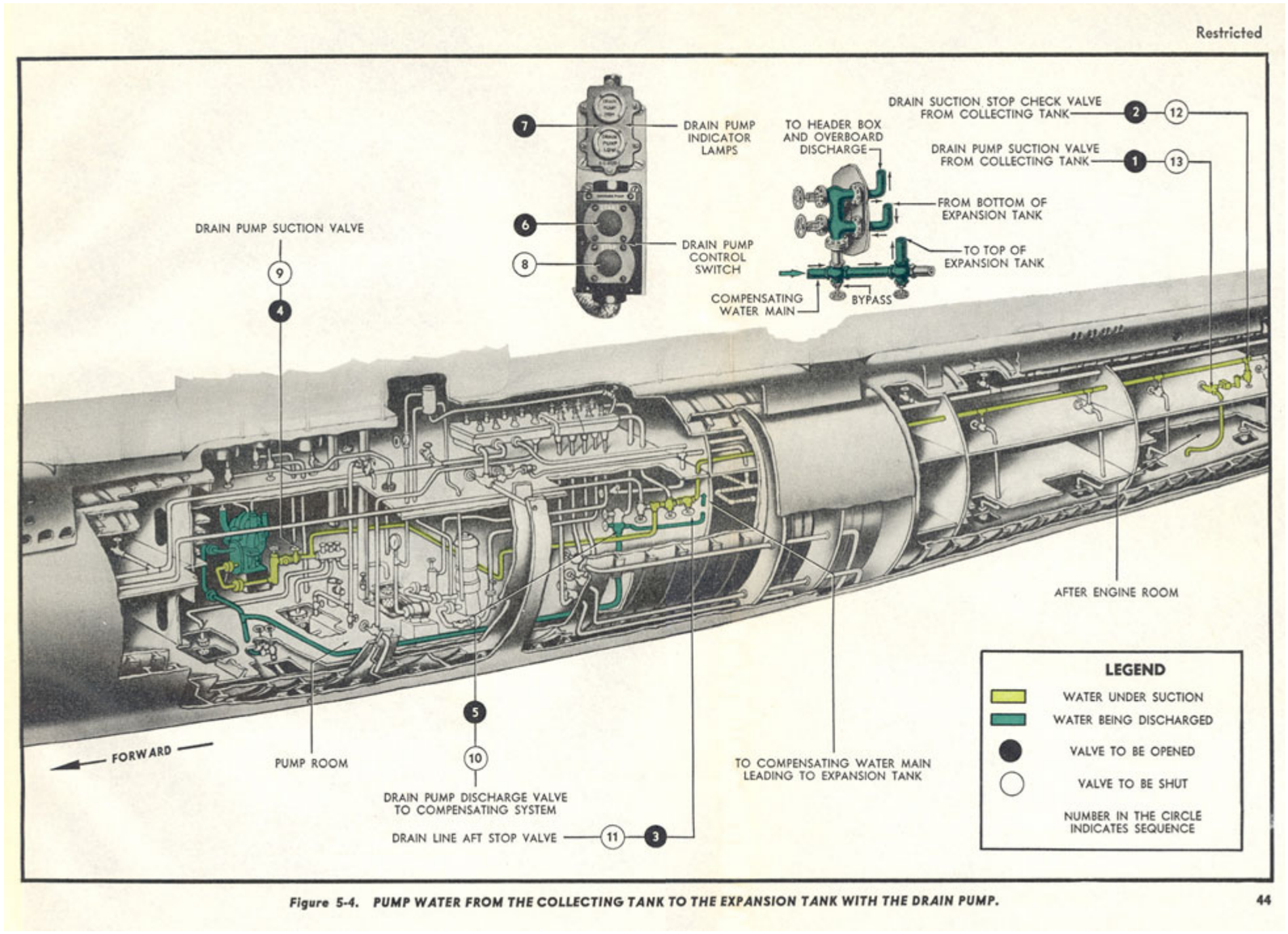

Figure 5-5. PUMP WATER FROM COLLECTING TANK TO EXPANSION TANK WITH TRIM PUMP.

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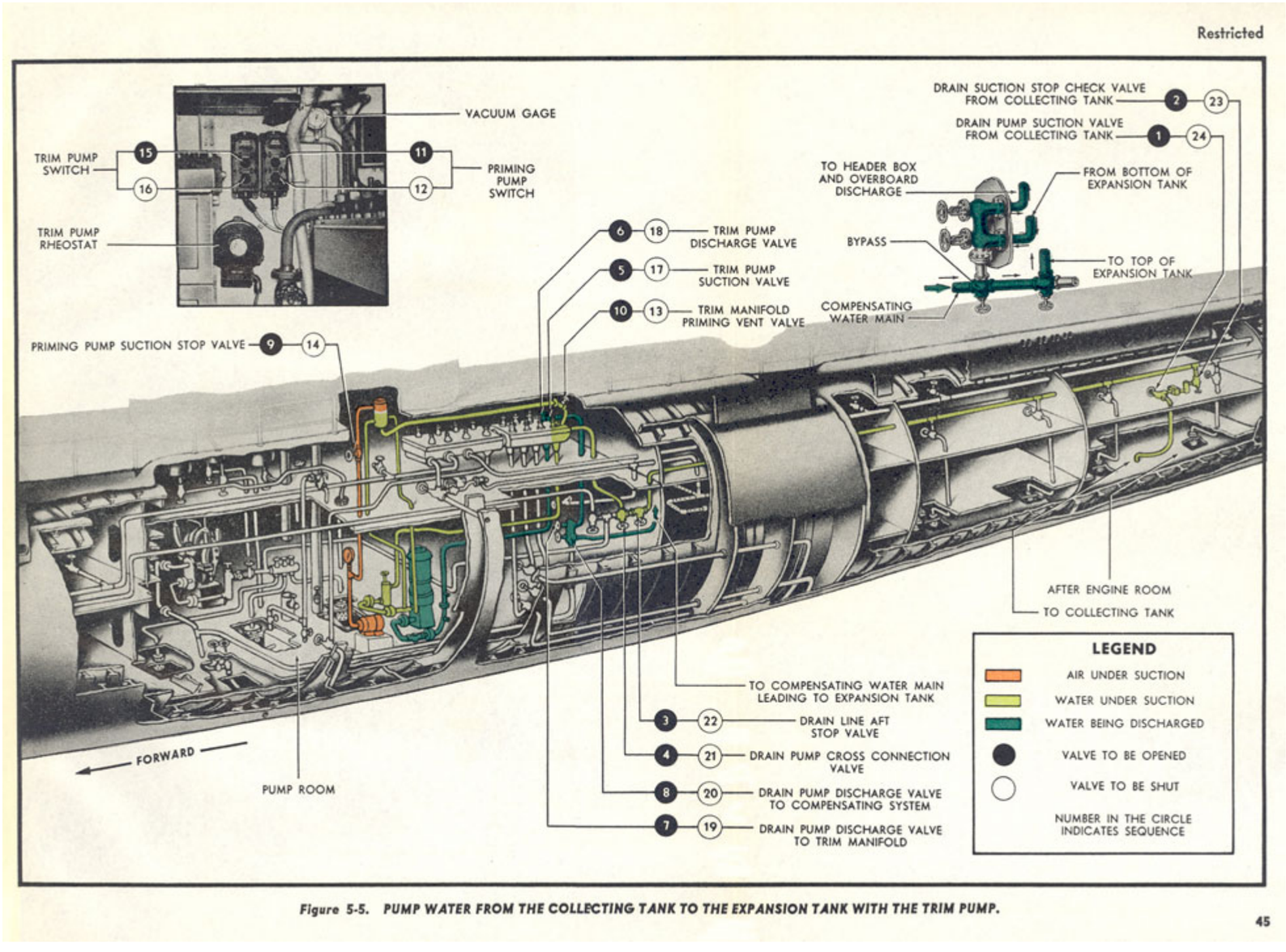

Figure 5-5. PUMP WATER FROM THE COLLECTING TANK TO THE EXPANSION TANK WITH THE TRIM PUMP.

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Figure 5-6. PUMP FROM POPPET VALVE DRAIN TANK TO SEA WITH DRAIN PUMP.

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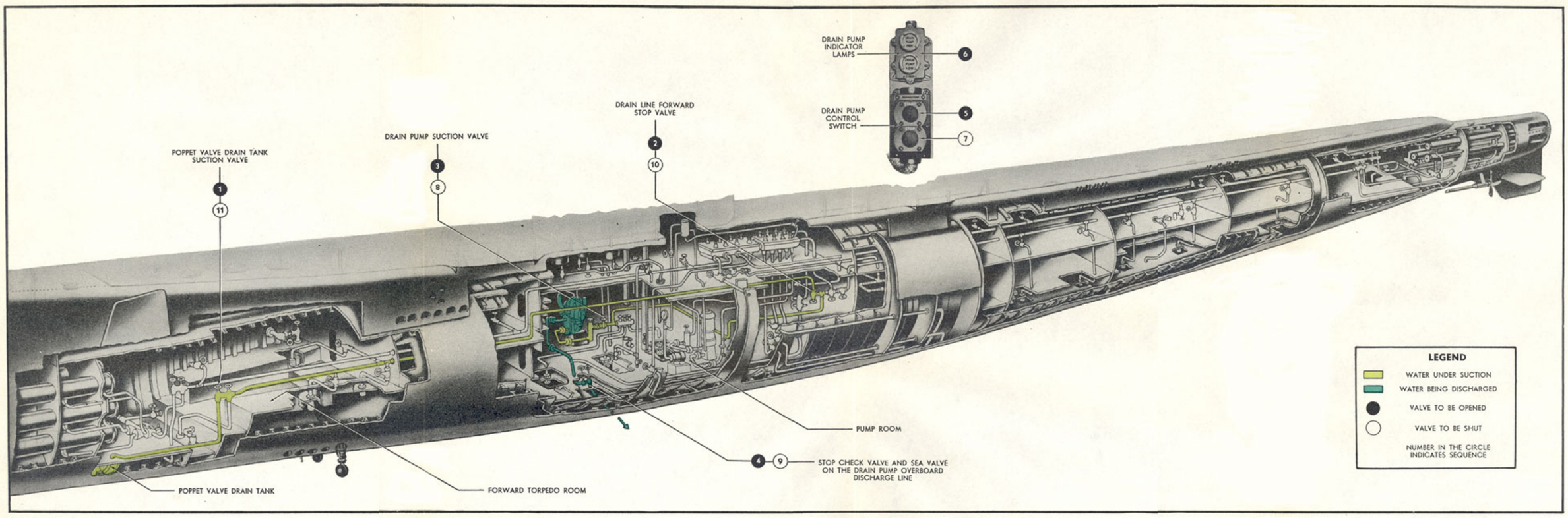

Figure 5-6. PUMP FROM THE POPPET VALVE DRAIN TANK TO SEA WITH THE DRAIN PUMP.