CHAPTER 7

PNEUMATIC EQUIPMENT AND COMPONENTS

Air, pressurized and unpressurized, is used in many ways in connection with guided missile systems-in the missiles themselves, in the control system, in the launching system, and in tools and equipment. The effects of air on missile flight were discussed as part of the fire control story in the preceding course. As a GMM 3 and GMM 2 you learned the types of missile air frame construction, characteristics of various missile configurations, and influence of missile shapes, wings, and fins on the effects of the air stream, wind, air pockets, etc, This information will not be discussed further here: refresh your memory when necessary by reviewing the preceding course in this series, *Gunner's Mate M (Missiles) 3&2*, NAVTRA 10199.

The use of pressurized air in the launching system and handling equipment will be covered in this chapter. The dud-jettisoning equipment, described in chapter 4, is one example of a pneumatic component that you have learned to operate, test functionally, disassemble, inspect, clean, and lubricate. Your knowledge of this component must now be expanded to include overhaul, repair and adjustment of the equipment, and planning and supervising the maintenance and repair program for the equipment.

The parts of equipments that are pneumatic are intricately connected to electrical and hydraulic components, so it is difficult to discuss the pneumatic features separately.

Compressed air is supplied to various systems by high pressure, medium pressure, or low pressure air compressors in the ship's engineering department. Compressed air outlets are located in the spaces where needed, such as checkout and repair spaces. Low pressure is 150 PSI or less; medium pressure is 150 to 1000 PSI; pressures above 1000 PSI are classed as high pressure. Reducing valves reduce higher pressure to a lower pressure for a specific system. Compressed air has many uses aboard a modem Navy ship, such as for operating pneumatic tools and handling equipment, charging and firing torpedoes, operating the dud-jettisoning unit, and other parts of the missile launching system. On most ships the air is dried. If you require dry compressed air, as for blowing out or drying out electrical components, check to be sure that the air at the outlet is dried. Use only rubber or insulating hose in portable air lines for blowing out electrical equipment. Also, pressure must be low, not over 30 PSI on motors and generators up to 50 horsepower or 50 kilowatts.

PNEUMATIC COMPONENTS USED WITH AND/OR IN MISSILE SYSTEMS

In the descriptions of the weapons systems in this course and in the preceding course, mention has been made of various pneumatic components. Of these, the dud-jettison unit was described and illustrated with the most detail.

TOOLS

The tools operated by compressed air are old friends of yours from your Seaman days. Your chief concern with them is to see that your men use them properly and observe safety precautions. Be sure the tools are returned in good condition to their proper place. Any defects in a tool should be, corrected before it. is placed on the tool board, or in a locker or other storage place. *Tools and Their Uses*, NAVTRA 10085, describes and illustrates the pneumatic hand tools commonly used in the Navy, and gives the safety precautions to observe when using them. Even at low pressures, an air hose should never be pointed at anyone. The pressurized air can do serious bodily harm. Two air hoses on automatic rewind reels are conveniently located just inside each access door in the space where the missiles are unpacked.

Pneumatic Wrenches (Decanning Tools)

Wherever missile components are received in packaged form, usually in gasketed metal barrels or cans, special tools are provided for opening or for closing the cans. It is important to prevent damage to the sealing edge of the cans so they can be re-used for protected packaging of components. Even though the component being repackaged is a damaged, malfunctioning, or nonfunctioning part being returned to a depot for repair, it is important to protect it by proper packaging, which in most cases means placing it in a gasket-sealed metal can with desiccant, and cushioning or blocking material. A portable pneumatic impact wrench used for installing or removing nuts and bolts is described and illustrated in *Tools and Their Uses*, NAVTRA 10085. Use only the equipment and tools authorized for the job; consult the OP and/or the MRC.

AIR DRIVEN HANDLING EQUIPMENT.

Power for operating missile handling equipment may be electric, hydraulic, pneumatic, or a combination such as electro hydraulic. Chapter 2 mentions some pneumatic-powered equipment used during replenishment. The power used varies with the ship installation more often than with the type of missile handled. Some typical air-operated equipments are described. On all components of an air system, the inlet and outlet parts of all valves and air motors must be plugged or covered until installed and during repairs. It is important that dirt, metal chips, filings, and other extraneous material be kept from getting into the system. Under no circumstances should water be allowed to get into the system. All tubing and flexible hose must be clean and free from scale or other foreign matter. Whenever equipment appears to be malfunctioning, it should be shut down and the cause investigated. Before dismantling any part of the air system, make sure that the part is shut off from pressure; allow trapped pressure to escape gradually. Keep grease and oil off air hoses and outlets.

Bi-Rail Trolley Hoists

Cruisers of the CG-10 class have three pneumatically operated bi-rail trolley hoists (one forward and two aft in the Talos launching systems), and CGN-9 class ships have two of them. Bi-rail trolley hoists provide for athwartship transfer of Talos innerbodies at the second, deck between the receiving stand and the elevator, and in the warhead magazine. While in the hoist, the innerbody can be rotated 360 degrees in azimuth and locked in any azimuth position.

Bridge Cranes

The trolley hoists travel on air-driven bi-rail overhead bridge cranes. The trolley hoist can be moved onto the bi-rail section of the bridge crane and secured. When not in motion, the bridge crane and trolley hoist will automatically lock in position.

Receiving Stands

Two pneumatic-powered receiving stands are provided on the second deck of CG-10 and CGN-9 class cruisers for each of the Talos launching systems. The stands hold the innerbody or the warhead during transfer to the mating area. They move athwartship between the strikedown hatch and birail trolley hoist. The innerbody is supported in, the receiving stand ring assembly and can be tilted or rotated to the position necessary for mating to the missile, from vertical to horizontal. Handling adapters are provided for handling warheads.

Telescoping Warhead Hoists

On CGN-9 and CG-10 class ships, two telescoping warhead hoists in the forward and after deckhouses travel on overhead bi-rail tracks from the checkout area to the warhead strikedown hatch on the main deck. They are air-operated, telescopic guided, vertical lifting and lowering, trolley-type devices. The telescopic guides stabilize the hoist and prevent swinging with the ship's motion. The load can be rotated from the horizontal to the vertical position. Adapters make it usable for handling standard and exercise heads and tactical or exercise innerbodies. It is used for removing or installing innerbodies and warheads, specifically for hoisting and lowering Talos components. The hoist in the magazine for spare Talos components also uses telescopic guides for stabilization against ship's motion.

Similar equipment is used on DLGs and other ships. Figure 7-1 shows use of handling equipment for a Terrier warhead on a CVA. The warhead is received in its container at one of the aircraft elevator receiving areas, and is moved by forklift truck across the hangar deck and positioned in front of either the port or starboard bridge crane. The outer container is removed and the warhead, in its inner container, is attached to the bridge crane with the aid of an adapter, and is lowered to the strikedown area, where it is secured to the tilt table. The tilt table is turned to the vertical position and the container is lifted off (with the hoist), so the warhead can be inspected before it is placed in warhead stowage. After the warhead has passed inspection, it is returned to the container and sealed, and taken to the warhead magazine, where it is secured against movement.

Chain Drive Fixture

An air-driven chain drive fixture with a manual air control vale, and a strike down hand control box, is used for strike down and for offloading Tartar missiles. The chain drive fixture is used with GMLS Mk 13 and Mk 22. Figure 7-2 shows the missile handling equipment attached to a launcher. The launcher captain, using local control operation, positions the launcher to a convenient position to attach the missile handling equipment.

The chain fixture is attached manually to the front of the launcher when preparing for strikedown or offloading. When the latch lever (fig.7-3) is pushed, the quick release pins can be inserted to attach the fixture to the launcher guide. The latch engages a block on top of the retractable rail. The chain drive fixture is easier to install if the launcher guide arm is depressed in LOCAL TEST.

Inside the fixture housing, or attached to it, are a chain, an air motor, a chain drive sprocket and gears, a pressure regulator, and an air throttle valve (fig. 7-3). The strikedown chain pulls the missile onto the launcher guide during strikedown, or controls the missile during offloading. There are four cams in the chain which actuate linkages to the throttle valve and interlock switch S1N2. The stop cam stops the air motor (through linkage to the air throttle valve) when the chain is fully retracted. The air motor shaft drives a simple gear train which drives the chain drive sprocket.

The PRESSURE REGULATOR reduces air pressure in the extend cycle of the chain. It is mounted in parallel with a check valve in the air line between the throttle valve and the air motor (fig. 7-3). The regulator is factory adjusted to a static pressure of 20-22 PSI, which must not be changed.

The AIR THROTTLE VALVE regulates the speed of the air motor and determines its direction of rotation. Two inlets are connected to the manual control valve (fig. 7-2) and one to the ship's air supply. Two outlets connect to the air motor and two others port exhaust air to the atmosphere. Cams on the chain shift the valve through linkages to open or close air inlets or outlets and thus control the speed of the air motor and chain.

The MANUAL CONTROL VALVE (fig. 7-2) ports air pressure to the air throttle valve to shift it to retract or extend the strikedown chain. The position of the control handle on the manual control valve for "retract" or "extend" has to be determined by trial (for each ship installation) and then marked. When not in operation, the plunger is centered to "neutral" by a double acting spring.

The HAND CONTROL BOX (fig. 7-2) positions the launcher in train and elevation for strikedown, checkout, or missile component removal. It is operated by the launcher captain and enables him to be on deck where he can

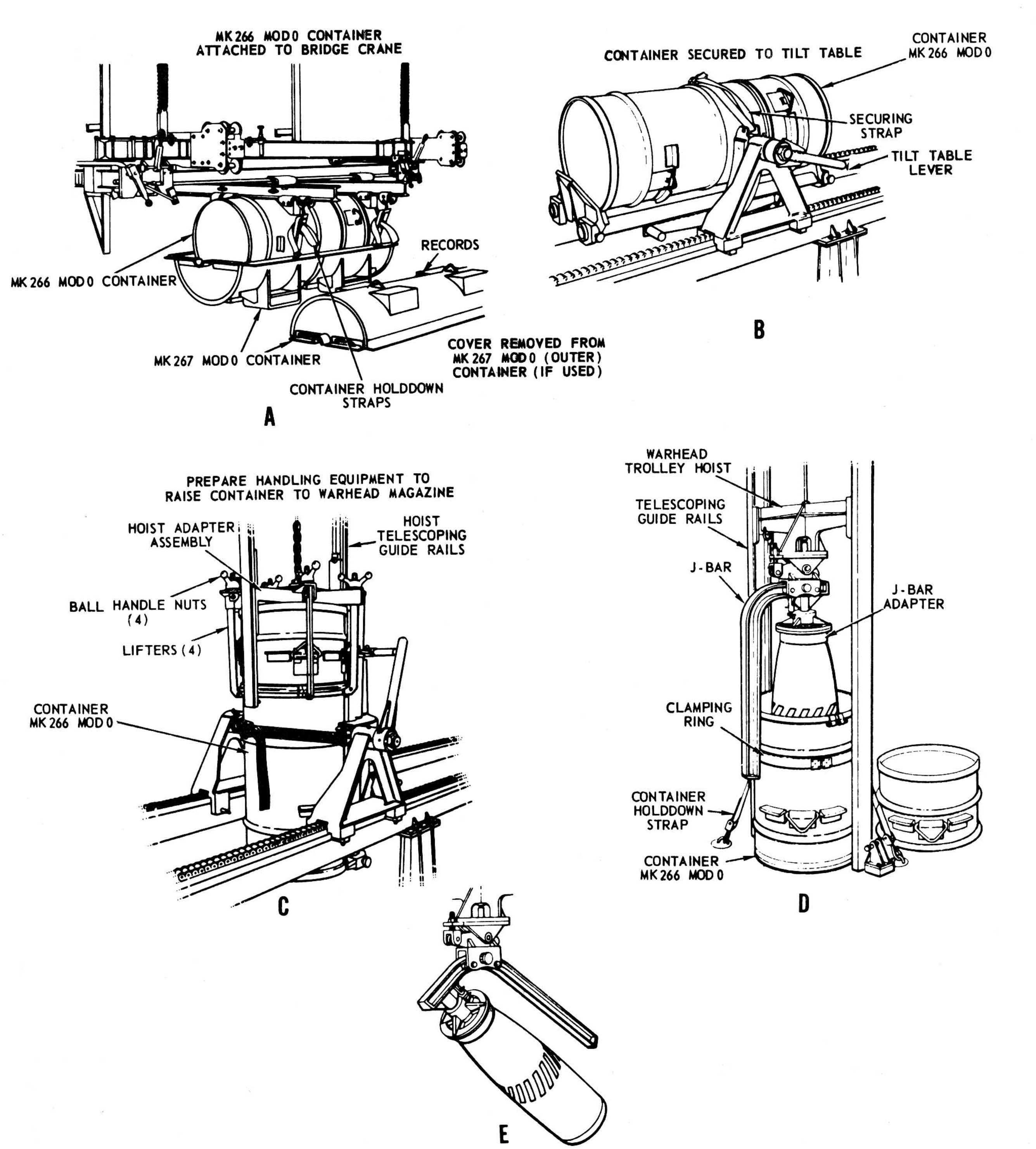

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Figure 7-1.—Decanning a Terrier warhead: A. Warhead in container attached to bridge crane; B. Warhead in inner container secured to tilt table in checkout area; C. Preparing handling equipment to raise container off warhead; D. Upper part of container removed, J-bar attached; E. Warhead held by J-bar in horizontal position for receipt inspection (aft end).

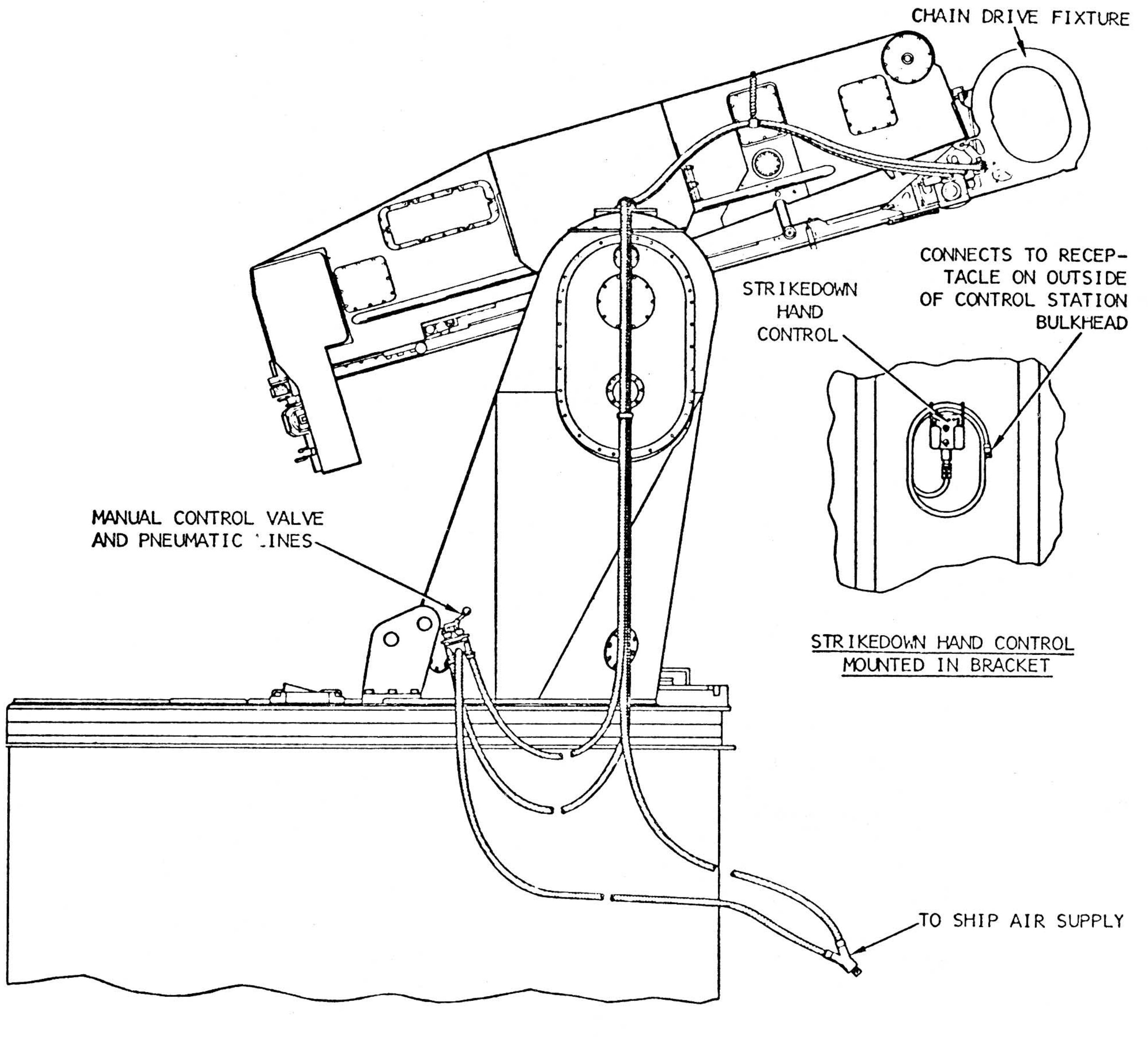

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Figure 7-2.—Strikedown Gear.

have a full view of the launcher and the operations. To position the launcher for mounting the strikedown gear and chain drive fixture, the EP2 panel operator and the launcher captain follow the procedure as for checkout operation. The launcher is trained to a convenient position by local control, and the guide is lowered to zero degrees elevation. The Firing Safety switch. handle must be removed from the EP2 panel before anyone is permitted to begin mounting the strikedown gear to the launcher. This is to make certain that the launcher cannot be started while someone is working on it. When the fixture is attached and air line hoses connected (two hoses between the throttle valve and the manual control valve, one between the throttle valve and the ship's supply "Y", and another between the manual control valve and the ship's

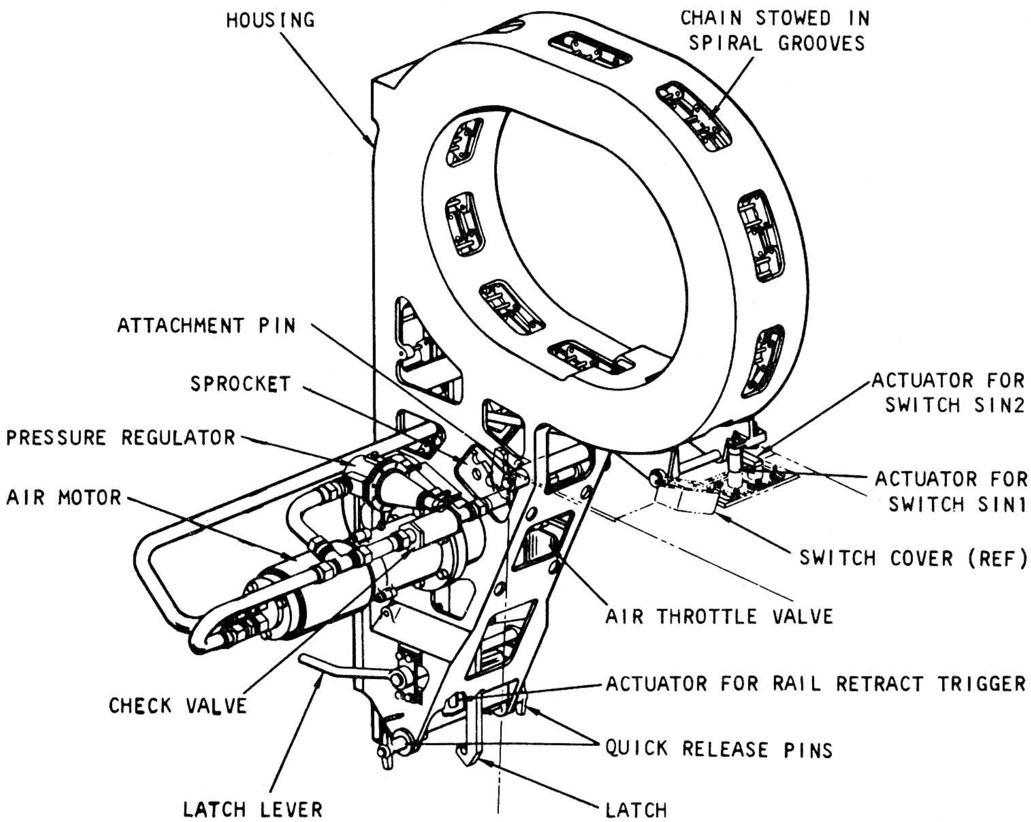

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Figure 7-3.—Chain drive fixture, strikedown gear, Guided Missile Launching System Mk 13 and Mk 22.

supply "Y"), then the Firing Safety switch handle can be returned to the EP- 2 panel and the system reactivated.

Consult the publication for the Mk 13 launching system, OP 2665, or complete description of the steps in strikedown, offloading, checkout, and deactivation. OP 3 15 is the publication to consult regarding the M 22 Tartar system.

PNEUMATIC COMPONENTS OF LAUNCHING SYSTEMS

In addition to the handling equipments described above, and the dud-jettisoning units described in a previous chapter, pressurized air is used in several other parts of the launching system: in the missiles, the test equipment, and the control systems. Frequently, electric and hydraulic components are closely related to the air-powered parts to actuate and control a system.

Train and Elevation Air Drive Motor

Air motors have been mentioned in connection with the missile component handling crane, monorail overhead air hoist, receiving stands, deck fixtures, and chain drive fixture. They are also used to train and elevate missile launchers in manual control. The air drive motors used on the Mk 10 launching system are described below. In case of a power loss, the air motors may be used in conjunction with hand pumps and hand cranks to perform essential operations with the launching system. For example, the loader chain can be retracted by use of a hand crank. A hand pump can be used to furnish hydraulic fluid directly to a component inactivated by a power loss. The blast doors, for example, can be closed by this means in an emergency. Manually controlled air motors are attached to the power-off brakes of the train and elevation systems. If manual operation is to be used, the power for the side (A-side or B-side) is turned off at the EP-1 panel. Figure 7-4 shows the location of the air drive motor in relation to the power-off brake. The location is similar for train and elevation systems. The air motor drive is used during power failure or during installation and maintenance procedures.

When the air motors are to be used, the power system must be off, either through power failure or turned off. The air motors drive the associated gear reduction. The air pressure to operate the air motors is supplied from the ship's air lines, using 100 PSI. No electrical control is used. An air control valve assembly (fig. 7-5) controls the flow of air to the train and elevation air motors. The assembly is fastened to the left side of the base ring, above the train power-off brake (fig. 7-4). The valve assembly has two identical sections (fig. 7-6); one section controls the elevation air motor, and the other the train air motor.

CAUTION: When operating the launcher with the air motors, normal safety interlocks are bypassed. Use extreme caution; specifically, never move the launcher if the blast doors are open, and never open or close the blast doors by use of the hand pump if the launcher has been moved off the stow position with the air motors.

The train section of the train control valve assembly (fig. 7-5) consists principally of a control handle, air control valve, and check valve. The control handle, employed as a first class lever, operates the air control valve. If the handle is moved up and down, air is ported through one of the two outlet ports to the train air motor. The outlet port through which the air is supplied determines the direction of rotation of the air motor.

The air control valve is linked to the control handle at the upper end. The lower end of the valve is attached to a bottle spring that holds the valve at neutral until displaced by the control handle. With the valve at neutral, the two output ports of the train air motor are closed. The check valve prevents passage of air from the supply source to the center chamber of the control valve unless the check valve plunger is unseated.

When the control handle is moved, it forces the train control valve plunger off neutral which unseats the train check valve plunger and allows air to flow through the central chamber of one of the two outlet ports of the air motor.

The elevation air motor operates in the same way as the train air motor.

Before using either the train or elevation air motors, be sure train and elevation latches are retracted. In manual operation, they are retracted by use of the hand pump, and power drives must be off.

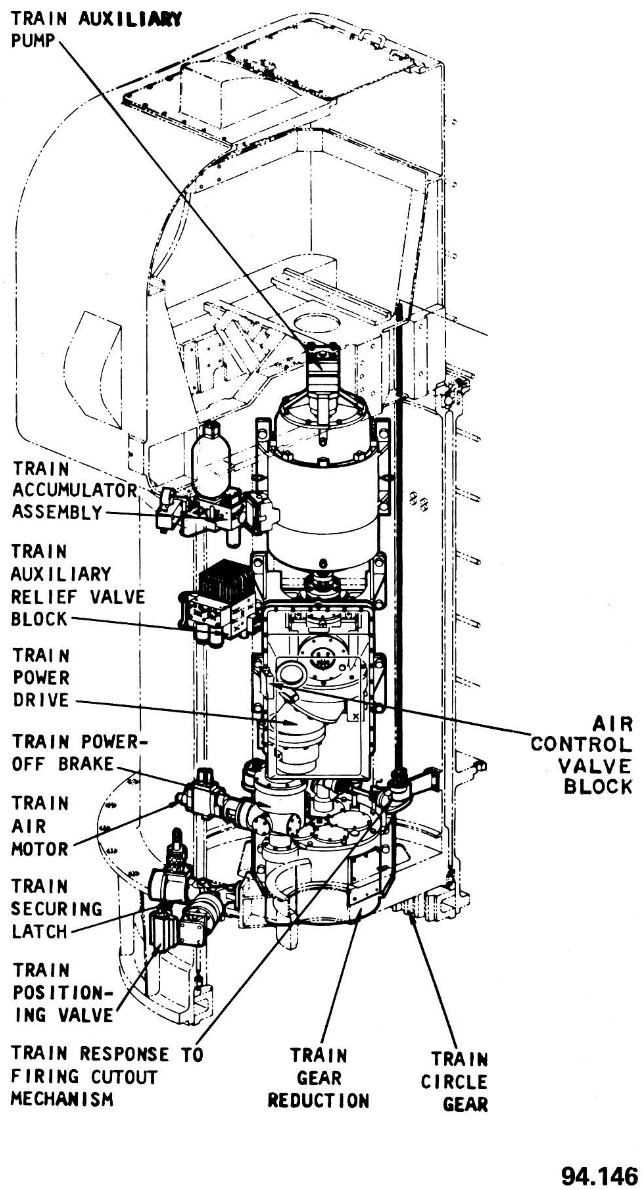

Figure 7-4.—Train system, general arrangement of components.

If lubrication is scheduled, follow instructions in system OPs and MR cards and review safety precautions for manual operation. When you are making use of the air motors, you will also use the handpumps for hydraulic actuation of components, and handcranks for mechanical actuation. Be sure automatic power is off in each case.

Although we have illustrated and discussed the use of air motors only in the Terrier Mk 10 launching systems, similar air motors are used in the Talos and some Tartar launching systems. For manual operation of train and elevation power drives in the Mk 13 Tartar system, a handcrank is attached to the splined end of the worm shaft of the power-off brake assembly.

Asroc Loading Fixture

Before Asroc missiles can be loaded into the Mk 10 Mods 7 and 8 launching systems, they must be placed in adapters. The loading fixture has three major components: the stowing mechanism, the drive assembly, and the chain assembly (fig. 7-7). The stowing mechanism is mounted to the loader trunk in the strikedown- checkout area. It consists of two mounting brackets, a worm, a gear quadrant, four supporting arms, and an extended-retracted latch mechanism. A special handcrank is needed to crank the fixture down from stowed. position. The latch mechanism serves to lock the latch pin on the drive in either the drive-retracted or the drive-extended position, and to actuate the interlock switch SINB6 or SINB7 to indicate in the loader electrical circuits either the retracted or the extended position of the drive assembly. The latch handle has two positions, LATCHED and UNLATCHED. It is positioned manually.

The loading fixture drive assembly is mounted on the chain stowage housing (fig. 7-7). It consists of a manual control valve, an interlock valve (not shown in fig. 7-7), a throttling valve, an air motor, a speed reducer and chain drive sprocket assembly, a chain stowage housing, and chain-retracted interlock switch SINB8.

The manual control valve (fig. 7-7) is a three-position valve spring-loaded to OFF, EXTEND, and RETRACT. The throttling valve is a three-land. three-position valve. It is initially shifted

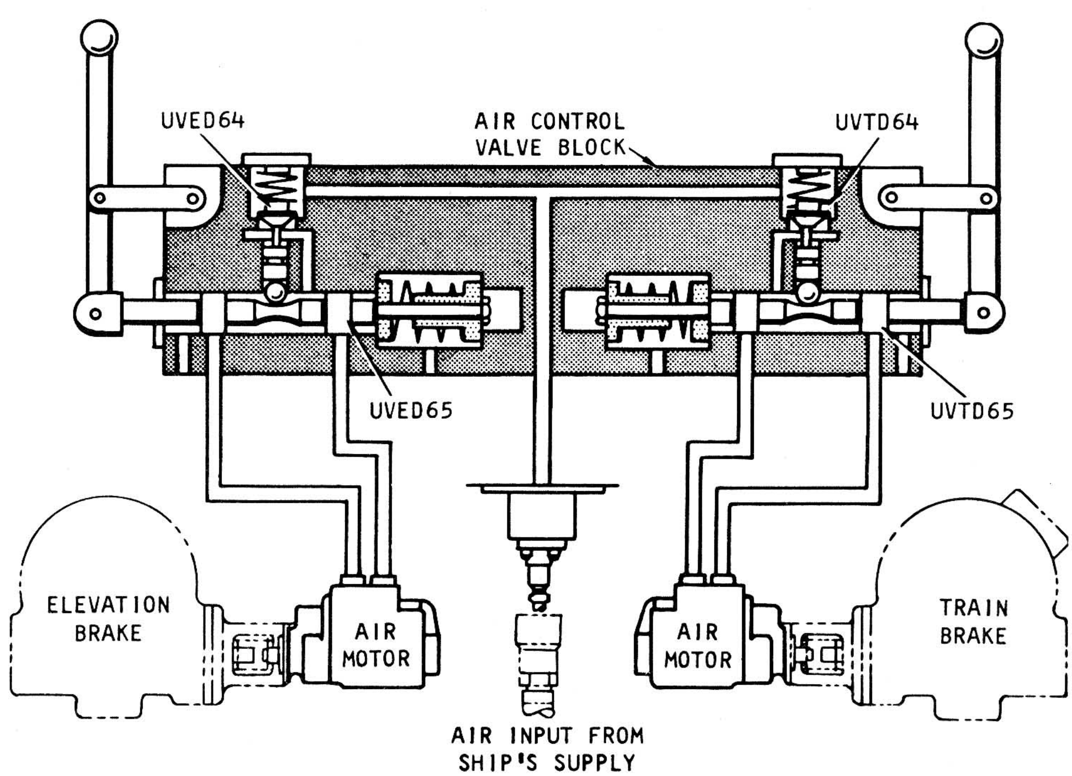

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Figure 7-5.—Air control valve assembly.

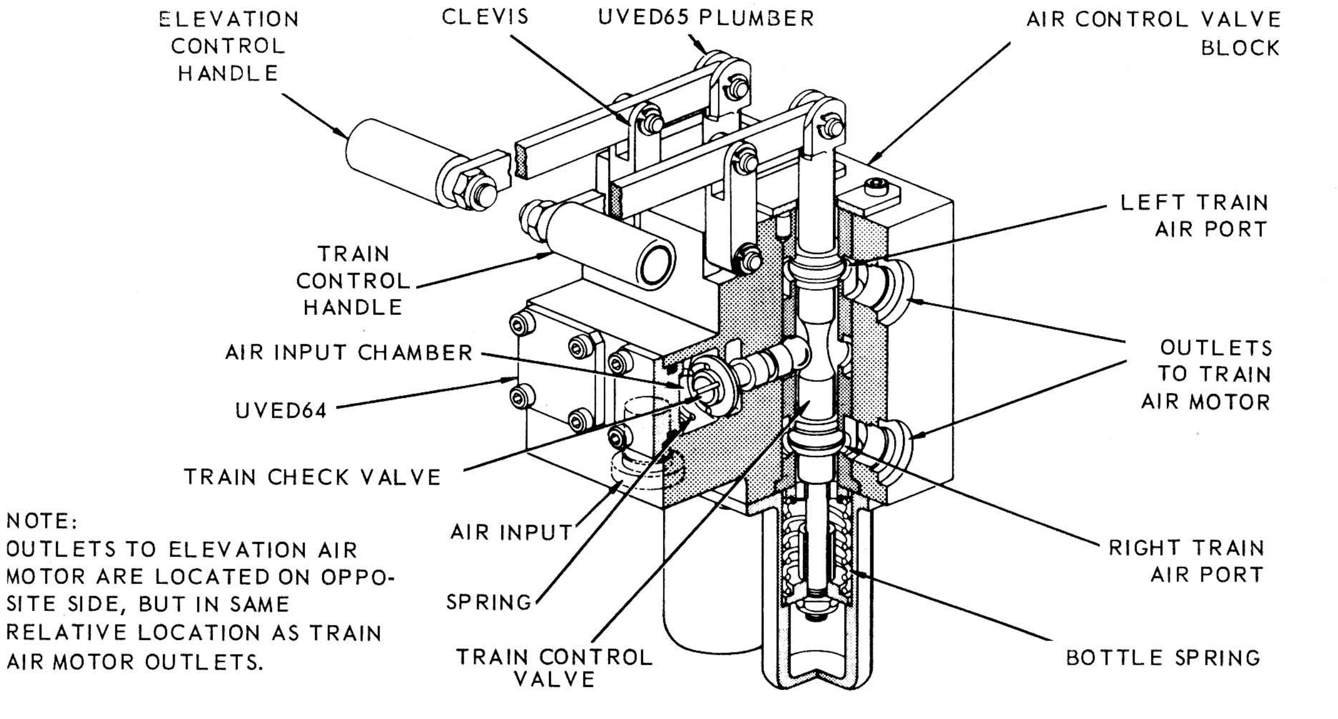

Figure 7-6.—Schematic of air motor drive.

by air pressure. It is returned to neutral and held there by spring-loaded linkages. The reversible air motor drives the chain drive sprocket through a worm and worm gear speed reducer.

The J-shaped chain stowage housing (fig. 7-7) serves as a mounting base for the drive assembly. The retracting chain is drawn into the housing by the drive sprocket, and as it passes around the sprocket section it enters the stacking section where the chain is folded link-on-link to stow it. The chain assembly is a rammer-type roller chain and pawl.

The throttling valve is between the manual air control valve and the air motor in the pneumatic circuit (fig. 7-8). The chain-extended cam or the chain-retracted can return it to neutral after it is activated by the air motor. The loading fixture pawl is pivoted to the end of the chain. The interlock valve is in the pneumatic circuit between the ship's air supply and the control valve. It is actuated by a cam that is shifted when the Asroc adapter contacts it.

LOADING THE ADAPTER. - The first step is to crank the loading fixture to the loading position, called No. 1 Stop position, and to extend the pawl cam pins. This is done manually.

Next, bring an empty Asroc adapter to the strikedown area. Be sure it is the proper type of adapter (fitted for torpedo or for depth charge). When the empty adapter rests in position on the loading fixture, the system is shut down to protect personnel working in the area. The snubbers in the adapter are in closed position, the arming tool socket and safety key mechanism is at reset position, the restraining latch is set at LATCHED, and the adapter contains no umbilical cable.

To prepare the adapter to receive the missile, he snubbers must be opened. The restraining latch and snubber release is turned to UNLOCKED with a special wrench. Torsion bars opens the snubbers when (the latch is released; personnel must stand clear of snubbers, as they open quickly and forcefully. The restraining

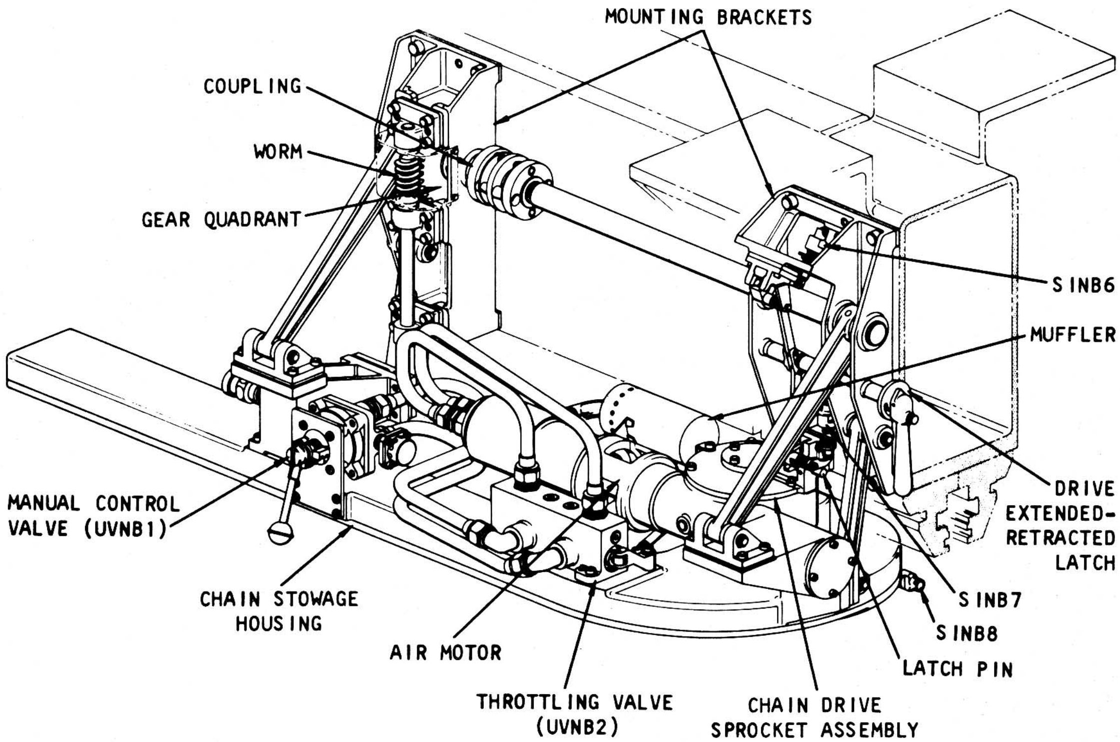

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Figure 7-7.—Adapter loading fixture assembly (for Asroc).

latch pawls are then retracted out of the way of the aft shoe of the Asroc. The cover over the U-shaped channel of the cantilever beam of the adapter is removed, and the umbilical cable is strung in the channel, the connectors are plugged in, and the cover is replaced. Then the Asroc missile is placed under the adapter and aligned to engage the shoes with the adapter and the fixture pawls. The strikedown car is then moved to the stowed position and secured.

The Asroc is now moved to its final position on the adapter by the fixture chain, powered by the air motor. Position the manual control valve (fig. 7-8) to EXTEND. This opens a port to the left side of the throttling valve so air pressure (ship's air supply at 100 PSI) passes through the left chamber of the throttling valve to the air motor. The pressure buildup opens the port to furnish a greater volume of air to the motor.

When the Asroc aft shoe nears its position behind the pawls of the restraining latch, the chain-extended cam on the fixture chain actuates the roller on the throttle valve actuator and shifts the throttling valve to neutral. This cuts the air supply to the air motor, decelerating it. When the Asroc aft shoe contacts the stop block on the Asroc adapter, the air motor is forced to stop, and the operator releases the manual control valve to OFF.

The Asroc is secured in the adapter by resetting and locking the restraining latch, pumping (with a hydraulic hand pump} the snubbers closed and locking them, and plugging the connector into the socket in the missile. The fixture chain and pawl are retracted by use of the air motor, the reverse of extending. When the chain and pawl are retracted, the fixture is ready to load another adapter or, if no more missiles are to be loaded, to be stowed. The Asroc, attached to the adapter, is struck down to the magazine.

Always remove the special tool (pump handle, cam wrench, or other tool) after using it, before proceeding with the next step.

If Asroc missiles are to be off-loaded, they are separated from their adapters with the aid of the loading fixture.

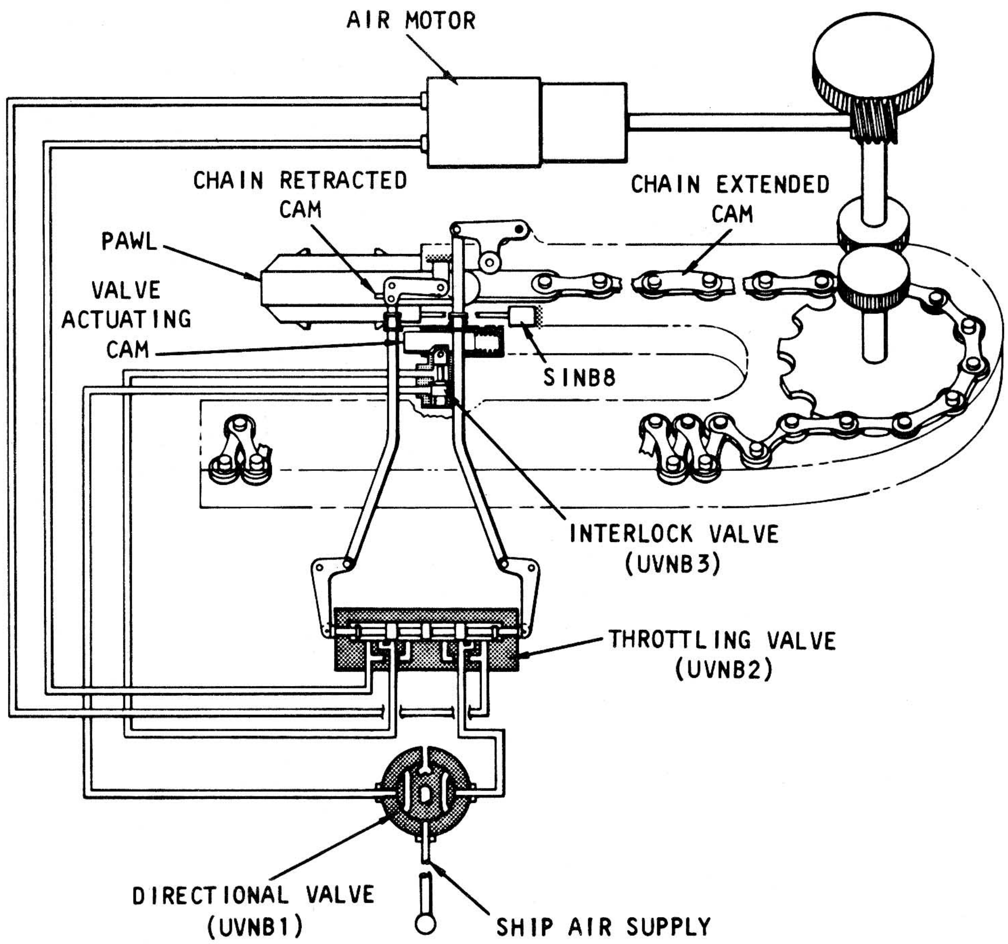

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Figure 7-8.—Loading fixture (for Asroc) pneumatic schematic.

Ejectors and Dud-Jettisoning Equipment

Chapter 4 described and illustrated methods of jettisoning dud missiles in Tartar, Terrier, and Talos systems. In the Terrier/Asroc system, Mk 10 Mods 7 and 8, the same jettisoning equipment is used for all types of missiles loaded. The three main components of the jettison unit are the A-side ejector, the B-side ejector, and the control panel. A manually operated shut-off valve on the panel shuts off the 4500-PSI air supply to the jettison controls. The positioner air supply valve admits (or shuts off) air at 100 PSI from the ship's air supply to the A and B positioner control valves. The 4500-PSI air supply is used to charge the air chamber (fig. 7-9) and to operate the firing valve. The air pressure gage is usually set at 3500 PSI, and the panel operator cuts off the air supply when this pressure is reached. He does this by moving the operating lever of the Charge and Fire Control valve to the READY position. (Although there are some differences in control panels for different systems, the one shown in figure 4-3 is typical, and can be referred to for location of. parts.) The B ejector controls are on the right-hand side of the panel, and duplicate controls are on the left-hand side for the A ejector. Each side had four indicating lights, a positioner control valve, a charge and fire control valve, and a pressure gage. The shutoff valve and the positioner air supply valve control both sides.

OPERATING THE DUD-JETTISONING EQUIPMENT. - Figure 7-9 shows the location of some of the valves and other components, on the

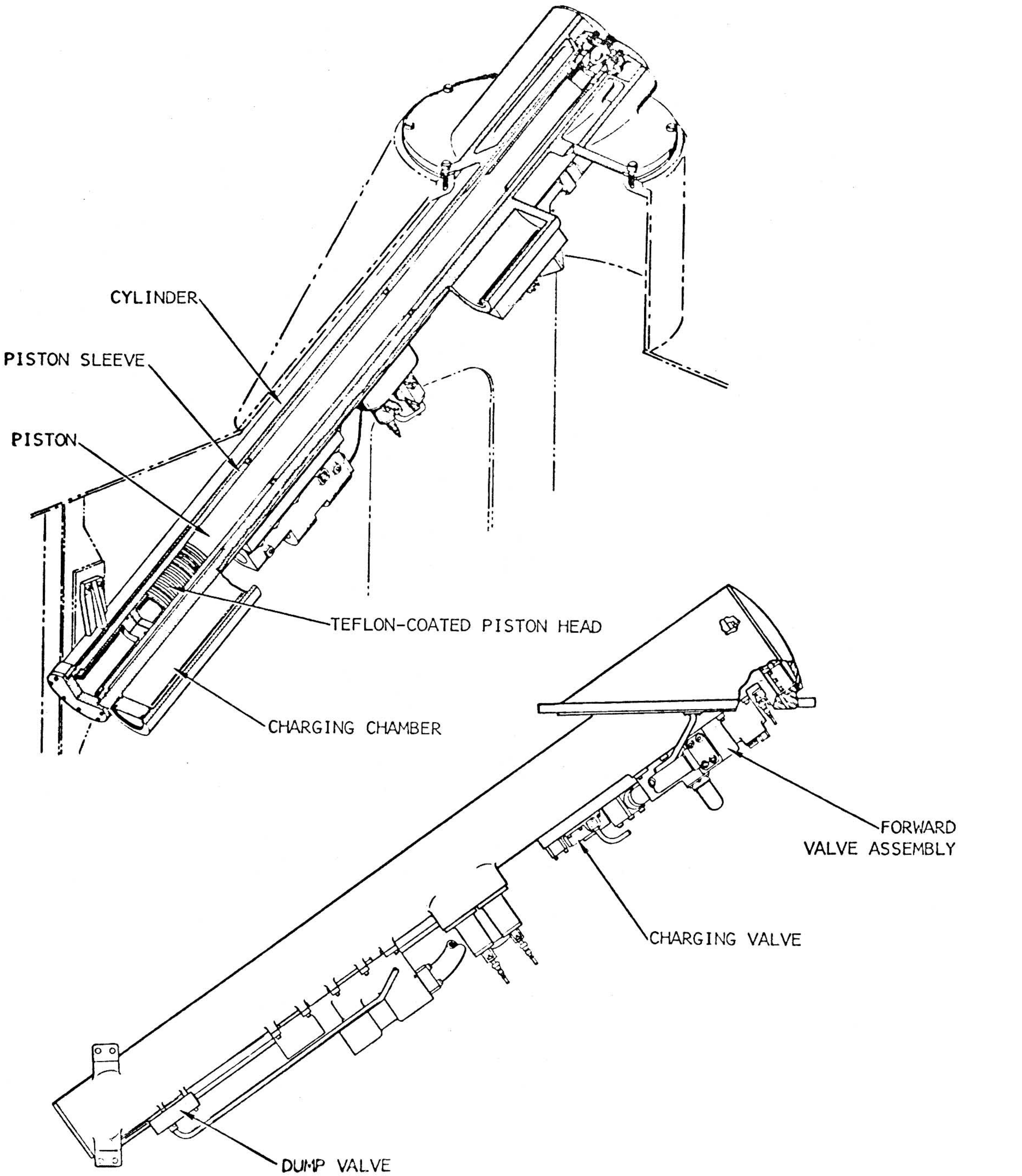

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Figure 7-9.—Dud Jettison Ejector.

cylinder weldment that are actuated when you move levers on the control panel. The dud jettison order synchros, of which there are eight for each unit, are mounted in a housing in the EP-2 panel. The rotors of the dud jettison order synchros are adjusted and fixed at predetermined positions so they train and elevate the launchers to preset dud-jettison positions when the launcher captain turns the switch to DUD JETTISON on the EP-2 panel. The dud jettison normal relay (KCB1) and associated electrical circuitry must be energized before the ejector will move to position I. (Position II is not used with Mk 10 Mod 7 launching system.) Position II was used for small booster missiles (BW-1) which have been phased out.

When the operator stationed at the dud jettison panel is signaled that everything is ready at the EP-2 panel, he executes the steps listed on the instruction plate on his panel. First, he turns the Positioner Air Supply Valve to OPEN, which directs 100 PSI air to the Positioner Control Valves. Since only Position I is to be used, the Positioner Control Valve (in the upper right-hand corner of the panel) is turned to POSITION I. The dump valves (fig. 7-9) then port 100 PSI air pressure to the rear of the ejector sleeve which causes the sleeve to move forward about 24 inches. Meanwhile, 4500 PSI air is going to the Charge and Fire Control valve, which you set at CHARGE. Air is ported to the firing safety valve (not shown), the charging valve (fig. 7-9), and both ends of the firing valve which is in the forward assembly.

When the indicating needle on the pressure gage reaches the stationary needle (which was preset), move the lever of the Charge and Fire Control Valve to READY. This shuts off the 4500-PSI air supply so the pressure will not go higher.

Check all the indicating lights on the panel and the pressure gage to be sure everything is in readiness, and observe the inclinometer which is adjacent to the control panel. If the roll of the ship is more than 20 degrees, the weapon must be ejected only on the down roll in the direction the weapon is pointing.

Now move the Charge and Fire Control lever to JETTISON AND OFF. The lines to the firing safety valve, the charging value, and the spring-loaded end of the firing valve are vented to atmosphere. Charging pressure is vented from the firing valve to the check valve and the shuttle valve in the forward valve assembly. This supplies air to both forward and rear ends of the ejector piston and to the plungers and the check valve in the rear valve assembly. As the piston moves forward, the pan at the front contacts the booster. The resistance causes an immediate pressure buildup behind the piston, which causes the control valve in the rear valve assembly to open and send air behind the piston to force the missile overboard. The rate of piston movement is controlled by orifices and the position of the control valve. In practice sessions, when you are not using a missile, the control valve assures that the piston will move at about the same rate as if loaded.

Anti-Icing Systems

Anti-icing systems keep vital areas of the launching system ice-free during freezing conditions. The anti-icing fluid is circulated by a motor independent of the rest of the launching system. Air bladders in the heat exchanger tank (fig. 7-10) maintain a constant head of pressure on the anti-icing fluid, compensating for expansion and contraction of the fluid under varying temperature conditions. The heat exchanger tank and components shown in figure 7-10 is of the type used in the Mk 10 launching system, and a similar one is used in the Talos launching system, while that shown in figure 7-11 is used in the Mk 13 launching system. The principles of operation are the same. The same special tool, air-charger-and-gaging assembly, is used to check the air pressure in each bladder and to charge it to the correct amount. The frequency of checking and charging the air bladders will depend a great deal on the temperatures in which the ship is operating.

USE OF SHIP'S AIR SUPPLY

The source of compressed air used in the equipments described is the ship's compressed air supply. The succeeding paragraphs describe the use of compressed air in equipments and systems that you will use, other than the missile launching systems.

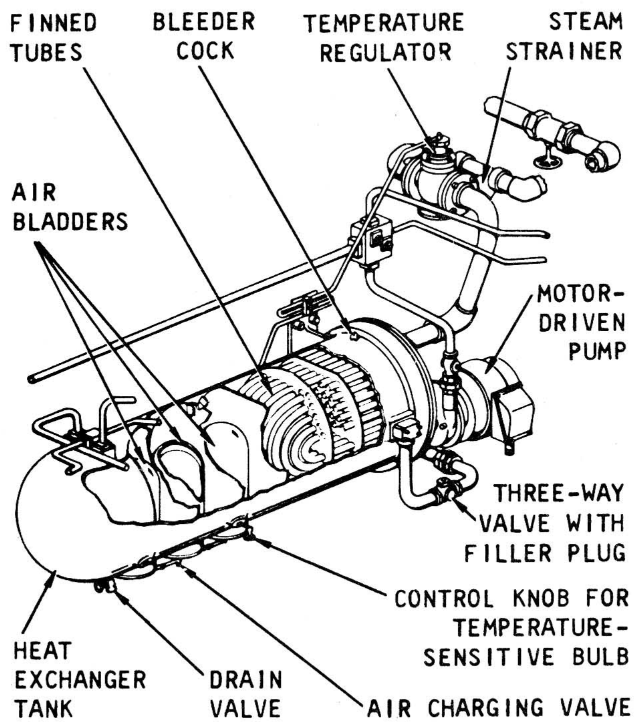

Figure 7-10. Major components of anti-icing system.

Ship's air supply is used for testing and servicing missiles, and for the launching systems. Each missile must be checked as soon as possible after being brought aboard. The pneumatic tests are only a part of the tests used on the missile and the launching system. A great many of the tests are electrical to check the transmission of signals. The ship's compressed air supply lines are the source of compressed air used for all the tests of missiles as well as of launching system components. However, at present, no pneumatic tests of missile components are performed aboard ship. Air is used for charging air bladders, though compressed nitrogen is used for accumulators. Keep safety rules in mind when using compressed air and see that your men observe the rules.

THERMO-PNEUMATIC CONTROL SYSTEMS

A thermo-pneumatic control system is designed to actuate a magazine's fire suppression system in response to either a rapid rate of rise in temperature or a slow rise to a fixed temperature in a protected space. The automatic thermo-pneumatic system is installed as an adjunct to a hydraulic control wet or dry type magazine sprinkling system or a independent carbon dioxide (CO_2) system. Some missile magazines also use a water injection system containing a compression tank which supplies fresh water under air pressure as part of a fire suppression system. The procedures for testing, operating, and maintaining magazine fire suppression systems are explained in GMM 3/2, NT 10199, and chapter 8 of this text.

Pneumatic Components

The pneumatic operated components of a CO_2 system are heat sensing devices and pneumatic control heads. For a sprinkling system, they are heat sensing devices and pneumatic release pilot (PRP) valve.

The heat sensing devices detect temperature increases and transmit pneumatic pressure changes to a PRP valve or CO_2 pneumatic control heads.

A pneumatic control head reacts to pneumatic pressure from a heat sensing device by opening a discharge head and releasing liquid CO_2 from a supply cylinder. A control head consists of an air chamber and a diaphragm. When pressure in the control head chamber increases, the diaphragm expands and trips a lever that releases a trigger mechanism which activates the CO_2 fire suppression system.

The PRP valve, figure 7-12, connects pneumatically to a heat sensing device. In addition to a diaphragm, the PRP valve contains a lever, a spring mechanism, and a compensating vent. The diaphragm expands in response to sudden pressure changes and moves a lever to release a spring mechanism which opens the PRP valve. Salt water from the ship's fire main flows through the PRP valve and opens the sprinkling system main control valve which admits fire main supply water to sprinkle the magazine. The compensating vent functions to leak-off normal temperature fluctuations within the pneumatic piping system and heat sensing device to prevent inadvertent tripping to the PRP valve. The compensating vent is calibrated and adjusted at the

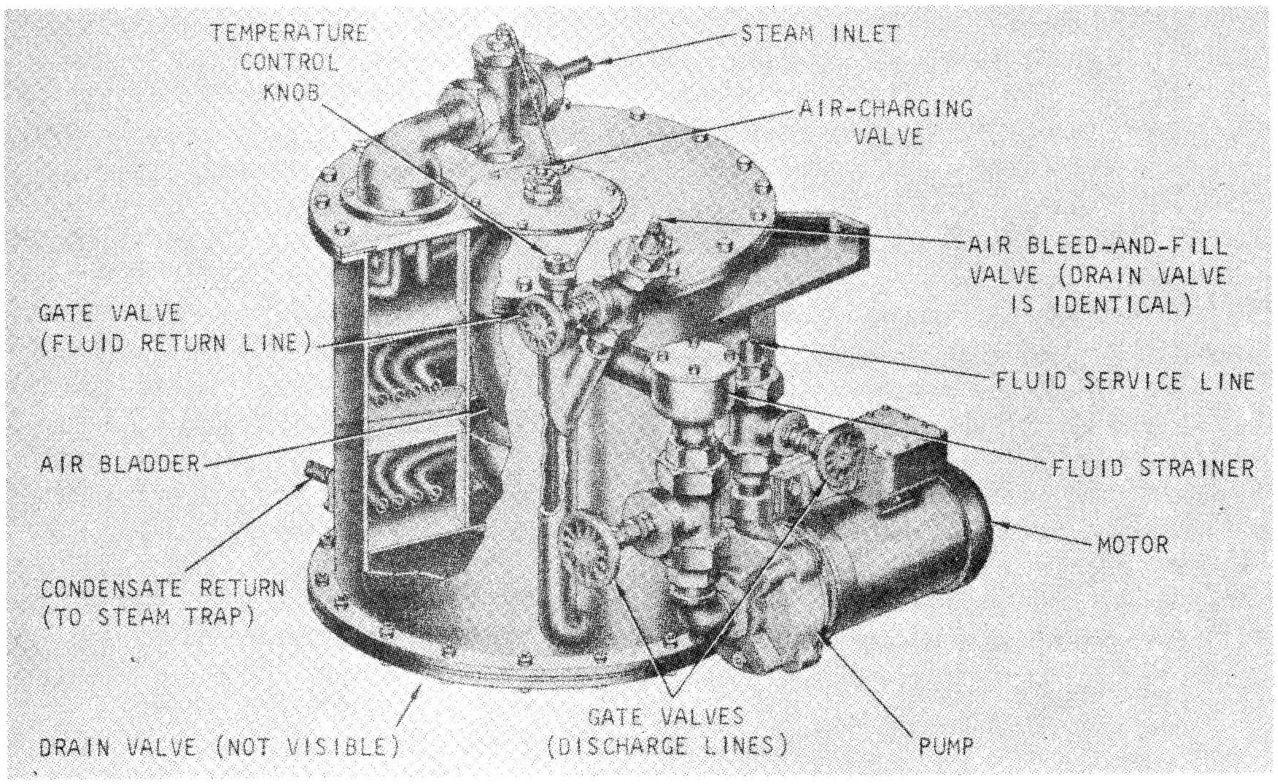

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Figure 7-11.—Anti-icing heater tank, Mk 13 launching system (Tartar).

factory. No adjustments should be undertaken by ship's force.

Pneumatic Control Circuits

The majority of systems installed on board ships consist of separate "rate of rise" and "fixed temperature" circuits. The "rate of rise" circuit uses a Heat Actuated Device (HAD) as sensing devices, and the "fixed temperature" circuit uses Fixed Temperature Units (FTU's) as sensing devices. A recent modification to some of the pneumatic control systems has been the replacement of HAD's and FTU's by Heat Sensing Devices (HSD's). The HSD combines the functions of the HAD and the FTU.

The "rate of rise" circuit is the primary circuit in most control systems. The operation of the "rate of rise" circuit is based on the following principles:

(a) Air expands when heated.

(b) Pressure is created when air expands in a closed system.

(c) Pressure can be converted to mechanical energy.

A differential pressure of at least 8 ounces per square inch across the release diaphragm is necessary to trip the PRP valve. A heat sensing device creates pneumatic pressure in two ways. First, a rapid temperature increase in a missile magazine heats and expands air in a bellows to increase air pressure. Second, a fusible slug melts and releases a spring which collapses the bellows producing a sudden increase in pressure in the pneumatic lines leading to the PRP valve or the CO_2 control heads. The pressure is converted to mechanical action by the expansion of a diaphragm. When the diaphragm expands, it releases a spring mechanism which opens a valve in the sprinkling system or shifts a plunger in the CO_2 system, thus activating a magazine's fire suppression system. Figure 7-13 shows the pneumatic control components of a CO_2 system.

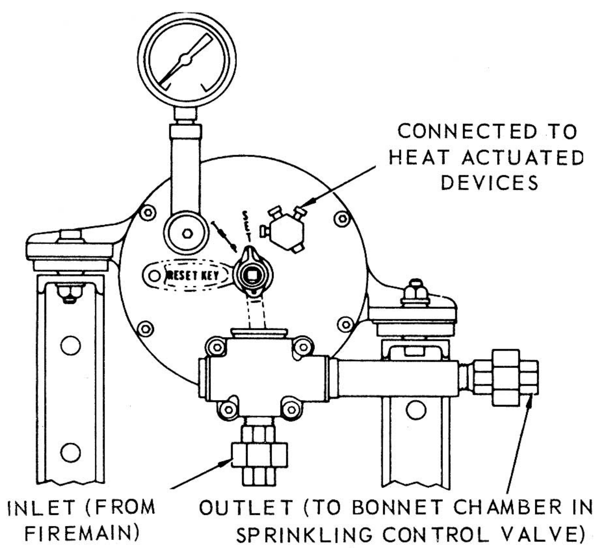

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Figure 7-12.—Pneumatically released pilot valve (PRP) used with heat-sensing devices in sprinkler systems.

Charging Flasks, Bladders, and Accumulators

Figure 7-14 shows the charging and gaging assembly used for air-charging and gaging the anti-icing bladders in the Mk 10 launching system. The bladder pressure for the anti-icing system on the Mk 10 launching system is 10 PSI. Check the requirement for the system you have aboard. The pressure should be checked monthly.

Compressed air is also used in the compression tank for the water injection system in the Mk 11 and Mk 13 launching systems described in the next chapter.

Accumulators in the hydraulic system of the missiles and the launchers are pressurized with nitrogen. When the missile is mated in the checkout area, the pressure in the accumulators must be checked and more nitrogen added if necessary.

PNEUMATICS IN MISSILES

The 3- T missiles (Terrier, Talos, and Tartar) all use air taken in through the missile nose to operate parts of the missile internal system. Figure 7-15 shows a cutaway view of the nose section of a Terrier BT -3 missile. The probe

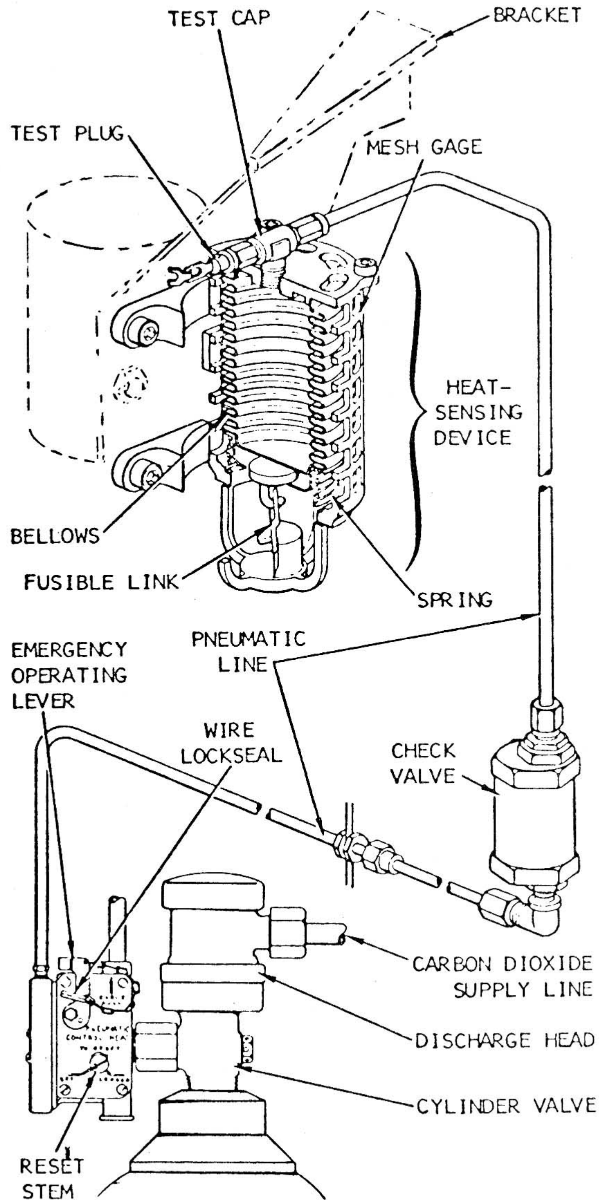

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Figure 7-13.—Carbon Dioxide System: Pneumatic Components.

shield is a protective covering to prevent entrance of dust and moisture. The shield is blown away by air pressure against its face when the missile is launched. The nose orifice admits air to the transducer. The gas pressure transducer is a variable-reluctance device that senses total air pressure (static pressure plus pressure caused by missile velocity) and converts it: to a voltage which regulates the servo gain in the roll and

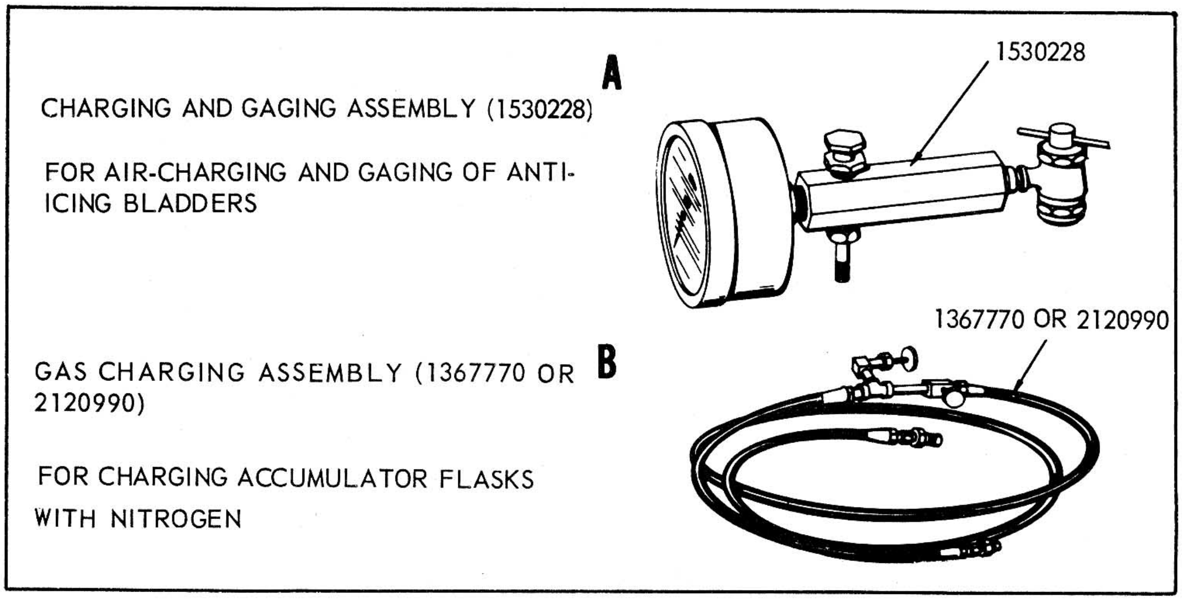

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Figure 7-14.—Charging assemblies: A. Charging and gaging assembly for anti-icing bladders; B. Nitrogen charging assembly.

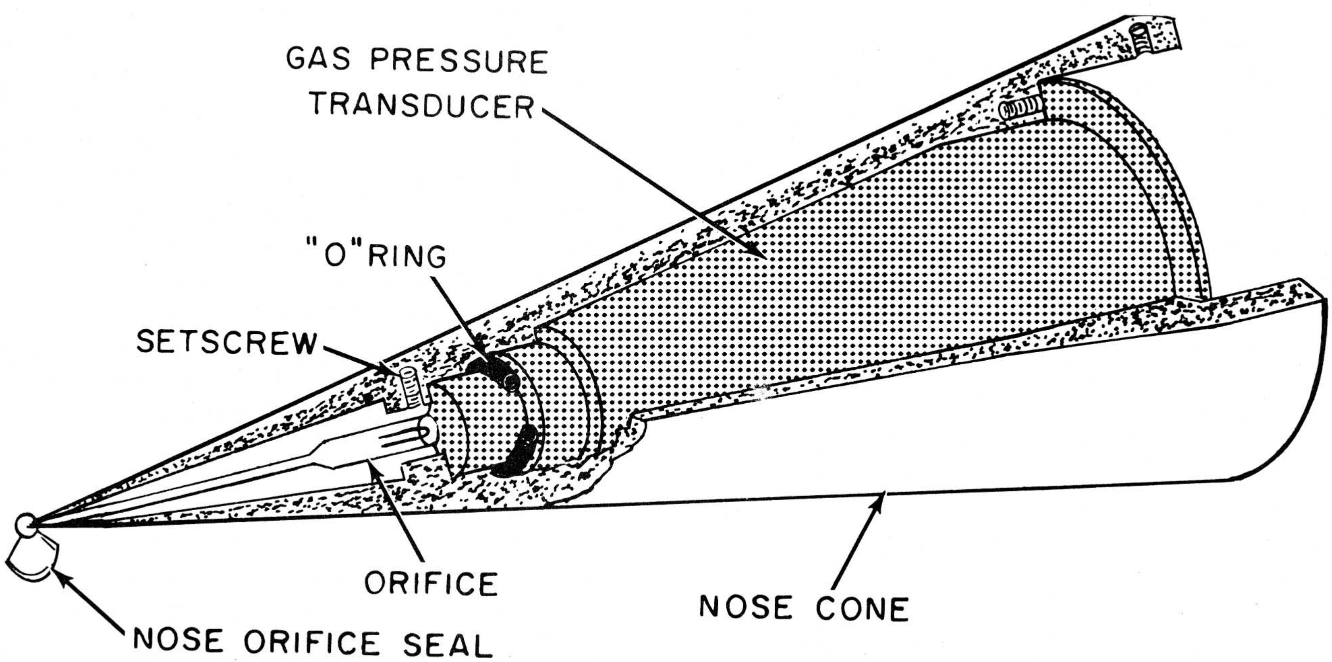

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Figure 7-15.—Nose section of Terrier BT-3 missile; cutaway view.

steering systems to compensate for changes in the control surface effectiveness caused by changes in missile velocity and altitude. The potentiometers associated with the gas pressure transducer are located in the signal control package. Changes in the ram and static air pressure are signaled to the signal control package to effect changes in the missile attitude.

The Terrier HT-3 missile has similar parts with slightly different names. The nose section is called the radome section, and it has a ram pressure probe that supplies the pressure transducer With ram air pressure. The transducer, in turn, supplies an electrical output that drives the servometer. As the servometer turns, it positions the ganged potentiometers as a function of missile ram pressure. The potentiometers act as fractional multipliers for various signals in the guidance computer so that the steering system gain is correctly controlled for variations in air density and missile velocity. The same technique is used in Tartar missiles.

The Talos missile has a more extensive air intake system because it must also take in air for operation of the ramjet engine in the propulsion system. An air-turbine-driven fuel pump delivers fuel from the tank. Ram air enters the diffuser, which is an annular passageway (leading to the combustor) where the supersonic low pressure air is converted to a low-velocity, high-pressure airstream. In the combustor, fuel is sprayed into the airstream and the air/fuel mixture is ignited by a spark ignition unit (spark plug). The hot exhaust gases develop thrust in passing through the exit nozzle to speed the missile on its way.

As in the other missiles, the control surfaces (wings, fins) are moved by hydraulic power. But hydraulic pressure is developed by the ram air turbine. Before the missile is in flight and the ram air turbine is operating, hydraulic pressure is built up by a high-pressure nitrogen pressurization system.

OVERHAUL, REPAIR, TESTING, AND ADJUSTMENT

The GMM 1 must be able to test, overhaul, repair, and adjust the pneumatic components of missile handling and dud-jettisoning equipment; the GMM C must be able to plan, implement. and supervise the maintenance and repair program for the pneumatic equipment. The Naval Ordnance Systems Command has contracted for technical services to assist naval personnel in the proper assembly, installation, inspection, test, repair, servicing, modification, maintenance, and operation of guided missiles, missile targets, and associated special test and handling equipment (NAVORD INST. 4350.5A). However, for fleet self-sufficiency and to conserve funds, GMMs are expected to be able to take care of their weapon systems and request help only in unusual circumstances.

WARNING: Always deenergize equipment before attempting any repairs. Exhaust air from lines or pipes in or to the equipment.

In any pneumatic system, loss of air pressure is the most common failure. Checking with the pressure gage can give you proof of the loss of pressure; slow or weak action is a symptom of pressure loss.

CAUTION: Plug all lines, openings, and connections during disassembly and assembly so no dirt, dust, water, or other foreign matter can get into the system.

Plan the job before attempting any overhaul. This planning should include obtaining the proper tools, checking availability of repair parts, study of the equipment and illustrations, review of safety measures pertinent to the type of machinery involved, and allocation of sufficient personnel to complete the overhaul in the allotted repair time. A well planned project will result in better, quicker, and safer results.

AIR MOTORS

Whenever any repair or maintenance is required on the train or elevation system of launcher, the air motors are used for moving the launcher. They are also used if the automatic system for operating the launchers is disabled. Air motors, therefore. must be kept in operating condition by proper maintenance, repair, and overhaul. Solenoid-operated control valves, which have identical components it hydraulic or pneumatic control, must actuate on signal. All O-rings and gaskets should be replaced With new ones whenever the valve is overhauled. The caution to "remove gaskets carefully," is intended chiefly as a caution against scratching or gouging the seat for the gasket. Take the valve to a dirt-free area to disassemble, clean, replace parts, and reassemble. Do not use waste for cleaning; use clean, lint-free rags. Be sure to secure all power to the launcher before removing any parts.

WARNING: Position the main power circuit breaker and the train and elevation air drive motor manual control valves at OFF. Place warning tags on these controls.

To remove the air drive motor, disconnect two air lines. Plug lines to prevent entrance of dirt or foreign particles.

Air motors used in Talos, Tartar, and Terrier launching systems are of similar construction. Obtain and study the maintenance instructions for those on your equipment before attempting repair work on them.

Assembly is the reverse of disassembly. Do not disassemble any more than necessary. Careful alignment and snug fit are important; frequent disassembly tends to destroy these. If replacement of the head gaskets or the rear gasket is necessary, scribe the cylinder and cylinder-to-rear housing for alignment on reassembly. Make alignment scribe marks on the head, distributor, and drive shaft before disassembling these parts from the head. These scribe marks are important because rotation of the distributor by 180 degrees changes motor rotation to the opposite direction.

Use new gaskets and new cover plate screws when reassembling, and replace any pitted or worn balls, and worn oil seal.

AIR LUBRICATORS

Air lubricators (fig. 7-16) are of the Micro Fog type which convert the oil to a vapor which is carried along with the air to give internal lubrication to the air drive motors. One lubricator supplies oil vapor to the train and elevation air drive motors; the other supplies the guide pneumatic cylinders. Do not disturb the factory adjustment of the lubricators unless you are positive a malfunction is caused by lubricator maladjustment. The oil level may be seen through a sight glass on the lubricators; if the level falls to the lower third, replenish the oil (check NAVORD drawing for correct type). Remember to secure all power to the launcher before doing this.

The air-driven chain drive fixture used with the Mk 13 launching system for strikedown, described earlier in this chapter, also has an air lubricator in the air supply line to the air motor, air throttle valve, and manual air control valve components. Although not always mentioned, other air motors also have air lubricators to supply air that lubricates.

The air lubricators, which provide a fine mist of oil to the air motors, sometimes need cleaning or adjustment. Check the fluid level monthly and replenish with the proper grade of oil if the level falls to the lower third of the sight glass on the lubricator. Check the applicable drawing for your equipment. For example, NAVORD Dwg 1600594 (for Guided Missile Launcher Mk 5 Mod 3) directs that train and elevation air motors need to have their reservoirs filled after 4 hours of operation.

Symptoms of maladjustment are:

1. Oil accumulation in the guide (or near the lubricators).
2. Noisy air drive.
3. Sticking pneumatic cylinders causing jerky piston operation, binding, or slamming.
4. Loss of power in air drive motors.
5. Lubricator has to be filled too often.
6. Lubricator needs no oil after extended launcher operation.

Each air lubricator has an oil feed adjusting screw (fig. 7-16) by which you can adjust the drip to 8 to 10 drops per minute (this vanes for lubricators in different systems). The position of the plate under the sight feed dome should be checked; remove the clamp ring and the sight feed dome. The bottom horizontal plate in the sight cavity should have the cast arrow pointing to position B for full air flow to the air motor and the lubricators. Adjust the plate with a screwdriver if it is not in position B. Type "B" lubricators have a bypass screw for adjusting the air flow (fig. 7-16B).

Operate the equipment to check the success of the adjustment. Several adjustments may be necessary before you achieve good results. Although air lubricators are of rather simple construction, adjustments must be made with care. They are NAVSHIP equipment if installed on ship's air lines.

Air control valves may require adjustment or overhaul. Any time a control valve is disassembled, all O-ring and backup seals should be replaced.

PNEUMATIC TEST SET TS-1165/DSM

Pneumatic Test Set T8-1.165/DSM is used for depot testing of the BT-3 and BT-3A Terrier missiles. Figure 7-17 A shows the exterior of the test set and figure 7-17B shows the pneumatic circuit. Depot MSTs are performed with regulated air to operate the auxiliary power supply turbines. The air is furnished through the TS-1165/DSM. Aboard ship, the MST is performed with external hydraulic power, supplied by the HD-259/DSM pumping unit. External electrical power is furnished by the Guided Missile Test Missile Test Set AN/DSM-54(V)C2. Both depot and shipboard checkouts use pneumatic pressure to actuate the missile ram pressure system. On shipboard, a gas pressure actuator is used (fig. 7-18), but a pneumatic test is not conducted.

The pneumatic test set weighs 200 pounds and is housed in an aluminum cabinet 24 inches square and 27 inches high. On the top panel are five gages and three indicator lamps for monitoring operation. The meter indicators and light on the front panel (fig. 7-17 A) are part of the automatic safety mechanisms. They are mounted on an individual chassis and may be removed easily for servicing. All controls except one manual shutoff valve for each channel (fig. 7-17B) are electrically operated. The test set can be operated from the panel or from a remote source. If can be controlled automatically by the use of the program tape of the AN/DSM-54(V)C2.

Ensure that all air lines and electrical connectors are securely attached t the proper ports and connectors at the top of the pneumatic test set, including a hydraulic pressure switch. Apply pressure from an external source of clean, dry air, either a compressor or a tank (600 to 1000 PSI).

WARNING: Make SURE that output hoses are SECURELY connected and ends tied down to prevent whipping.

The pneumatic test set accepts high pressure air and directs it through tubing into one of two separate channels which supply pneumatic power to the turbohydraulic and turboelectric systems of the BT-3 or BT-3A Terrier. The two channels can be used simultaneously and controlled independently. The principal elements of each channel are the manual valve for complete shutoff and a dome type regulator with high flow capability (fig. 7-17B). The controlling pressure applied to the dome is passed through a low-volume regulator capable of precise control. The dome is exposed to continuous compensation in either increasing or decreasing direction at a level preset manually prior to test operations.

When the turboelectric supply channel is opened by means of the manual control, pressurized air is applied to the pilot regulator and to the principal dome regulator; however, the valve in the latter remains closed as long as there is no pressure in the dome. The pilot regulator stabilizes the pressure but is prevented from influencing the dome by a solenoid shutoff valve. Air flow will begin when the solenoid is energized. The regulated air of the pilot valve will then enter the dome and establish a large flow through this channel at an outlet pressure determined by the preset conditions of the pilot valve. Flow will continue to the limit of the source and variations of input pressure and external demand will be compensated so that the output pressure will remain constant, within working limits. A pressure gage connected into the channel continuously monitors the output pressure, and a temperature gage indicates the temperature of the regulated air.

Deenergizing the solenoid valve between the pilot regulator and the dome stops the air flow between them but does not stop the flow through the main channel, as a certain amount of air is trapped in the dome. Another solenoid valve must be opened to permit the dome to release the trapped air. A check valve senses the reduced pressure and simultaneously dumps any retained air from the output tube unless it has already been dissipated. The exhaust vent is open at all times except when a regulated flow is required. The vent closes and the line from the pilot regulator to the dome opens when both solenoids are energized.

The second channel (turbohydraulic supply) functions the same way but has an additional pilot regulator and solenoid (fig. 7-17B), so two preset dome pressure levels are available, electrically selected by means of the solenoid valves.

The only pneumatic element common to both channels is a pressure gage indicating the source pressure.

Note (fig. 7-17B) the capped ports for calibration, one in the main supply line and one in each channel. Calibration of the test set is necessary each time before use. Follow the instructions supplied with the test set, or in the applicable OP.

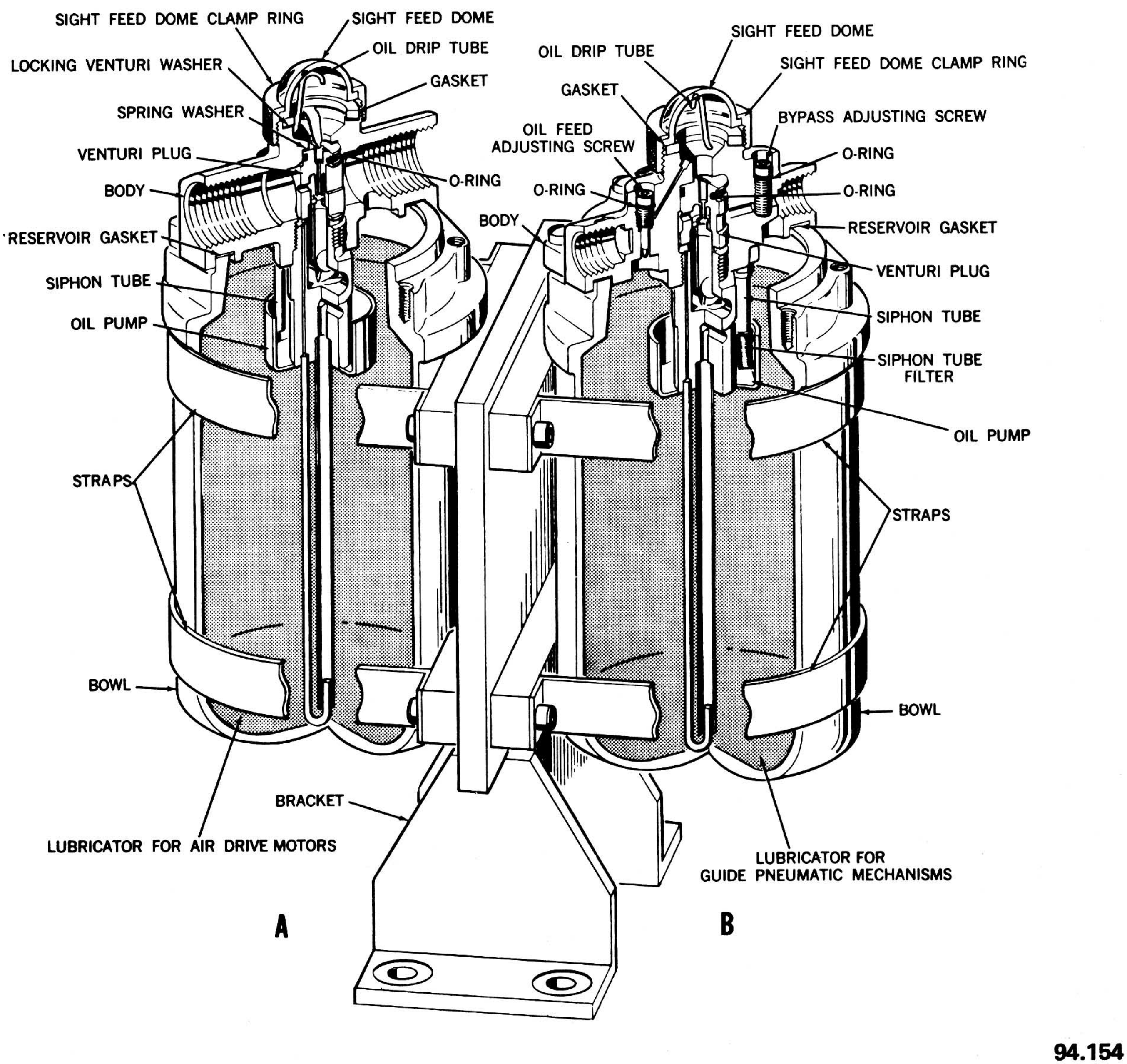

Figure 7-16.—Air lubricators, cutaway view; types A and B.

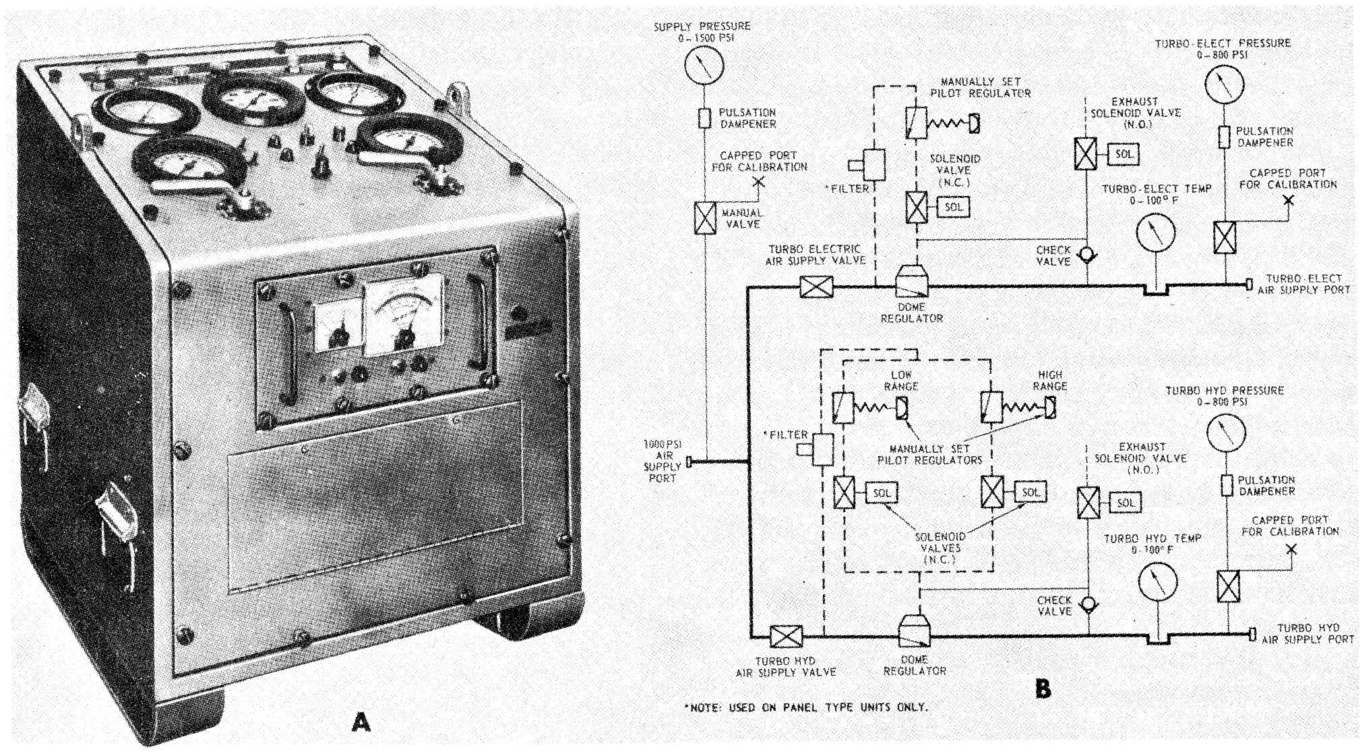

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Figure 7-17.—Pneumatic testing of missile: A. Guided Missile Pneumatic Test Set TS-1165/DSM; B. Pneumatic circuit diagram.

WARNING: All depot MSTs are performed on missiles with a live sustainer. This necessitates that the missile be grounded at all times. Observe all safety precautions.

For a pneumatic MST, the missile is assembled without the warhead section, S & A device, and fuze booster. A tactical test spacer (fig. 7-18A) is used in place of the warhead section, and a station test cable is used to connect the TDD and the electronic section. Present type depots perform only pneumatic MSTs. The sustainer is not electrically or mechanically armed, but is propulsive with the sustainer igniter squibs electrically grounded. There is no electrical connection between the test equipment and the sustainer igniter squib.

All-up type depots, which have special steel lined, reinforced concrete test cells where the missile is tested, perform electronic MSTs on completely assembled missiles with live sustainer, warhead, S & A device, and fuze booster.

Testing Aboard Ship

Pneumatic Test Set T8-1165/DSM is not used aboard ship to test missiles. Note its absence in figure 7-18B. However, Guided Missile Test Set AN/DSM-54(V)C2 is used, as at depots, to program the electronic test. The test set is connected to some pneumatic lines as well as to cabling, but no pneumatic test is performed.

On shipboard, checkout is performed with the missile completely assembled, with a warhead, S & A device, and fuze booster installed. The missile is brought to the. checkout area on the checkout car (fig. 7-18B), the booster is removed from it and is returned to the magazine for the duration of the test. The missile, on the checkout car, is moved to the blowout port and connected to it with the blowout pipe adapter.

The connections for missile testing aboard ship are sketched in figure 7-18B. The need for the blowout pipe has been discussed in previous chapters. The nose probe shield is removed from

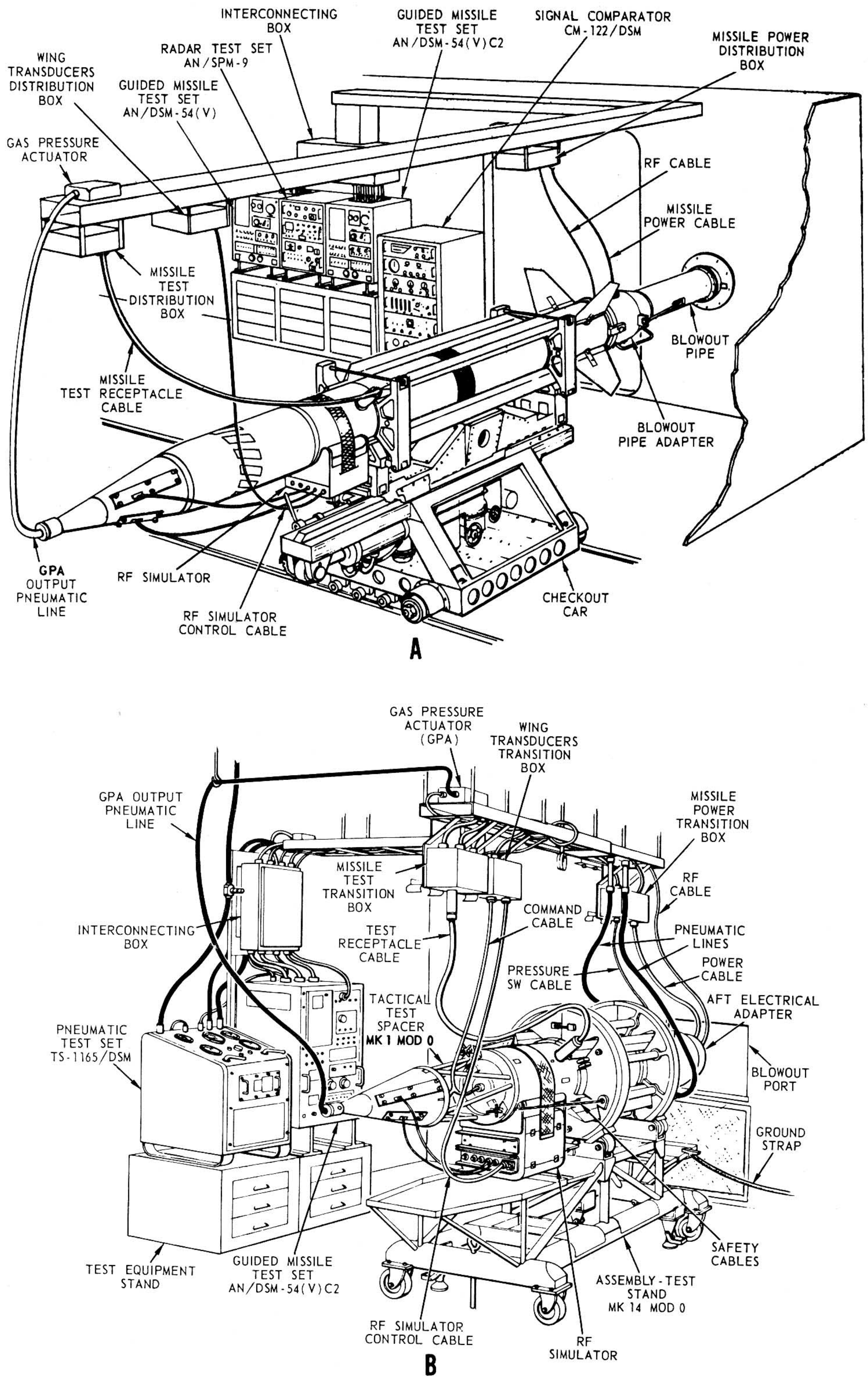

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Figure 7-18.—Missile Systems Test· A. Typical shipboard MST station installation; B. Typical depot MST station installation (present type).

the nose section of the Terrier for attachment of the gas pressure actuator air hose. To expose the missile test receptacle so the test receptacle cable can be attached, remove the forward end cover from dorsal fin No. 1, and then remove the test receptacle cover. A removal tool is required for this.

Full information on the equipment, pneumatic lines, and cables used at the individual shipboard test stations may be found in NAVORD OP 3119, *Terrier Guided Missile Test Stations*. Chapter 10 also gives some instructions for conducting the MST aboard ship, but the OP is needed for complete step-by-step procedures.

At the. end of the test, the Missile Test Set gives a GO or NO-GO indication of the missile flight readiness. If the test is NO-GO, Fault Location Lamps will illuminate on the test set, indicating the package which was found faulty during the test. With the aid of the fault location chart, it will usually be possible to determine the trouble.

After a successful test (GO indication), the missile can be restored to its previous condition by disconnecting all test connections, removing the TDD and nose section (to be reinstalled prior to flight), removal of the exercise head, if used, and reinstallation of the warhead, replacing the S & A device. Then the booster can be brought back for re-mating to the missile, and the round can be returned to the magazine.

If the test gives a NO-GO indication, fault isolation and troubleshooting procedures must be followed. There are different procedures for depot and for shipboard fault isolation. There are 13 FAULT LOCATION lamps on the test set. If any of the tests on a package fails, the associated lamp light. The lamps are interlocked so there will not be multiple lamps illuminated for the same fault. If several lamps light, it is almost always an indication that there were several failures.

A missile package or component that has been found defective should be replaced with an identical spare component. After replacement, the MST should be repeated to verify missile flight-readiness. Severe damage to missiles will result if the MST rules are not observed between tests. The troubleshooting between tests must be held to a definite minimum. The use of pressurized air is restricted to 6 minutes at low pressure (150 PSI) or 1 minute at high pressure (450 PSI) on aft section hydraulics. Other minimums are established for application of electrical power.

REPAIRS ABOARD SHIP

The pneumatic equipment used with missile launching systems is repaired on board ship to the extent of the ability of the men aboard and the repair parts available. Test sets, used by the FTs for testing the missile, may have to be returned to a depot or facility for repair and adjustment.

SUMMARY

Pressurized air is used to some extent in all the missile launching systems studied, but hydraulic and electric power are used to a greater extent. The air drive motors and air lubricators described are used in the Terrier and Talos systems for training and elevating launchers when there is a power failure, and also for maintenance and repair work. On Tartar launching systems, a pneumatic hand drive can be attached to the manual drive mechanism for moving the launcher.

The kind and number of handling equipments that are air operated vary with the installation. Some typical ones are described and illustrated. You are expected to maintain the ship's equipment that you use, but major repairs and overhaul are performed by other rates.

The pneumatic machinery that is part of the launching system, such as the receiving stand used with the Talos, and the chain drive fixture attached for loading the Tartar, are your responsibility. You must be able to maintain them in operating condition.

The use of Pneumatic Test Set TS-1165/DSM in checkout of Terrier missiles at depots, and shipboard testing without it were discussed. GMMs usually do not conduct the checkout alone, but should be prepared to do so.