CHAPTER 5

GUIDED MISSILE LAUNCHING SYSTEMS

INTRODUCTION

The guided missile launching system (GMLS) on a ship is that part of a ship's installation designed to stow and launch the missiles. Its purpose is to deliver a missile, ready for firing, from the missile magazine to the launcher guide arm. It must also return a missile from the launcher to the magazine for stowage. The launching system includes the feeder system, the launcher, and the launching system control. The feeder system stores the missiles and delivers them to the launcher. A typical feeder system consists of the missile magazine, loader, assembler, and strikedown and checkout equipment. Figure 5-1 shows these components for the Mk 12 GMLS (Talos). Not all launching systems have all these major components. The Tartar system, for example, does not have an assembler. For launchers with two arms, there are also duplicate components of the other parts of the system, one for the A-side and the other to supply the B-side, either simultaneously or independently.

Although the ship's fire control system is essential for successful missile action, it is not considered part of the launching system.

In your work around missiles and launchers you have undoubtedly heard the term "launching groups." The term "group" means the same thing as system - a group of inter-related equipments. The launching system for the ASROC, which is the responsibility of the Gunner's Mate (T), is called "launching group."

GENERAL DESCRIPTION

The discussion here, because it is limited to but one chapter in a course that must take up many topics other than this, will unavoidably omit a good many details.

The overall configuration of a missile launching system is determined by the type of missile used and the class of ship on which it is installed. The missile type is the most important factor to be considered.

The types of launching systems, however, are designed for specific ships, or rather, classes of ships. Many changes have evolved since the USS Gyatt was converted from a conventional DD to the first guided missile ship.

The arrangement of the major components of a launching system that handles the same type missile will vary with the Mk and Mod of the launching system, and the ship on which it is installed. This is especially the case with the location of the stowage area or magazine.

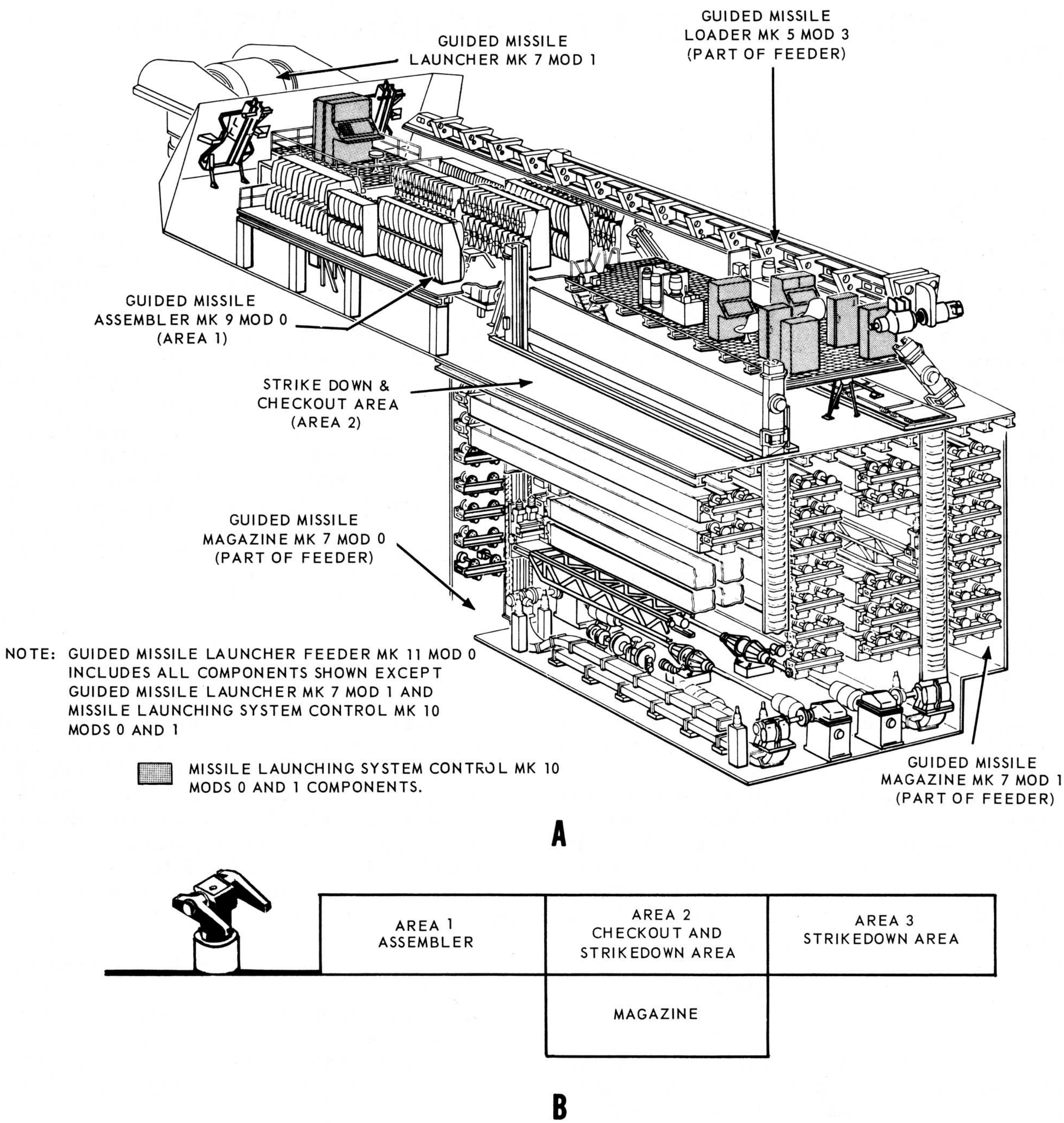
The Talos system, being large, is placed only on CGs, CLGs, and CGNs. The much smaller Tartar system is placed on smaller ships, such as DDGs, although CGs may have Tartar as well as Talos systems aboard.

LAUNCHERS

The main purpose of a launcher is to provide a launching platform or pad for missiles. But launchers have secondary purposes too: they must support missiles, aim them, prepare them for firing and, finally, launch them in the direction of the target. All missile launchers you will work with do these fundamental jobs.

The modern missile launcher is characterized by:

1. Its ability to position itself in train and elevation.
2. A structure that can support missiles singly or in pairs.
3. Devices that provide a method of inserting information into the missile before it is fired.
4. Devices that fire the missile.
5. Systems that provide for the safety of the ship, missile, and personnel.



83.36
Figure 5-1.—Guided Missile Launching System Mk 12. (Talos)

Every missile launcher has these general characteristics. In this section we will take up the more significant and common features of launchers.

Types of Launchers

Missile launchers may be classified in many ways:

1. By the common name of the missile it launches. Thus, you can call a launcher a Talos, Tartar, or Terrier launcher.

2. By the number of rails or guide arms. This method of classification is illustrated in figure 5-2. Notice that Terrier and Talos launchers are dual-arm ones, while Tartar launchers come in two varieties - single- or dual-arm types.

3. By the elevation position of the guide or missile-supporting structure when loading missiles. All Tartar launchers are vertical-load types. Early Terrier launchers are also vertical- load launchers. But the more modern Terrier launchers load missiles with the guide arms horizontal to the deck plane, or nearly so (at an angle on forward installations). Talos launchers receive missiles with the guide arms horizontal to the deck.

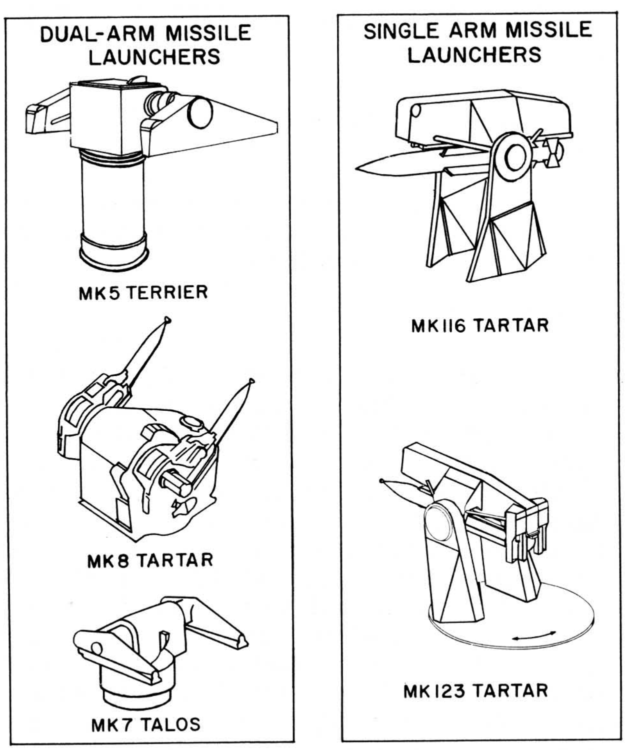


Figure 5-2.—Launchers classified according to the number of arms. 83.37

4. By the distance the missile travels on the launcher during firing. If the first motion of the missile during the launching process releases it from the launcher, the launcher is called a zero-length type. But, if the missile travels any distance along its supporting rail, the launcher is designated a rail-type launcher. Terrier and Talos launchers are sometimes loosely called zero-length launchers, but their missiles during launch do travel several inches before they detach themselves from the launcher.

Various proposals have been made to use guns for launching missiles, but at present this method has not been used on ships, although successful test firings have been made. The Tartar Mk 22 launching system was designed to use the training circle of a 5"/54 caliber gun.

FEEDER SYSTEMS

Some of the most noticeable differences are in the components of the feeder system.

Magazines

The three Terrier systems use magazines of entirely different designs. The Mk 4 system, which is installed on the USS Boston and USS Canberra, has the missiles stored in a vertical position and the launcher is located directly over the magazine, so the missiles are loaded vertically. The Mk 10 system, now used on most Terrier ships, stows the missiles in a horizontal position; but there are differences in the details of loading and unloading. The Mk 10 system has the missiles stowed in a ready service ring that rotates to the position directed when a missile is to be transferred. The Mk 9 system also had the missile stowed in a horizontal position, but in cells, and the hoist (a transfer car on rails) has to go to the missile to bring it up, instead of the missile being brought up to the hoist for moving to the loader, as in the Mk 10 system. The missile is extracted from the cell, and placed on the transfer car, which moves it to the loader.

The Mk 7 Talos system stows the missiles in a ready service compartment which contains trays that index to bring the selected missile to the hoist for loading. In addition, there is a replenishing magazine for additional missiles.

The Mk 12 Talos system (fig. 5-1) stows its missiles in trays, positioned like the cells in the Mk 9 Terrier system, but movable.

The missiles in all of the Tartar systems are stored in a vertical position in ready service rings directly below the launcher. Since Tartar missiles are complete, no assembly area is needed. The missile fins, which are on the missile in a folded position, unfold automatically after the missile is on the launcher.

Loader

In figure 5-1, locate the loader, sometimes called the rammer. It picks up the missile after it has been brought up from the magazine, moves it to the assembly area, where the wings and fins are attached, and then moves it to the launcher. Of course there are many more steps in this sequence, which we will not detail here. In systems where the launcher is directly above the magazine, there is no need for this lengthy transfer, and the loading sequence is shortened.

Assembler

The assembly area is in the missile house, near the launcher. The wings and fins that are to be attached to the missiles are stored in racks in this area. Men are stationed here (the number varies with the type of missile and its Mk and Mod) and they attach a wing or fin to the missile as it rests on the loader. It must be done very quickly to maintain the timing sequence of the launcher, and the men must have had precision- timed training before they are assigned to the task.

Strikedown and Checkout Equipment

By strikedown we mean the loading of the ship's magazines with missiles, boosters, and other missile components. Checkout means the preflight checks on missiles by the use of special test equipment. The tests are conducted by men of other ratings; your part of the job is to position and prepare the missiles for testing. Mating and unmating of missiles is performed in the checkout area; this, too, is part of your job. The layout and the location of the checkout area varies with the missile and the ship. See chapter 14 for illustrations and detailed discussion.

LAUNCHING SYSTEM CONTROL

The third major component of the launching system is the control equipment. The control panels for components are located as close to the component as possible. The large control panel offers pushbutton control of most if not all parts of the system. The large control panel offers automatic control, but local control is necessary for testing, checking, repairing, or replacing individual units of components. The local control panels are necessary for those procedures. A "typical location" diagram is shown later in this chapter.

TERRIER LAUNCHING SYSTEMS

As we have mentioned before, Terrier systems have been under development for a number of years and many changes have resulted. The Mk 10 launching system is the one found on the largest number of Terrier missile ships, but there are variations in the mods of this, ranging from Mod 0 to Mod 8. The Terrier Launching System Mk 9 is installed on three CLGs: USS Providence, USS Topeka, and USS Springfield.

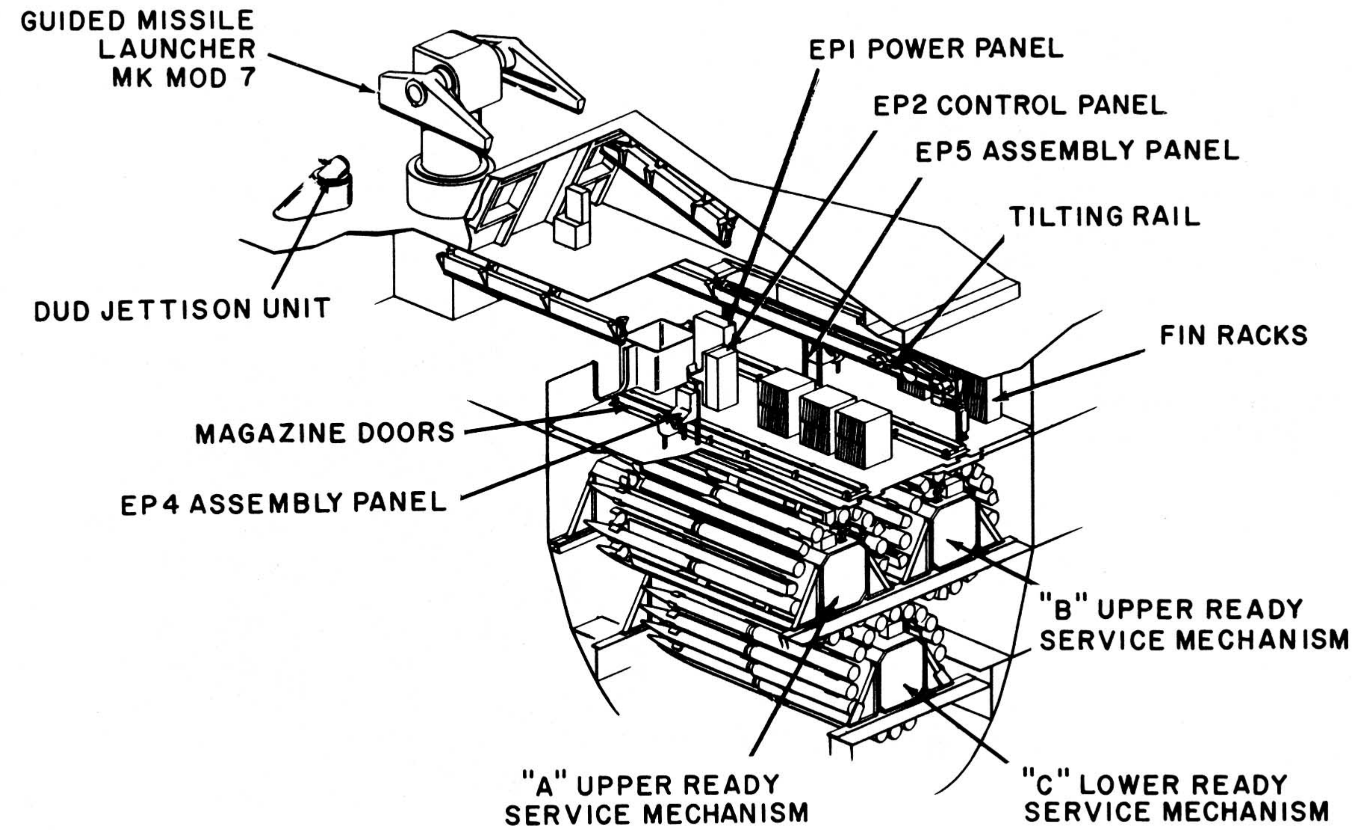
We will describe the Mk 10 launching system, pointing out the important differences in mods and showing where the Mk 4 and the Mk 9 systems are different.

LOCATION AND ARRANGEMENT ABOARD SHIP

The location of the components of the Terrier launching system varies with the type of ship and the Mk and Mod of the system.

Mark 10 and Mods

On a DLG-26 class destroyer, the launcher of the Mk 10 Mod 7 system is mounted at the ship centerline of the 01 level and the feeder system (magazines, loaders, strike-down equipment) is located below and aft of the launcher. As shown in figure 5-3, the Mk 10 Mod 7 Terrier system has three magazines (ready service rings), two of them at the upper level and one at a lower level. The one at the lower level is for auxiliary stowage purposes, and only Terrier missiles are stowed in it. The other two magazines can hold Terrier or a mixture of Terrier and Asroc (fig. 5-3). Each ready service ring has trays to hold twenty weapons. Because the Asroc is considerably shorter than the Terrier, it must be stored with an adapter attached to it. When an



83.159

Figure 5-3.—Guided Missile Launching System Mk 10 Mod 7 With Complement of Asroc.

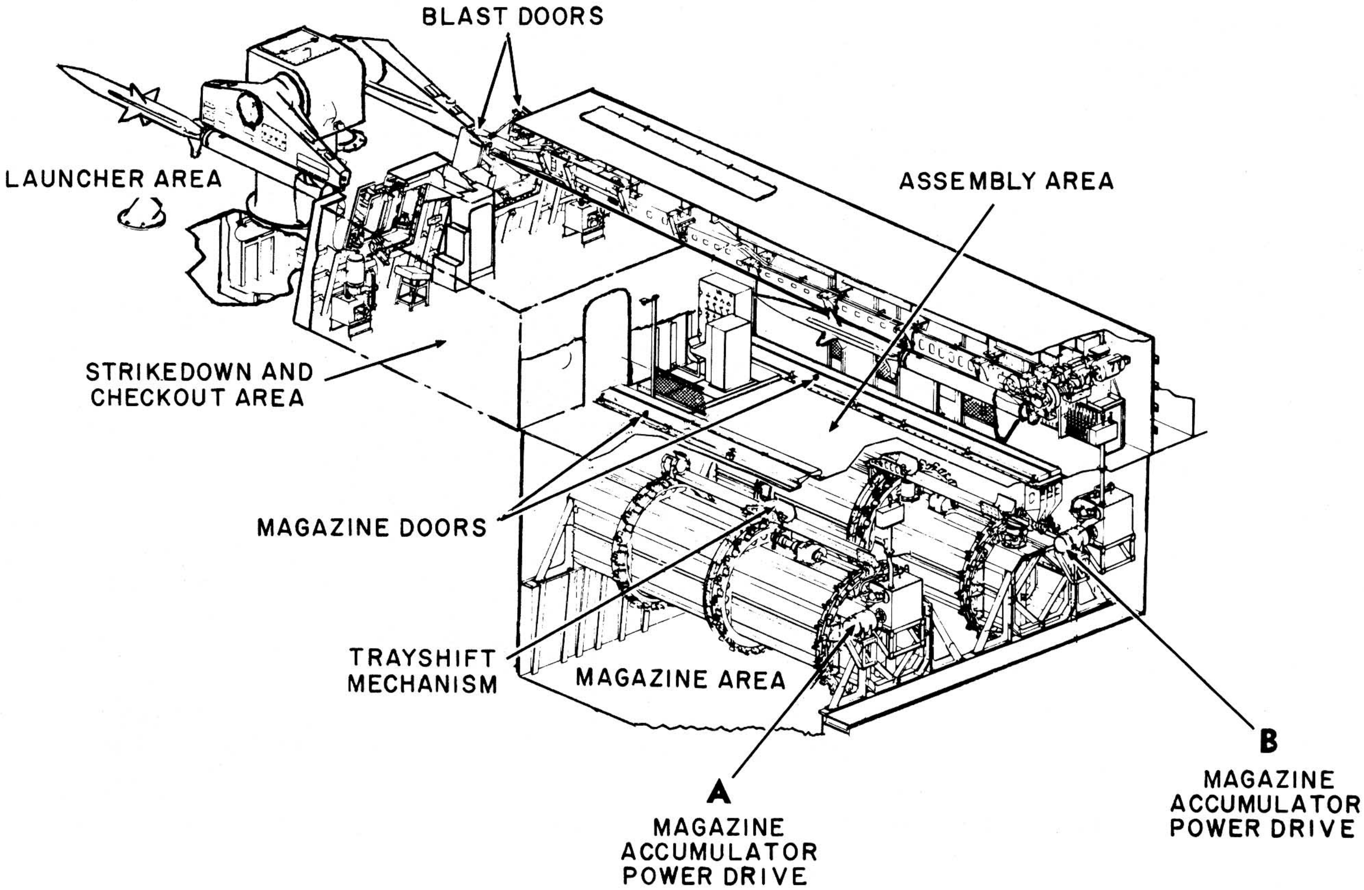
Asroc is fired, the adapter rail is left behind and must be returned to the ready service ring.

GMLS Mk 10 Mods 0, 5, and 6, has two ready service rings instead of three, and it does not accept Asroc missiles. Figure 5-4 shows a Mk 10 Mod 0 system. The launcher is near the aft end of the ship. Part of the launching system is in the aft deckhouse (missile house); the magazine area, containing the ready service rings, is below decks.

The aft deckhouse is divided into two compartments. The part nearest the launcher is the strikedown and checkout area, and the other compartment is the assembly area, with the missile magazine area directly beneath it. The missiles are transferred from the magazine area to the assembly area through the magazine doors (fig. 5-4) by the hoist. After assembly is completed, the missile is moved out of the assembly area on a loader r ail that extends from the magazine door, through the assembly area and the strikedown and checkout area, to the blast door. When the blast door is open, a rail extension connects the loader rail to the guide arm on the launcher, so the missile can move onto the launcher. The blast doors remain closed except during the moment of actual transfer of a missile to the launcher (or when unloading the launcher and moving the missile from the launcher to the magazine).

Mk 9 System

Instead of ready service rings that rotate to bring the selected missile to the hoist, the Mk 9 system stores its missiles in individual cells, and (instead of the hoist) a transfer car moves to the cell that contains the selected missile. This arrangement is shown in figure 5-5. The cells are numbered and identified on the control panel so that any missile may be selected for transfer from the cell to the launcher by pushing the correct button on the launcher control panel. A transfer car, which is part of the loader, runs athwartships on tracks to the selected cell, where an extractor beam extracts the round. As you can see in figure 5-5, there are two sets of magazines, one next to the assembly area and another for additional stowage.



83.160
Figure 5-4.—GMLS Mk 10 Mod 0, General Arrangement.

The system is divided longitudinally into two independent halves, as is the Mk 10 system. The "A" side equipment is the starboard side and the "B" side is the port equipment. The two halves operate simultaneously or separately, each to supply the launcher arm on its side.

Instead of a loader to move the missile round from the hoist to the assembly area, the Mk 9 system has a rammer system. The missile round rides on the rammer rail, which is driven by a continuous sprocket-driven chain that engages the booster shoe on the round. The first stage rammer carries the round to the assembly area and the second stage rammer takes the round from the assembly area, after the wings and fins have been assembled to it, to the launcher. The two stages have separate and independent hydraulic drives located in the overhead above the loader rails. Warmup power is applied to the missile while it is on the second stage rammer.

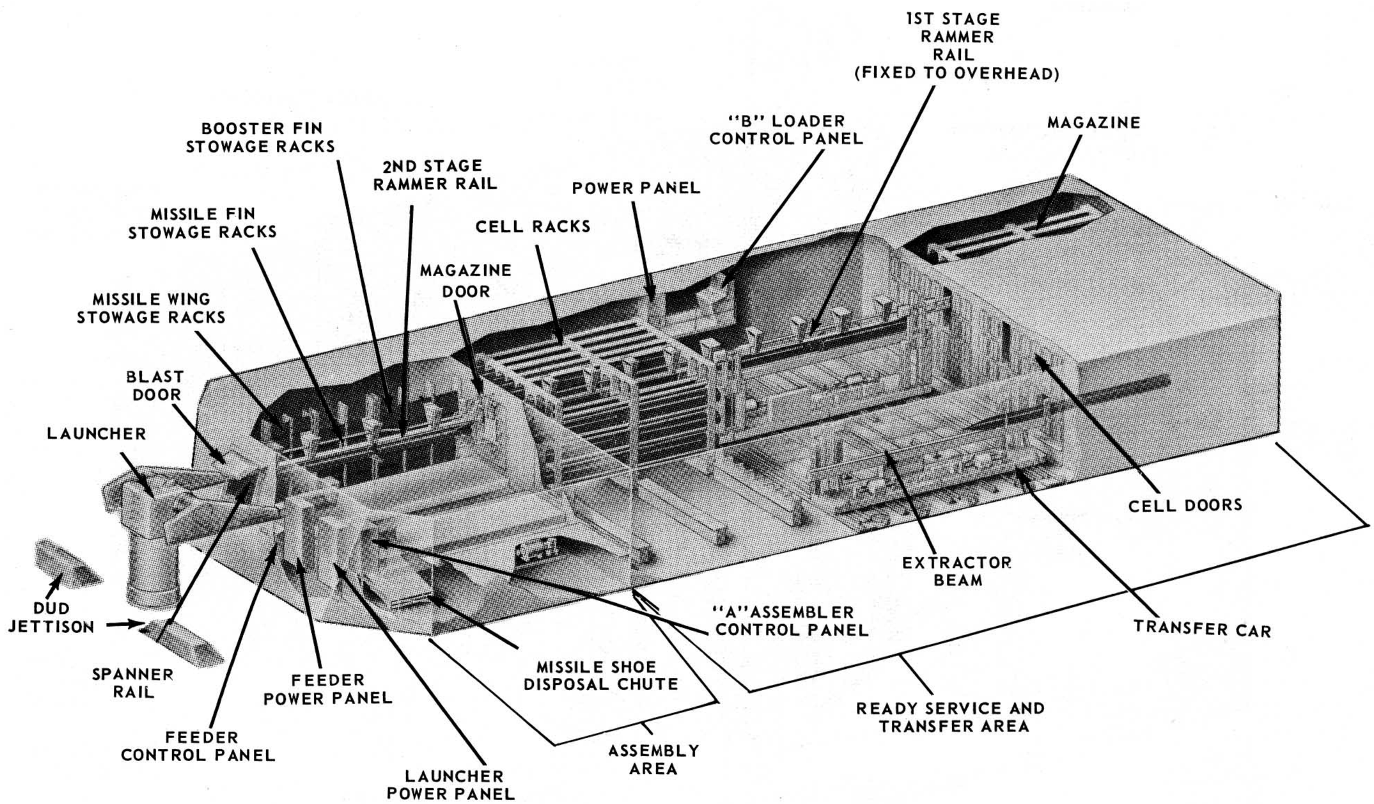
Mk 4 Launching System

The Mk 4 launching system is installed on two CAGs, USS Boston and USS Canberra. At this writing both ships have been placed in an inactive status in the reserve fleet so the system will not be discussed. Figure 5-6 is presented, however, to show the method of missile stowage in the magazine.

Control Equipments

Control panels for various parts of the launching system equipment are shown in figure 5-1, 5-3, 5-4, and 5-5. Most of them are in the assembly area of the system, but the power panels usually are placed as close as possible to the equipment they supply.

Power panel EP1 and Control Panel EP2 (fig. 5-4) of the launching system are manned by the launcher captain. If it is necessary to



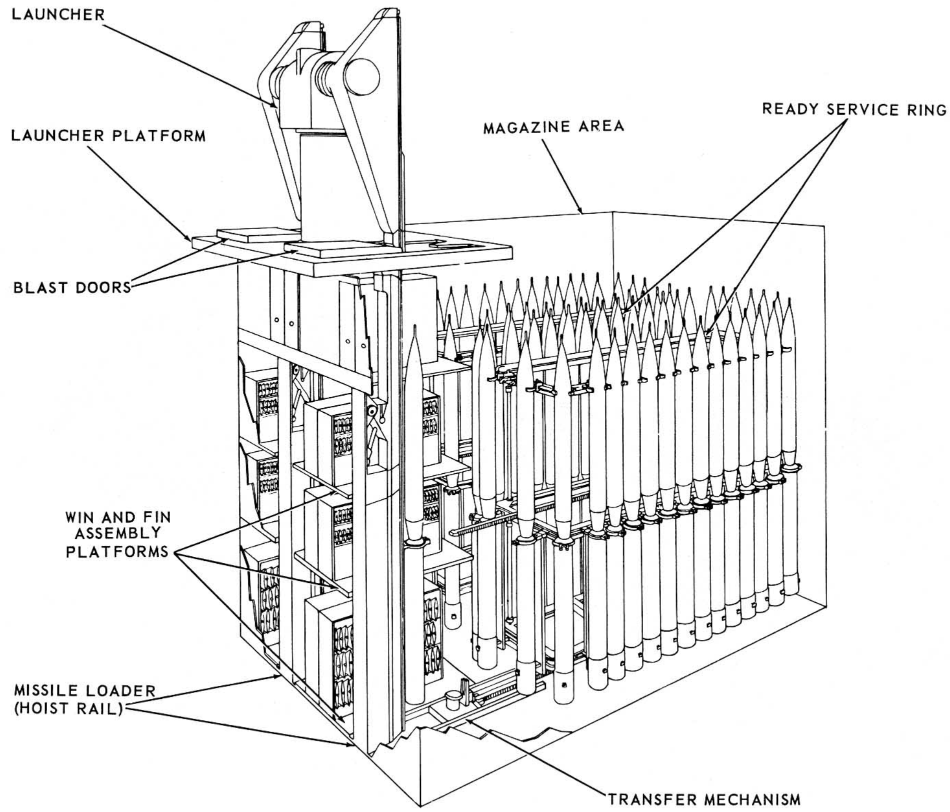
94.12
Figure 5-5.—Guided Missile Launching System Mk 9.

use EP3 and Dud Jettison panels, a crew member is assigned. The EP1 panel is the basic power distribution system for all electrical power to the launching system. It contains switches, circuit breakers, fuses, relays, and contractors for the power and control circuits. The EP2 panel is the operations control panel for the system. It contains the switches and relays to select the type of operation wanted, lights to indicate the phase or sequence of operation, the position synchros for the launcher, and the amplifier for the train and elevation movements of the launcher.

The EP3 panel is primarily a test panel, and is not manned during normal launching activities. Various test equipments can be plugged into it, and it can also be used for local control of the launching system.

The number and the functions of control panels vary with the launching system. Some systems have many more control panels than the three mentioned above.

So far we have talked only about the control panels in the launcher-feeder area. Orders for the operation of these controls must come from a higher authority. The Weapons Control System controls all the weapons on the ship, including missiles, guns, torpedoes, rockets, and depth charges. It consists of the Weapon Direction System and one or more Fire Control Systems. Figure 5-7 shows a specimen weapon control station with typical equipments. The launcher and feeder system are controlled by the operator of the Weapon Assignment Console (WAC). The WAC operator selects the missile rail to be loaded and the method of loading (single or continuous), applies warmup power to the missiles, selects the number of missiles to be fired per salvo, and assigns the launcher to a fire control system; or he can cancel the launcher assignment. These orders are not the whim of the operator, but are based on the information supplied to him by the WAC and the other equipment in the station. The men below deck can't see the target; they depend on the radars above deck to locate and track the target, the



83.161
Figure 5-6.—Missile Launching System Mk 4.

computer to figure the angle of train and elevation necessary for the launcher so the missile will intercept the target, and signals from various equipments in CIC to transmit decisions and orders.

THE FEEDER SYSTEM

The feeder systems of the different Terrier launching systems may be seen in the illustrations of the launching systems; figures 5-3, 5-4, 5-5, and 5-6. The general arrangement of the magazines, the assembler, and the launcher may be seen in the illustrations. The placement of control panels may be seen in figures 5-3 and 5-4.

Location

When missile systems were first installed on ships, ships already in service with conventional firepower were converted for missile use. The deckhouse was made to house much of the feeder system. The magazines were placed below deck as much as possible for protection of the explosives.

New ships, designed and built to carry missile systems, provide space below deck for every thing in the system except the launcher. Figure 5-8 shows the location of launchers and feeder systems on three types of ships. Figure 5-8A shows the arrangement on the first ships converted to missile use-the USS Boston (CAG-1) and the USS Canberra (CAG-2). Each ship is equipped with twin launchers, which replace the aft 8- inch gun turrets. The two automatic vertical missile launching systems, one for each twin launcher, provide the means for stowing, handling, and loading 144 Terrier rounds. Originally designed for BW missiles, the equipments have been modified to take BW1 Terriers.

Figure 5-8B shows the arrangement on the converted light cruisers, the USS Providence (CLG-6), USS Springfield (CLG- 7), and USS Topeka (CLG-8). On these ships, much of the launching equipment is in the deckhouse, mounted aft,

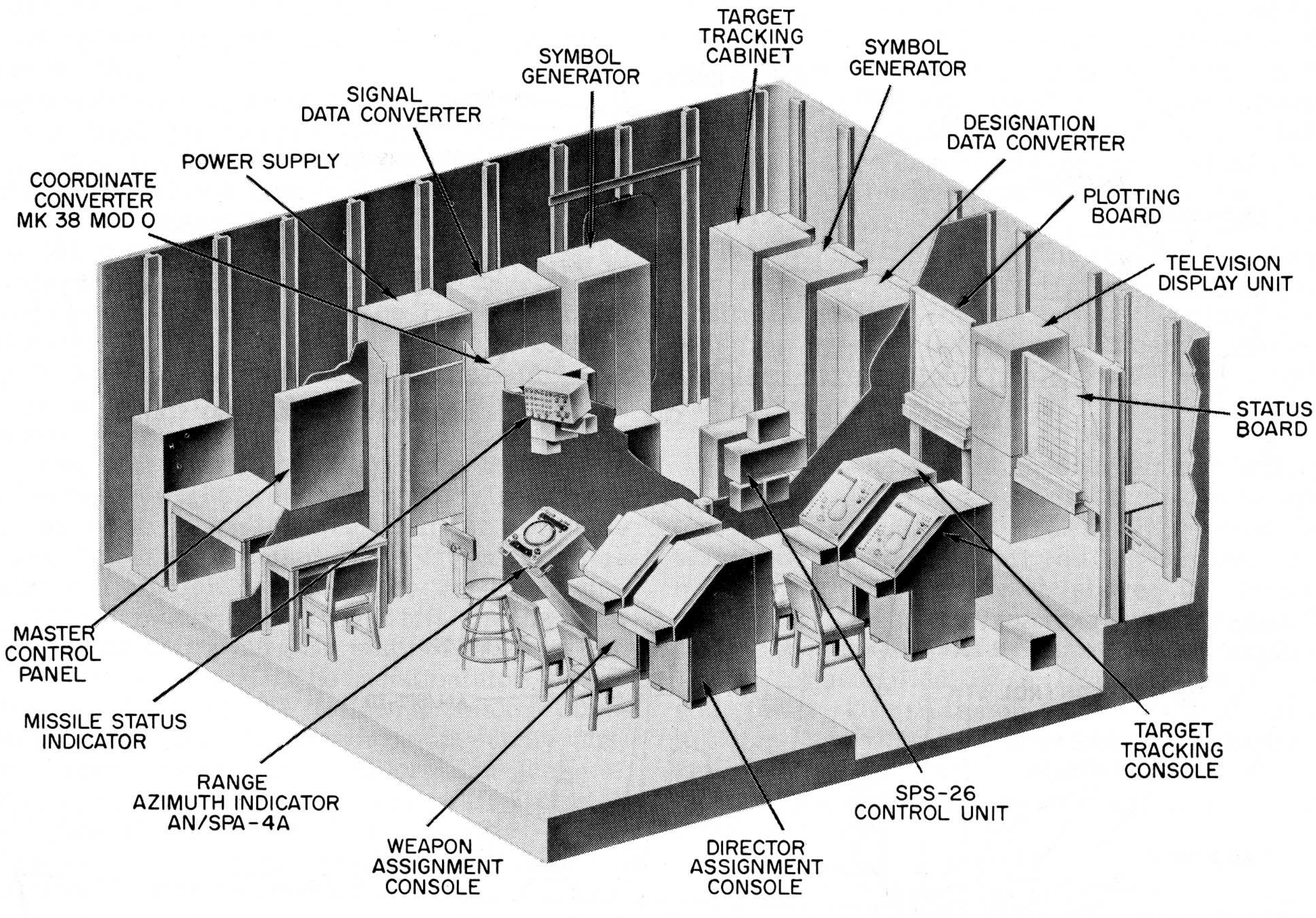


Figure 5-7.—Weapon Control Station (WCS).

with one twin launcher on the main deck. All of them have the missiles stowed in horizontal position.

Most of the ships carrying Terrier missiles are guided missile destroyers. The first of these, a converted DD, was the USS Gyatt (DDG-1), from which many lessons were learned in designing missile ships. Everything except the launcher is below deck. The dud jettison unit is mounted to the deck, but its control panel is below deck, as is the power supply. Figure 5-8C shows the location of missile system major components on a destroyer class ship. All of them use the Mk 10 launching system, varying in the mods used.

The Navy also has some missile frigates and these, too, carry the Mk 10 launching system installation. Carriers, too, have the Mk 10 Terrier system as part of their missile armament.

Components of Missile Magazine

Of the four major components of the feeder system, we've already given most attention to the missile magazine, its type (ready service ring or cell; vertical or horizontal stowage), and its location with regard to the launcher on different ships. Let's turn our attention now to other components.

POWER SUPPLIES. - You realize that considerable power is necessary to turn the ready service ring loaded with large, heavy missiles. We've mentioned a power panel that supplies electric power. In figure 5-3, locate the EP1 panel in the assembly area. In figure 5-4, locate the A magazine accumulator power drive and the B magazine accumulator power drive. Where there is an accumulator, there is hydraulic power. Figure 5-5 points out the power panels

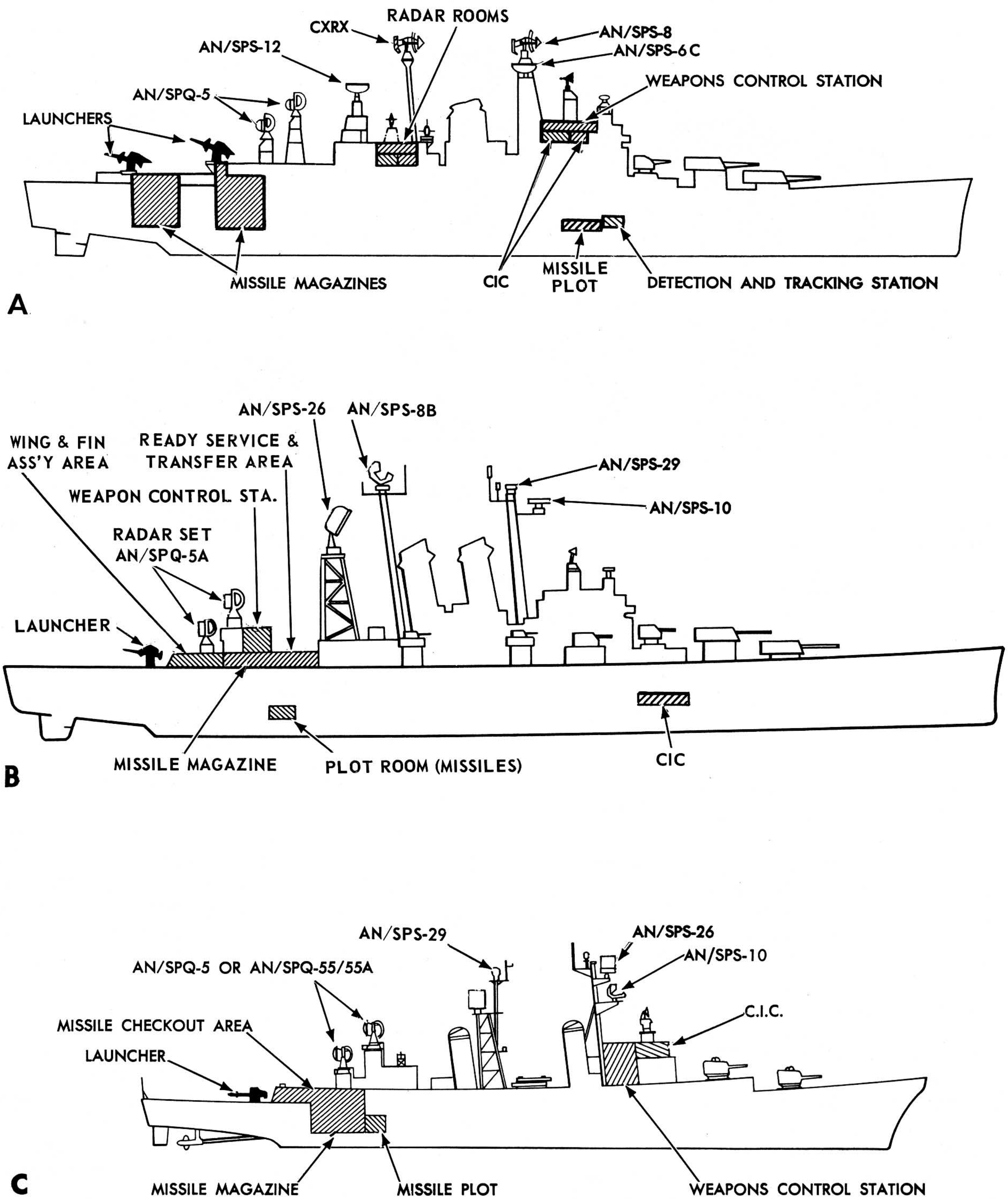


Figure 5-8.—Terrier Missile System Installations: A. On CAG (Terrier); B. On CLG (Terrier); C. On Destroyer Class Ship. 141.4-.6

for the feeder, the launcher, and another panel in the transfer area. These panels provide electric power supplied from the ship's electric power supply.

Hydraulic power is used to rotate the ready service rings: (1) to move the tray shift mechanisms that move the missiles from the trays in the ready service ring to the hoist; (2) to open the magazine doors to permit missiles to pass from the magazine (or return to it); and (3) to operate the hoist mechanism that carries the missile from the ready service ring tray to the loader-rail.

The magazine accumulator power supply system is located on the bulkhead near the ready service ring booster (aft) bearing assembly (fig. 5-4). The four accumulators for the system are located on the ready service ring truss. Separate power supplies are used for each side (A and B). The accumulator system supplies hydraulic fluid for operating the ready service ring drive motor, the tray shift mechanism, the magazine hoist, the load status recorder, and the magazine doors. The accumulator power system consists of the following major components: electric motor, piston pump, supply tank, header tank, control valve block, and accumulators. A conventional B-end hydraulic motor is used. (See Fluid Power, NavPers 16193-B for review of hydraulic motors and valve blocks.) Directional valves control the hydraulic fluid flow so the ready service ring can be turned clockwise or counterclockwise as desired. A power-off brake makes it possible to move the ready service ring manually, which may be necessary during repair.

In the Mk 9 system, hydraulic fluid and power are supplied to the first and second stage rammers, the blast and magazine door mechanisms, and to the rail operating fixtures such as latches and positioning pistons. The launcher power panel Mk 180 contains the circuit breakers, contractors, and overload relays for the launcher power drives. The Feeder Power Panel Mk 183 contains the circuit breakers, contactors, and overload relays for the feeder system motors. They are activated by the launcher captain at the beginning of operations and are then left unmanned. They are located in the after area of the deckhouse.

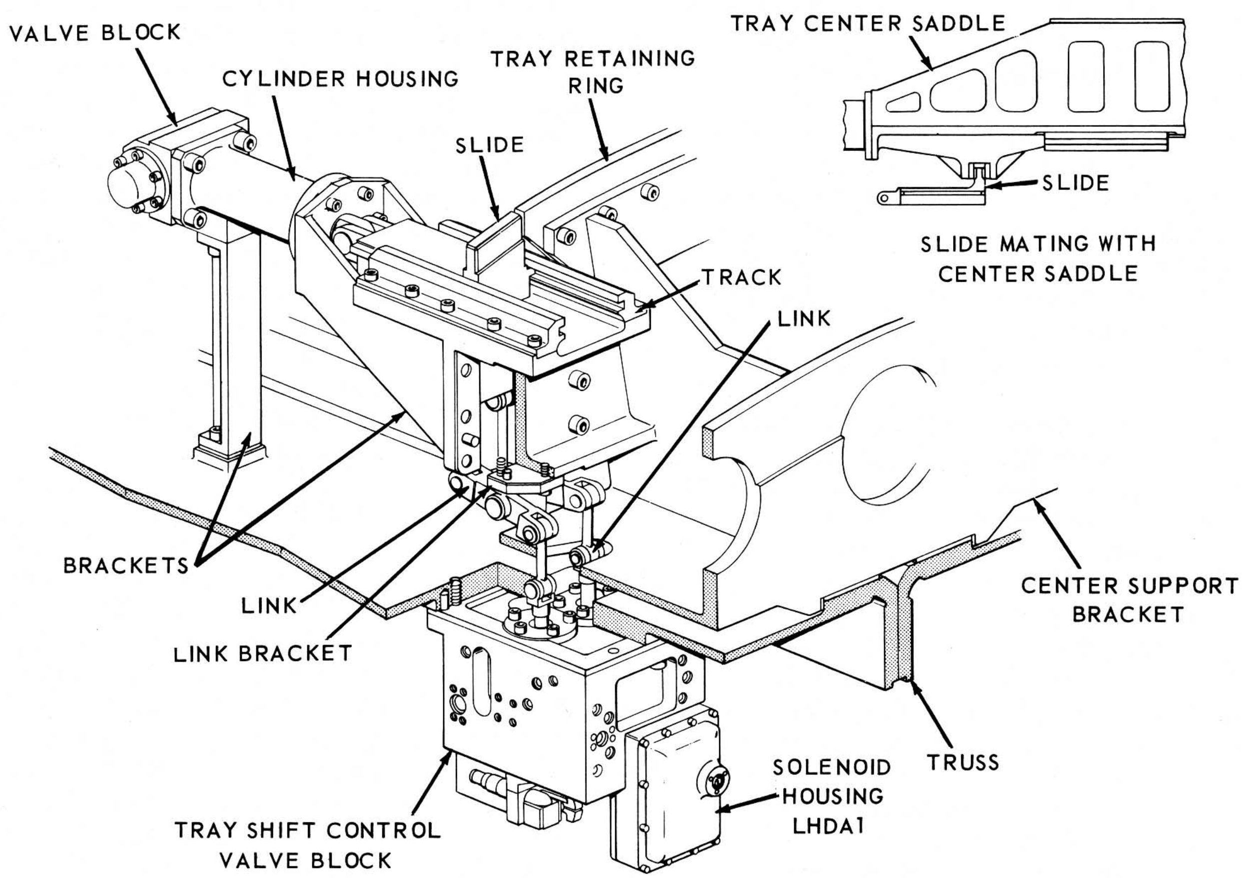
TRAY-SHIFT MECHANISM. - The ready service ring rotates to bring the selected missile to the loading position at the top, but there must be some means of transferring the missile from the tray that holds it in the ready service ring. This device is the tray-shift mechanism. The tray-shift mechanisms are hydraulic-mechanical devices (fig. 5-9) that shift the weapon and tray as a unit, disengaging the weapon shoes from the ready service ring and engaging them on the hoist. Two tray-shift mechanisms are mounted on each ready service ring, one at each transfer station. Each Terrier has forward and aft shoes by which the booster is secured in the ready service ring. Each tray in the ring has three saddles with two clamp arms that fasten around the missile. When the tray-shift mechanism positions a tray for the hoist, the clamps release by opening the arms. The center and rear saddles have cutouts to receive the forward and aft hoists, respectively.

HOISTS. - The hoist mechanism can transfer a booster or a booster-missile combination (complete round) from the ready service ring trays to the loader rail (or the reverse when unloading). As mentioned above, the forward shoe hoist engages the center saddle and the aft hoist engages the aft saddle on the tray. Power is supplied by a hydraulic drive unit and lower transmission and an upper transmission and drive shaft. As the weapon is raised to the loader, a guide on the aft hoist head contacts the overhead trunk and assures alignment.

MISSILE TRANSFER IN MK 9 SYSTEM. - In the Mk 9 system, with its missiles stored in banks of fixed individual cells, another method must be used to get the missile out of its cell and move it to the assembler. A transfer car which runs athwartship on tracks carries the missile from its cell to the loader (rammer). An extractor beam on the car can be lowered or raised and it can extract a missile round from a cell or return one to it. After extracting the missile round, it deposits it on the overhead loader rail, or it can transfer it to the checkout area for checkout tests. The last named is a semiautomatic operation.

INTER-RING TRANSFER. - If the missile needed is not in the A or B side ready service ring, it is possible to obtain it from the reserve supply. In the Mk 10 Mod 7 system (fig. 5-10), this is in the single lower ready service mechanism. Other Mk 10 mods have two lower ready service rings and the Mk 9 has a rear bank of cells from missiles.

We've mentioned station 1 in discussing the tray-shift mechanism (fig. 5-9). In the upper ready service rings (fig. 5-10), there is a



83.163
Figure 5-9.— Tray Shift Mechanism At Station 1 on ready service ring.

station 1 on both the A and the B sides, and missiles may be transferred to the loader from those positions. For inter-ring transfer, hoists are positioned to transfer between station 3 on the lower ready service ring and station 13 of the B side upper ready service ring. The other transfer point is between station 19 on the lower ready service ring and station 9 of the A side upper ready service ring.

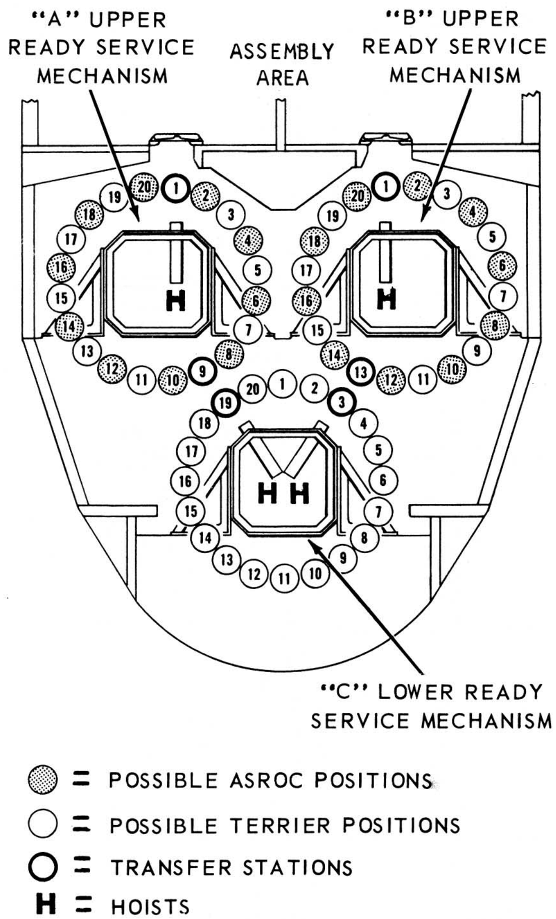
The Mk 9 system uses the transfer car for this operation.

The Loader Components

The loader consists of duplicate components for the A-side and B-side assemblies. It supports and moves the weapons between the assembly area and the launcher or between the assembly area and the strikedown area. Each loader assembly receives a weapon from the magazine hoist, moves it into position at the assembler, and then moves it onto the launcher. It is also capable of returning individual weapons or adapters (from Asroc) for restowage, or to the strikedown area, where they are tested.

Major components of each loader assembly are the loader trunk assembly and two types of power drives. The loader trunk is made up of several sections; a tilting rail (Mod 8 does not have this), a spanning rail, a blast door, and numerous operational components (fig. 5-11). The tilting rail may be latched in the horizontal position or at an incline. In figure 5-11 it is shown in the horizontal position as it receives the missile from the hoist. It is latched in this position to transfer missiles to the strikedown and checkout area via loader trunk sections I, II, and III. To move the missile to the launcher, the tilting rail is tilted up to meet loader trunk sections VI, VII, and VIII.

The Terrier shoes and the Asroc adapter shoes slide on rail segments bolted to the underside of the trunk sections. A sprocket-driven loader chain travels in the chain track in the



83.164

Figure 5-10.—Location of missile transfer stations on Mk 10 Mod 7 ready service rings (cross section of ship's hull).

loader rail. Power is furnished by the CAB- type power drive located in the overhead adjacent to the tilting rail.

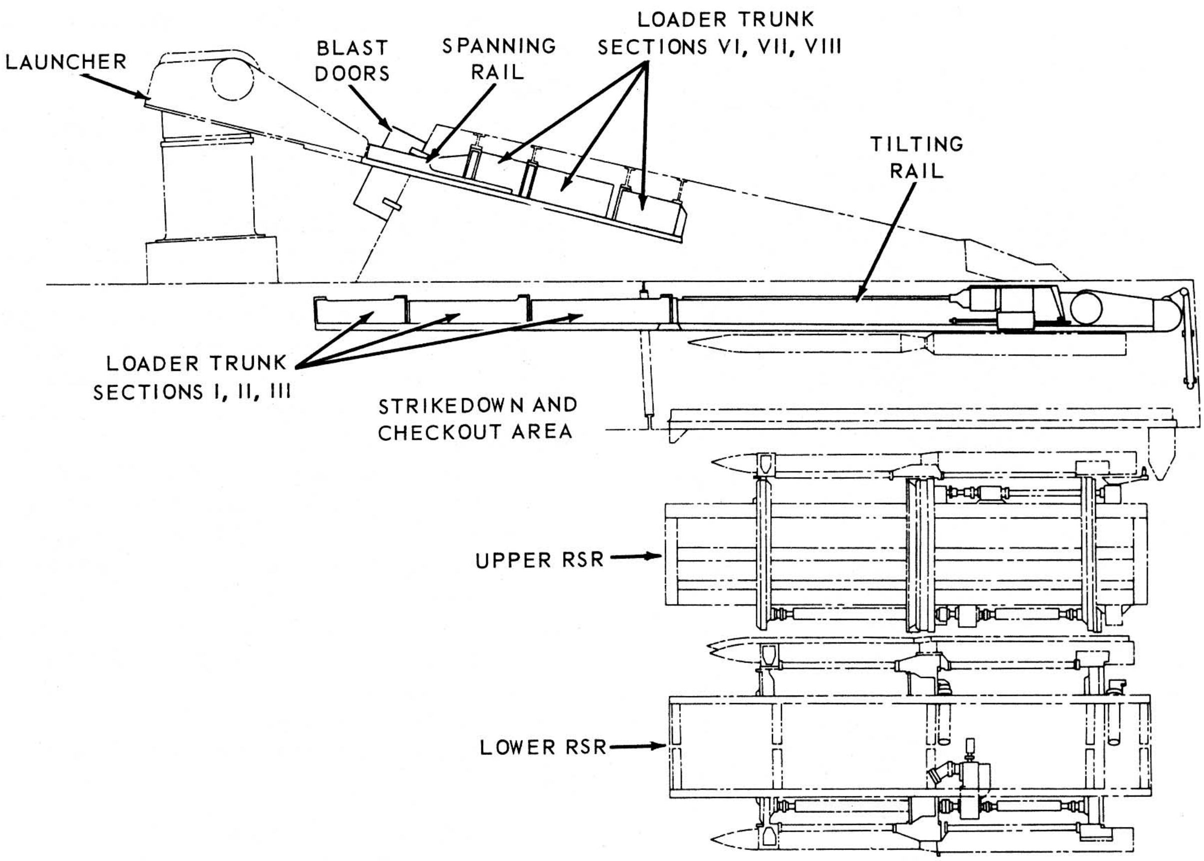
LOADER PAWL CONTACTOR. - Missile warmup has been mentioned several times. The pawl contactor (fig. 5-12), a five-prong electrical connector, mates with the warmup contactor pad for Terrier boosters or with the identification contactor pad on the Asroc adapter rail. When the aft shoe of the weapon engages the loader pawl, the contactor is forced onto the booster or adapter rail pad. The five-pronged contactor completes the circuitry to the missile. The loader pawl contactor remains mated until the contactor on the launcher takes over, so the warmup is continuous. Vacuum tubes in the missile must be warmed up to operating temperature, and gyros must reach a stable spinning speed.

SPANNING RAIL. - The spanning rail (fig. 5-11) bridges the gap between the loader rail attached to trunk section No. VIII and the launcher guide arm. It is operated hydraulically. When the blast doors open to permit the assembled weapon to pass onto the launcher, the spanning rail extends to meet the loader rail and provides a continuous path for the missile. After the missile has passed through the blast doors and is on the launcher, the spanning rail retracts and the blast doors close.

All Mk 10 Terrier systems have a spanning rail of this type for each launcher. In the Mk 9 system, the spanning rail is a component of the second stage rammer and bridges the gap between the launcher guide rails and the fixed second stage rammer rail. As the blast doors open, the spanner rail rotates into position and latches to the launcher rails. Although the relative position is different in the Mk 4 system, the operation of the spanner rail is similar to that of other models.

BLAST DOORS. - The blast doors are blast-proof and watertight hinged doors that prevent the entrance of missile blast (when closed) into the feeder compartment. A pair of doors is mounted on the exposed bulkhead between each launcher guide arm (fig. 5-11) and the A- and B-side loaders. The two doors are mechanically coupled to the spanning rail, causing the doors to open when the spanning rail is extended and to close when the spanning rail is retracted. Interlocks prevent opening the doors when there is a missile on the launcher and a condition is set. The position of the blast doors is different in the Mk 4 system, but the purpose is the same and the operation is similar to that of other launching systems.

The second power drive mentioned at the beginning of the section on the loader is the one that operates an accumulator-type power drive. It is located in the strikedown and checkout area. It supplies hydraulic power to operate the spanning rail, the blast doors, the tilting rail, the floating tracks, and the other loader components, such as latches and positioning pistons. The floating track mechanisms are located on the tilting rail to engage the missile shoes, fore and aft. The floating nature of these rail segments assures positive alignment between the loader and the hoist.



83.165

Figure 5-11.—Loader General Arrangement, Terrier Mk 10 Mod 7 system.

The Assembler and Assembly Area

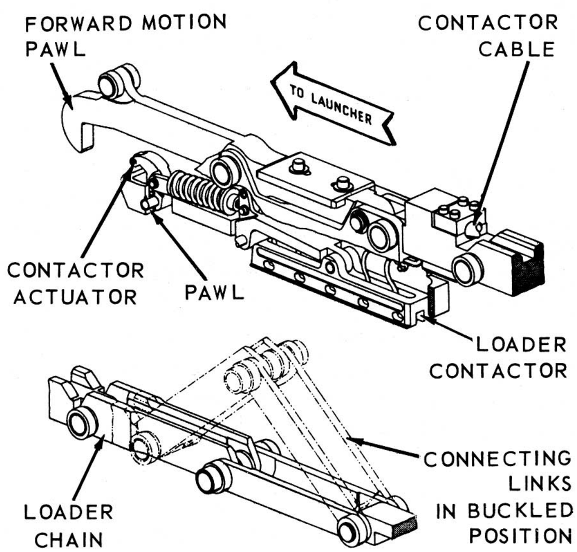
The assembler consists of stowage racks for the wings and fins that are to be assembled to the missile in the assembly- area. The older missiles, the BW type, had to have wings and fins attached, and fourteen assemblymen were required to man the assembly area. Only six men are needed for the BT3 missiles. Figure 5-13 shows the arrangement of the assembly area in the Mk 10 Mod 7 system, which also requires sixteen men, though only six per side (A and B) do the assembly work. It is located directly above the magazine area. Terrier booster fins and Asroc motor fins are stowed in the fin racks, arranged on each side of the loader for easy access. Each man has a safety foot switch which he presses after he has completed his portion of the assembly job and has stepped behind his safety screen. All six assemblymen must have their safety switches depressed before the missile can be moved. If both sides of the launcher are being loaded, simultaneously, there are twelve men, each with a safety switch to depress when he has "finished his work and assumed a safe position. Some foot switches have recently been deleted and twelve men are no longer required in systems with this change.

If the weapon is to be armed, this is done in the assembly area.

If a missile is being returned to the magazine, the removable fins are removed and stowed; the folding fins are folded; and the missile is disarmed in the assembly area before it is allowed to move on to the magazine area.

Strikedown and Checkout Equipment

In the strikedown and checkout area, testing and handling facilities are provided for missile checkout, maintenance, servicing, warhead substitution, and booster or rocket inspection. A checkout car that operates on rails is used when performing tests, checks, and adjustments. The area contains: (1) a guided missile test set (AN/DSM-23), (2) a hydraulic fluid pumping

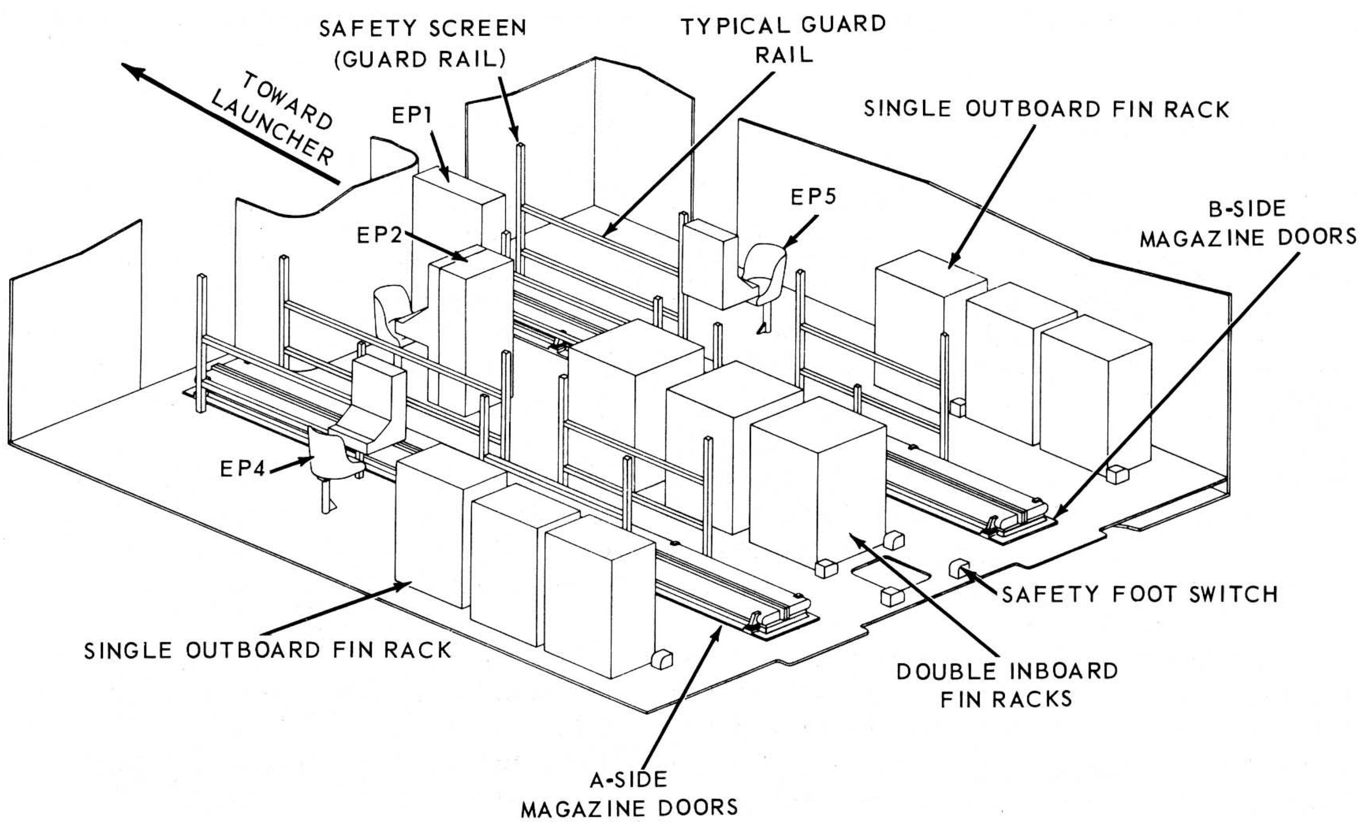


83.166
Figure 5-12.—Loader Chain Pawl Assembly, showing contactor parts.

unit (HD-259/DSM) for filling and flushing the hydraulic system in the missile and for operating the hydraulic system while testing the missile; (3) a compressed air supply; (4) radar test sets; (5) Dynamic Tester Mk 32 and Error Recorder Mk 9, for testing the computing and recording the results; (6) an operations event recorder which is a pen-tape recorder to mark on tape as the missile checkout is conducted; and (7) a photographic recorder which automatically photographs dials of the testers as the missile tests are conducted.

The testing of the missiles is done by other ratings, but you must transfer the missiles to the checkout area, and prepare them for the tests, then return them to the ready service ring. The operator at the control panel follows the step Control procedure to bring the missile to the checkout area. The steps are listed in the proper sequence in the OP for your equipment.

The checkout cars are also used for inter- ring transfer of missiles. Strikedown procedure is used, and the steps listed in sequence in



83.167
Figure 5-13.—Assembler, perspective view.

your OP must be followed. The Asroc is transferred without its adapter, but the tray to which it is transferred must have an adapter in it. Asrocs cannot be loaded in adjacent trays but must always have a Terrier or an empty tray between them. An Asroc with its adapter rail is shown in figure 5-14. When an Asroc is prepared for launching, the adapter is removed from the launcher guide arm after the missile is fired, and is returned to the tray in the magazine. As it is returned through the assembly area, the assemblymen must re-snub the snubbers and check the electrical cable.

THE LAUNCHER

All Mk 4, Mk 9, and Mk 10 launching systems use the Mk 5 launcher, but there are different mods. This means that there are differences but not great differences.

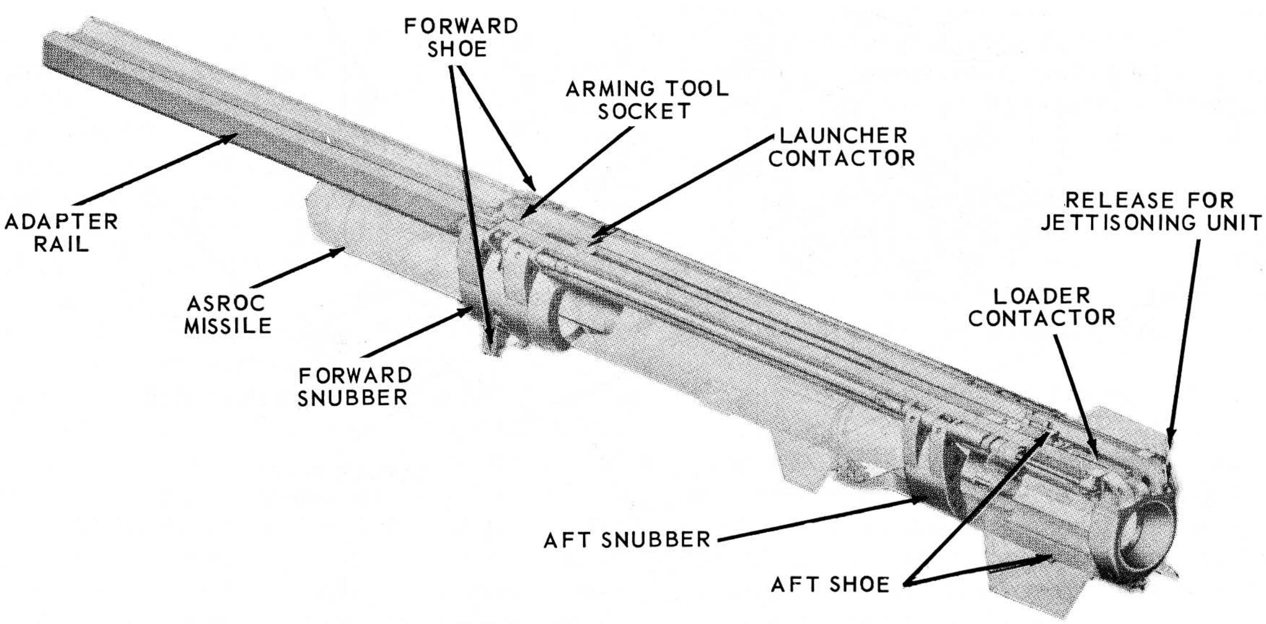
The launcher is a dual-rail mount that receives, aims, and fires single rounds or two- round salvos in accordance with signal orders received from the weapons system. After launching a weapon (or weapons), the launcher automatically returns to its load position, ready to receive the next ordered weapon or to return a weapon to the feeder for stowage. If an Asroc -was fired, the launcher must first return the adapter rail before it is ready to receive another missile. It is only the Mk 10 Mods 7 and 8 that can handle Asroc as well as Terrier missiles. The launcher is Mk 5 Mods 8 and 9. All mods have two guide arms but there are differences in the degrees of train and elevation possible. This is due in part to the location on the ship, for the launcher must never be pointed where a missile could strike any part of the ship.

Components

The main components of the launcher are the stand, carriage, power drive assembly, guide and guide arms, and the train and elevation system. (See figure 5-15.) Each of these is composed of many mechanisms and parts.

STAND. - The stand is a heavy circular steel weldment flange-mounted to the deck of the ship in a fixed position. The stand supports the carriage and the guides.

CARRIAGE. - The carriage is the rotating portion of the launcher. It is mounted within the stand. The electrical, mechanical, and hydraulic equipments for operating the launcher are mounted in it. The two principal parts of the carriage structure are the base ring and the trunnion support. The base ring is bearing mounted in the stand. The bearings permit horizontal movement in train. The trunnion support, a box-like weldment, is secured to the top of the base ring, and is exposed above the stand. Within it is the trunnion tube which supports the guides.



83.168

Figure 5-14.—Asroc adapter for use in Mk 10 Mod 7 launching system.

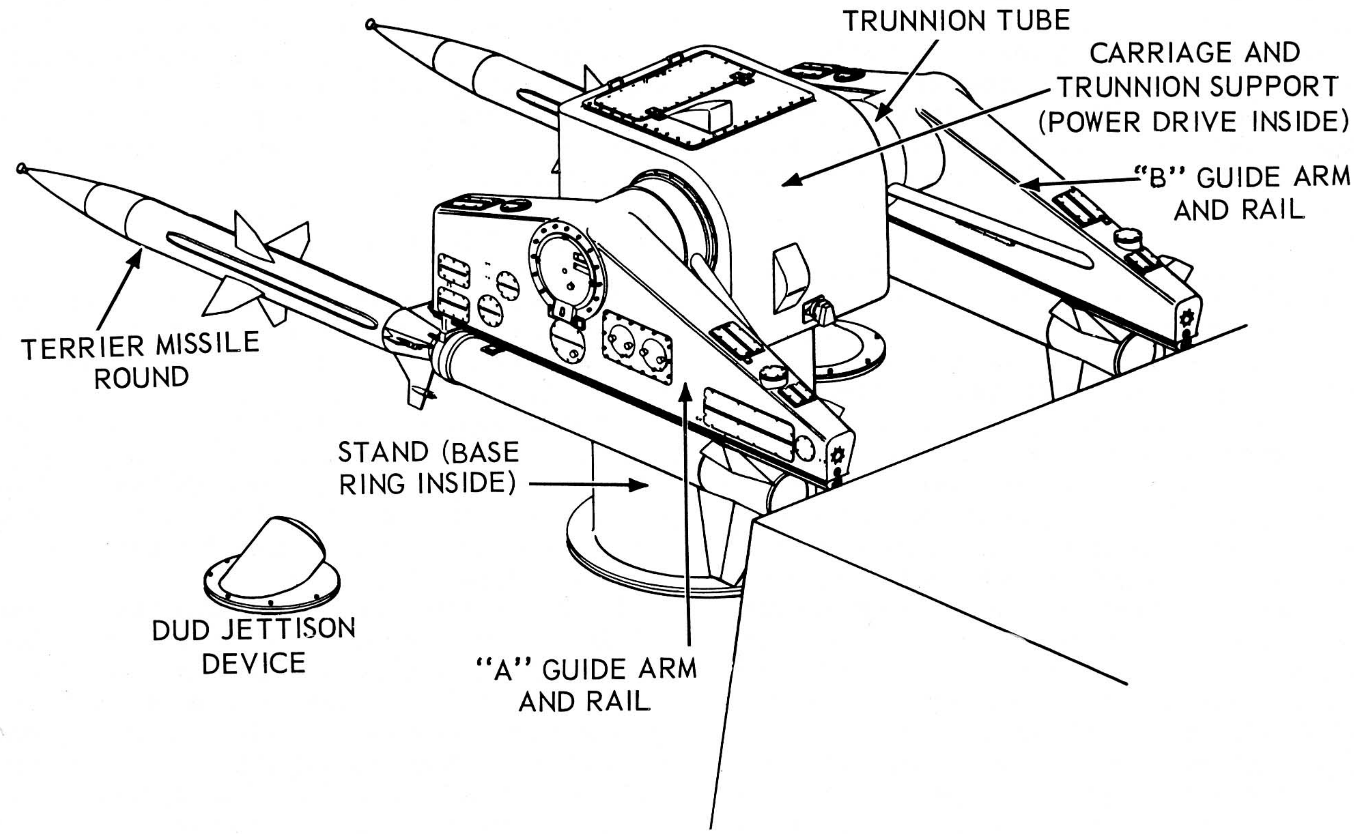


Figure 5-15.—Guided missile launcher Mk 5 Mod 3, general arrangement.

POWER DRIVE ASSEMBLY. - The power drives for operation of the launcher are mounted inside the carriage. Control orders are fed to the power units from the ship's fire control system.

Power Drive Assembly Mk 46 Mod 1 consists of two separate electric-hydraulic systems. One system operates the train system and the other operates the elevation system. The train and elevation systems position the weapons for firing by rotating the carriage (in train) and the guides (in elevation) as directed by orders from a computer in the Weapons Control Station (remote control).

Each system operates independently, but they synchronize their movements to place the weapon in the desired position for firing. They may be operated locally from an electrical panel at the launcher, but this is only for exercise and test, not for firing.

A third power drive, much smaller than the others with a small electric motor and an accumulator, is mounted in the right-hand corner of the trunnion support and supplies power to the guide arm components that position and retain the weapon on the guide arm, provide external warmup power to the weapon, and arm the booster. An electrical device ignites the booster.

A hand pump is mounted in the left side of the carriage to provide a means of operating the guide arms and the components of the train and elevation latch in case of power failure or during maintenance operations.

GUIDE AND GUIDE ARMS. - The launcher guide consists of two arms, a trunnion tube, a gear segment called the elevating arc, and a buffer actuating arm. The A- and B-guide arms are fastened to opposite ends of the trunnion tube, which is horizontally mounted through the carriage trunnion support.

The elevating arc is fastened to the trunnion tube and is inside the trunnion support. Elevation bearing assemblies located at each end of the trunnion tube allow the elevation movement of the guide arms.

The launcher guide arms are movable in two planes: in the training movement and in the elevating movement. They rotate with the carriage in train, and about the trunnions in elevation. The power is supplied by the train and elevation power drives.

TRAIN AND ELEVATION SYSTEMS. - The train and elevation power drives mentioned above are the main parts of the train and elevation systems. The elevation arc is one comparatively small part of the elevation system. Other parts of this system are the pinion gear (to mesh with the elevation arc), reduction gear assembly, elevation brake, latch, positioning valve, latch- control valve block, elevation and depression buffers, buffer accumulator, firing cutout mechanism, and ventilation power unit. The train system has similar components plus the training circle. The training circle is a heavy gear mounted in the stand. Figure 5-20 shows the training circle for a Talos; for the Terrier, the chief difference is in dimensions.

Each system receives and responds independently to order signals. The principal function of the receiver-regulator and servoamplifier in each unit is to convert electrical order signals into hydraulically powered mechanical movements. These movements control the velocity, acceleration, deceleration, and position of the launcher carriage and the guide arms.

Dud Jettison Unit

A dud jettison unit is associated with each Mk 5 launcher. Its purpose is to rid the ship of a dud missile by tossing it overboard from the launcher without firing the booster. Dud missiles usually are not jettisoned unless there is danger to the ship and personnel.

Dud Jettison Unit Mk 108 Mod 0 consists of two ejectors, mounted to the deck, and a control panel located below the deck near the launcher support, One ejector is located on the starboard side of the launcher and the other on the port side. Figure 5-15 shows the deck appearance of the unit when not in use. Figure 5-16 shows its mounting in cross section and its relation to the launcher when aligned for use.

When it has been determined that a missile must be jettisoned, the launcher is slewed into position to align the defective missile with the dud jettison unit. Launcher control is transferred to the jettison control panel. The ejector is a pneumatic cylinder with a disc designed to engage the after end of the booster nozzle. When the panel operator positions the handle to jettison on the control panel, the missile is pushed from the launcher by a quick thrust of the ejector.

LAUNCHER CONTROL

The launcher is controlled by the following five methods: remote control, local control, dud jettison control, load-order control, and test control. These are also called modes of operation.

Normal operation of the launcher is by remote control from the Weapons Control Station (fig. 5-7), by electrical signal through the control panels there. Remote control is normally used for target tracking and is also the only method used for weapon firing.

A local control station is provided in the launching system for exercise and routine maintenance. This is also called step control because each move in the system is activated by pushing a button on the control panel. Figures 5-3 and 5-13 show the location of a number of the control panels in the launching system. After the EP1 power panel is activated, it is not manned. The launcher captain then stations himself at the EP2 operations panel. During automatic operation, he monitors the panel, quickly reporting anything that seems wrong. In step operation, he pushes the buttons in the required sequence to perform the loading or unloading operation as needed.

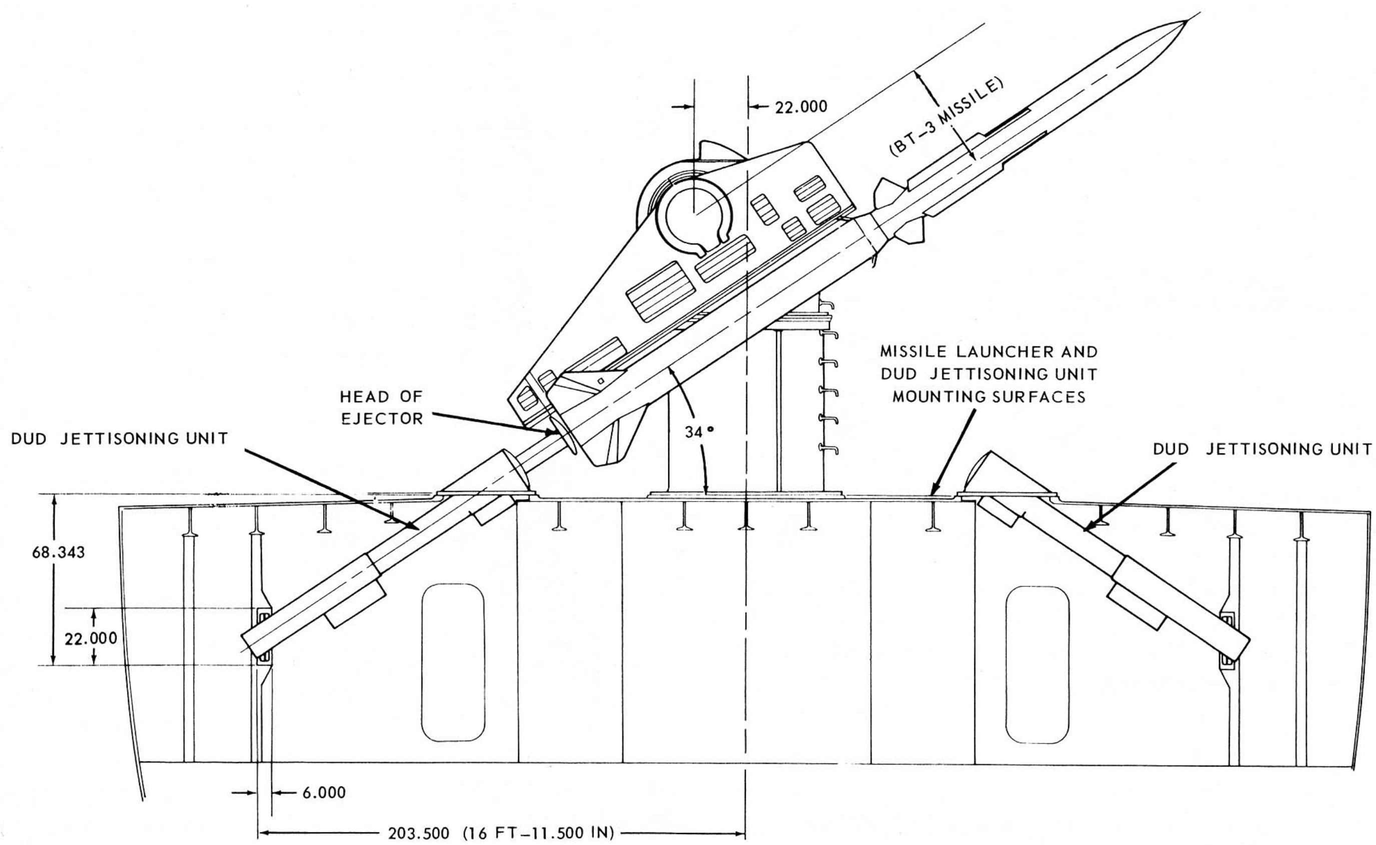
The EP3 panel is primarily the test panel and is not manned during normal launching activities. It can also be used for local control.

EP4 and EP5 panels (A-side and B-side) control assembly, strikedown, checkout, and inter-ring transfer.

Before the dud-jettison panel can be used, it must receive an electrical signal from a preset synchro in the EP 2 panel, which synchronizes the launcher with the dud jettison units.

Load-order control automatically returns the launcher to the "Load" position after the weapons have been fired from both rails. It is provided by means of an electrical signal from a preset synchro in the EP2 panel.

The EP3 panel contains the switches and jack connections necessary to perform tests on the launcher train and elevation systems.



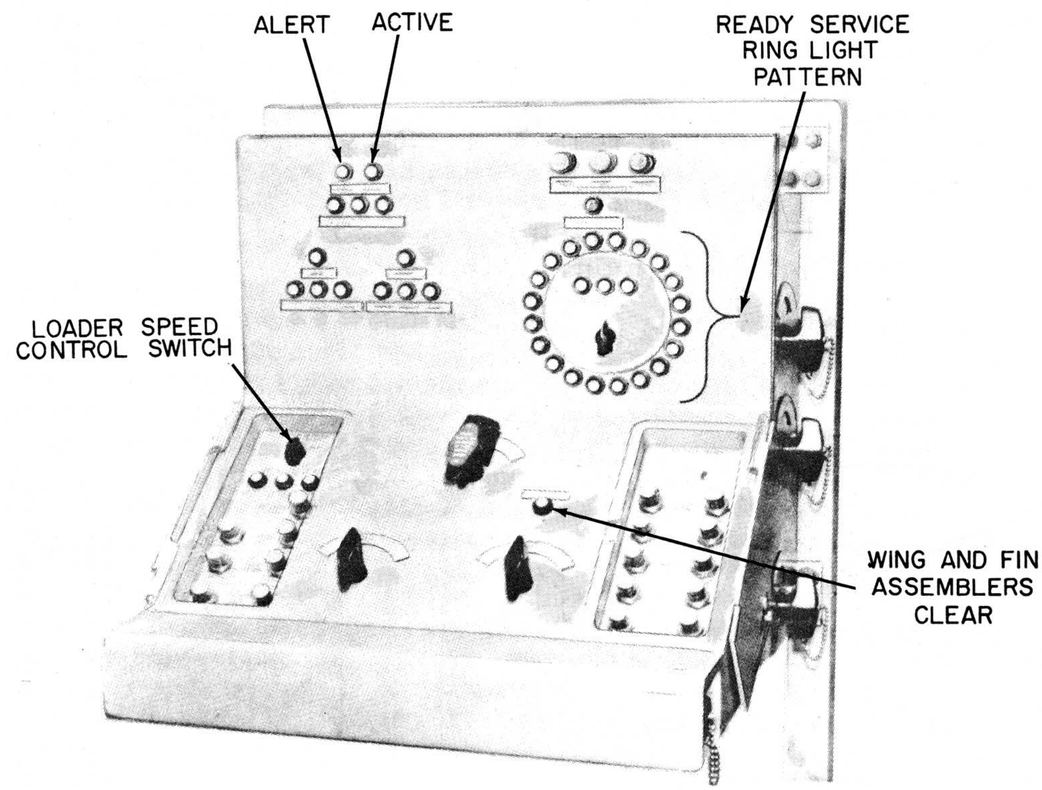
94.22

Figure 5-16.—Dud jettisoning unit Mk 108 mounted for DLG Terrier launching system Mk 10.

Dummy directors, signal generators, oscillographs, and other test equipment may be plugged into the EP3 panel. The test order signals originate in the dummy director. Chapters 13 and 14 describe testing.

Manual control is possible when all other types of operation fail, or for installation, maintenance, and checking purposes. Hydraulic handpumps, handcranks, and air motors are used, and operation of the launching system components is quite slow.

We've talked a good deal about control panels in this chapter. Your quals require you to be familiar with the work at all stations in the launching system which includes control panel stations. Figure 5-17 shows the face of the assembler control panel which is manned by the assembler captain. Each button or lamp is labeled; in automatic control the assembler captain does not operate the panel but watches the lights to see that they light up in proper sequence, so he can notify the launcher captain if anything is not right. When all the assemblymen have completed assembly or disassembly and have depressed their switches, the Wing and Fin Assemblers Clear light goes on indicating that all is clear for the weapon to be moved on to the launcher (or returned to the ready service ring). The ring of 20 lights represents the 20 spaces in the ready service ring. The lights are color coded to indicate the type of missile assigned to each station in the ready service ring. On the Mk 10 Mods 7 and 8 Launching System there is a second ring of light to represent the lower service ring, but those lights do not go on unless there is inter-ring transfer of weapons. In local control or step operation, the assembly captain



83.170
Figure 5-17.—EP4 (EP5) Assembly Panel.

must have before him the step-by-step instructions for operation of the assembler panel. These are in the OP for the equipment and should also be posted beside the panel.

The assembly panel shown in figure 5-17 is a combination strikedown, checkout, and assembly captain's control panel. EP4 is the A-side panel, and EP5 is the B-side panel, identical except for switch and light designations.

LAUNCHING SYSTEM OPERATION

As modes of operation, automatic control and step control have been mentioned several times. With the Mk 10 Mods 7 and 8 launching systems, we also have to consider the Asroc mode of operation and the Terrier mode.

Load Orders

Which mode of operation is to be used and which weapon is to be loaded must be decided before any launching system operation is undertaken. Load orders of the following types may be transmitted from the weapons control station:

1. Missile order-type of round(s) to be loaded.
2. Load select - simultaneous operation of A and B sides, or separate operation of either A or B side.
3. Loading order - hold, single, or continuous loading of the type of missile ordered.
4. Unloading order - unload launcher or unload assembly area.

If the load order (item 3) is for "single", the launching system proceeds to load one missile and then stop until further orders are received. If the order is for "continuous", the system automatically continues to bring up missiles of the type ordered for the launcher, each time the empty loader pawl returns to the load position in the assembly area. If both A and B sides are to be loaded, both sides proceed to load their launcher.

Sequence of Operation in Automatic Mode

At the sounding of General Quarters, the launching system captain activates the EP1 power panel, takes his station at the EP2 panel, sets it up for" step" operation, starts all motors, and then turns his ready switch to "Standby." This indicates to the EP4 and EP5 assembly captains and to the weapons control station that the launching system is activated and is at standby.

When the alert signal is given by the weapons control station, the" Alert" signal light flashes on the EP2, EP4, and EP5 panels, and an audible alert signal sounds.

The launching system and assembly captains signal the weapons control station when their crews are ready. The weapons control station signals what type of weapons are to be loaded, and the missile order signal lights on the EP2 panel.

ASROC MODE OF OPERATION. - If the signal is for an Asroc weapon (Mods 7 and 8 can handle Asroc), the launcher captain checks to be sure everything is clear and that there are no missiles outside the magazine. Then he presses the ASROC MODE button on his panel, which automatically switches the launching system. When the ASROC MOD E light becomes steady, the switching is completed and the launcher captain can press the LOAD button. Only one side can be used for Asroc loading and loading cannot be continuous. After a missile leaves the launcher, the adapter must be returned to the magazine. While the adapter is in the assembly area on its way back to the magazine, the fin assemblymen must close the snubbers and make sure that the umbilical cable is clear. The hoist then returns the adapter to its tray in the ready service ring of the magazine.

If another Asroc missile is wanted, another order is signaled from the weapons control station.

TERRIER MODE OF OPERATION. - On Mods 7 and 8, the launcher captain must switch to the Terrier mode after he has received the signal from the weapons control station that a Terrier missile is to be loaded. All other Mods handle only the Terrier, so this switching step is not necessary. Assuming that the system is activated and on Automatic, pushing the LOAD button starts the loading operation. The ready service ring rotates to bring the designated missile to the hoist station. Then the tray holding the round shifts to engage the booster shoes on the hoist. Simultaneously, the magazine door opens. The hoist raises the round to the loader rail. At this point the warmup contactor on the missile booster engages the electrical connector on the loader chain pawl and warmup power flows to the booster. The loader chain moves the round off the hoist and onto the loader rail, or tilting rail, which moves it to the assembly area. As soon as the hoist is free of the round, it lowers, the tray shifts back to its place in the ready service ring, and the magazine doors close. The ready service ring rotates to place another round at the no. 1 hoist station.

In the assembly area the crewmen attach the booster fins, erect the missile wings, then take safe positions and operate the safety foot switches. As soon as the assembler captain sees (on his control panel) that all the switches are closed, he positions his assembly ready switch to ASSEMBLED and the tilting rail can move on with the assembled round. As soon as the tilting rail elevates, the blast doors open, the spanning rail extends and the loader moves the Terrier onto the launcher rail. The loader chain pawl and its warmup connector disengage and retract from the round before the blast doors close.

The round is rammed onto the launcher where it is positioned and retained by the launcher positioning mechanism. Warmup power is applied through the launcher-booster electrical contactor. The arming tool extends. The train and elevation latches retract. As soon as the order is received from the weapons control station, the launcher synchronizes to the director signal, moving in train and elevation until the missile is pointed where ordered.

With a firing rate of approximately two rounds per minute, you can see that all the actions must take place very rapidly and in measured time sequences. If the wing and fin assemblymen, for example, were too slow in doing their work, it would disrupt the loading sequence. The next missile would have to be held at the no 1 station in the ready service ring until the way was cleared.

TALOS LAUNCHING SYSTEM

The Guided Missile Launching System Mk 12 is designed to stow and to launch all types of Talos missiles. The Mk 12 is made up of three major groups of equipment. Figure 5-1A shows a cutaway view of the Mk 12. You can see in a general way the three equipment groups and their physical location in relation to each other. The names of these groups are:

1. Guided Missile Launcher Mk 7. It serves as a launching platform for the Talos weapon. The launcher has two launcher guide arms which can be trained and elevated to point the missile at a capture beam.

2. Guided Missile Feeder Mk 11. This group of equipments provides for weapon stowage, for missile warmup, and for loading the weapons on the launcher.

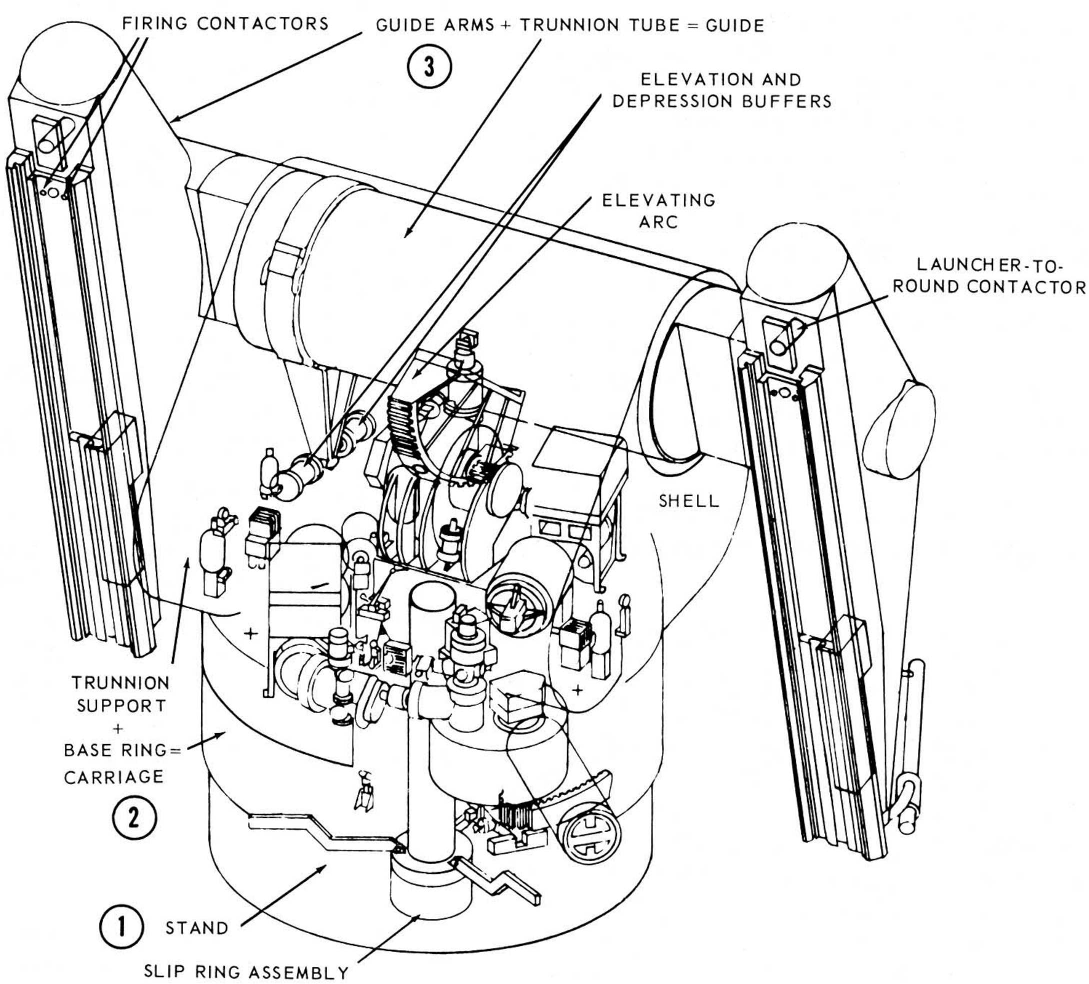
3. Missile Launching System Control Mk 10. This group of units includes consoles and electrical devices and circuits to control and to monitor system operations. Now we shall take up each of these major equipment groups and explain what they do. We will use the Mk 12 GMLS to illustrate how they do it.

MISSILE LAUNCHER Mk 7

The Mk 7 launcher (fig. 5-18) is designed for installation aboard Talos missile ships. It is an automatically loaded, remotely controlled, dual-arm launcher which provides a launching platform for all types of Talos missiles. 1 We can consider the structure of the Mk 7 launcher as being made up of three major components:

1. A launcher stand which is a stationary structure.
2. A carriage which rotates (trains).
3. A launcher guide which also rotates (elevates).

The stand is a round metal structure which is fixed to the deck and forms a permanent foundation for the launcher. The carriage, which is bearing mounted on top of the stand, is capable



83.38
Figure 5-18.—Main parts of the Talos launcher (Mk 7).

of unlimited train. Electric, hydraulic, and mechanical gearing devices used to rotate the carriage are mounted directly within it. The carriage itself is composed of a base ring section and a trunnion support section.

The major components of the launcher guide are the trunnion tube and the guide arms. These components form an H-shaped assembly. The trunnion tube is a shaft that is common to both arms and extends through the trunnion's support. The trunnion support is bearing mounted to the carriage. Rotation of the trunnion tube elevates and depresses the guide arms as the elevating arc moves up or down. Electric, hydraulic, and mechanical devices necessary for rotating the trunnion tube are housed within the launcher carriage.

Again consider the carriage. It houses the power drives for operation of the launcher. Control orders are fed to the power drives from a selected fire control computer. When the launcher is loaded and assigned to a fire control system, it is controlled by orders from a remotely located missile fire control computer. When the launcher is released or when both rails are empty, launcher control is transferred from remote control to fixed load order signals from load control transmitters in the launching system. Under control of these fixed signals, the launcher returns to and latches in the load position.

The train and elevation systems are electric-hydraulic power drives. The train system (fig. 5-19) rotates the launcher carriage; the elevation system (fig 5-19) rotates the launcher guide. These systems operate independently but simultaneously for synchronized operation of the launcher.

Components of the launcher guide prepare the missiles for flight, and arm and ignite the booster. The guide power drive operates the guide components. It is an accumulator type of hydraulic unit that operates the arming devices, the warmup contactors, the aft motion latches, and the emergency igniter injectors. The booster, as you learned in chapter 3, is ignited electrically.

The launcher guide components function independently of the train and elevation systems but are interlocked with them to ensure proper loading and safety during firing.

The launcher functions as part of the guided missile launching system and also as a part of the fire control system. When empty, the launcher aligns with its feeder system and is loaded. When loaded, the launcher is isolated from its feeder and is under the control of the missile fire control computer (remote operation).

As the launcher follows a remote signal, its missiles receive external warmup power to prepare them for flight. When firing is ordered (upon closing the firing key) and all conditions (safety and missile functions) are satisfied, the booster is armed, the warmup contactor and the arming tool are retracted, and the weapon is fired by electrically igniting the booster.

In salvo firing, two weapons are fired from the launcher with a short time interval between firings. Only the S-type Talos weapons can be fired in salvos. Nuclear tipped (W) missiles are fired singly.

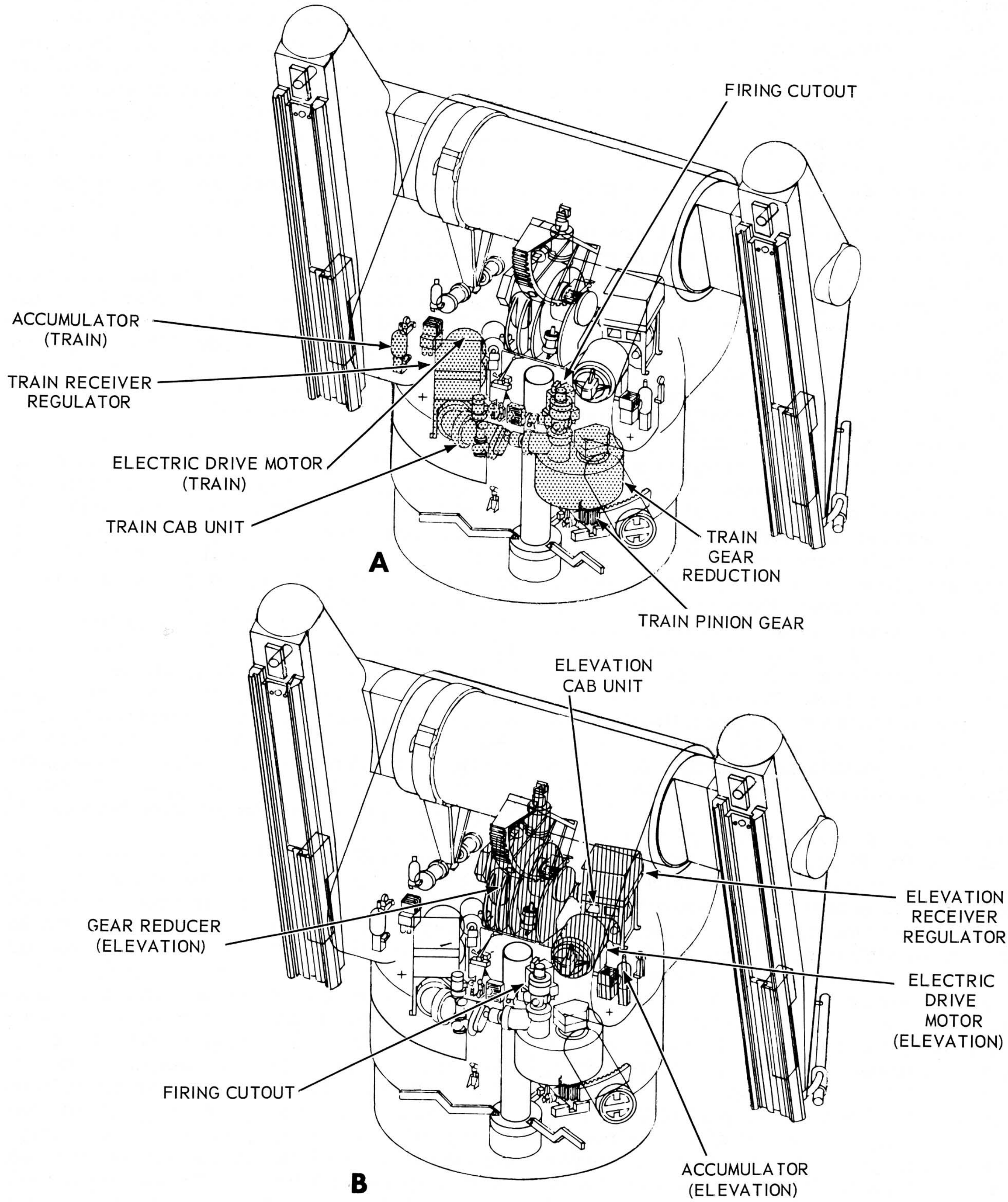
A weapon, as loaded onto the launcher, consists of a mated missile and booster with wings and fins installed (and missile arming devices if necessary): it is in a ready-for-firing condition.

Stand

The stand (fig. 5-20) supports the carriage and guide. (The carriage and guide, when considered as a complete unit, are called the rotating structure.) The stand is a fixed round steel structure attached to the ship's deck. The carriage, together with the guide, is free to rotate on the stand.

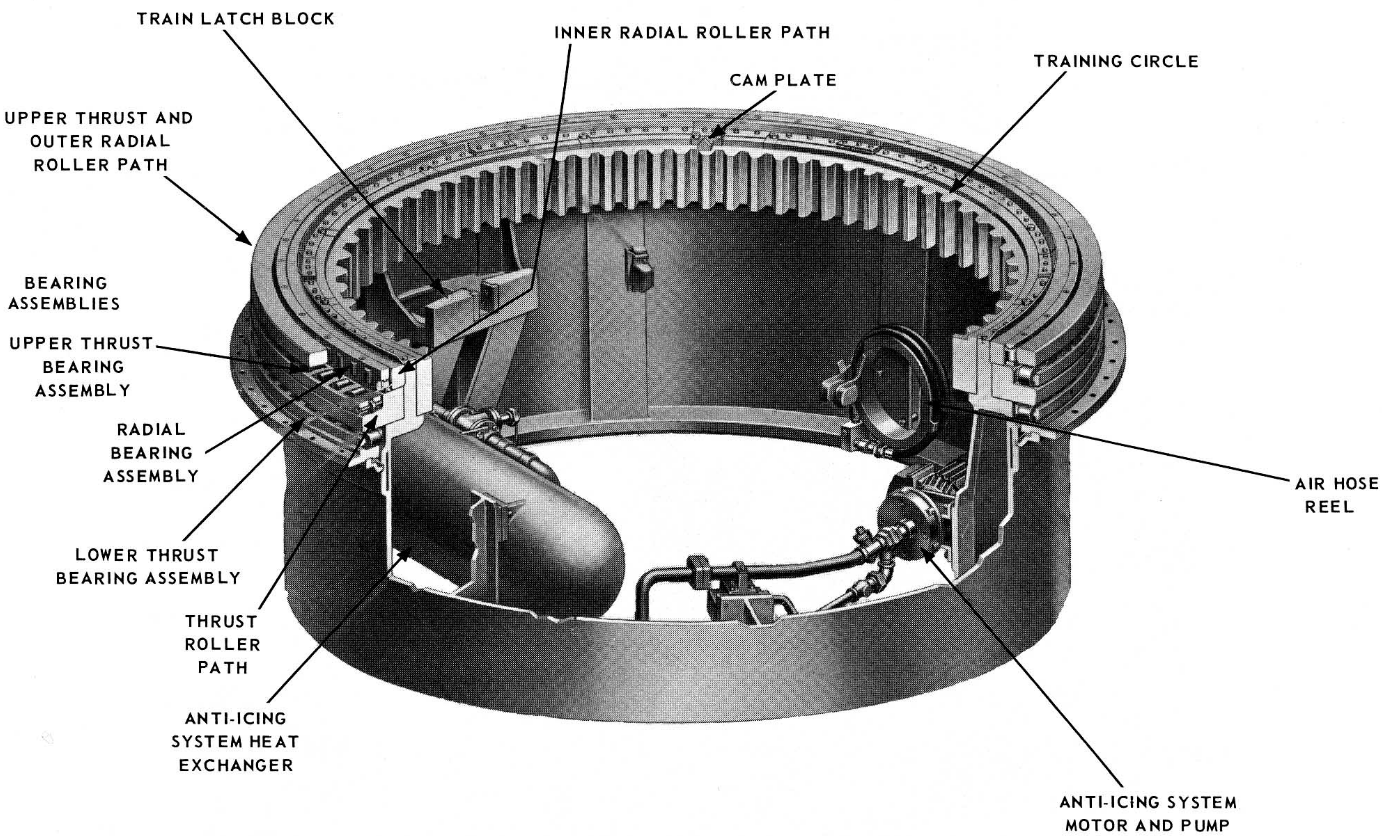
A large ring-shaped internal gear is mounted inside the stand. This gear has many names. Some of these are: training circle, training rack, and train circle gear. A pinion gear engages the teeth of the training circle, so that when the pinion gear turns, it trains the carriage and thus the guide. Bearing assemblies are mounted in the stand to support the rotating structure and to reduce friction between the stand and carriage.

Figure 5-20 shows the major subassemblies of the launcher stand. A drilled flange on the inside bottom of the stand is used to bolt it to the ship's deck. (You won't see the drilled holes in the illustration because the photograph was taken before any holes were drilled.) Now locate the upper thrust bearing assembly, sometimes called the main thrust bearing. The carriage assembly sits on top of this assembly. You can see that the entire weight of the carriage and guide rests on the upper thrust bearing assembly. At this point you may be wondering what keeps the launcher from leaving the stand if vertical movement of the ship pushes up on the bottom of the carriage, tending to push it off of the stand. Figure 5-21 gives us a better view of the train bearing assembly and the method used to oppose a



83.40

Figure 5-19.—A. Launcher train system. B. Launcher elevation system.

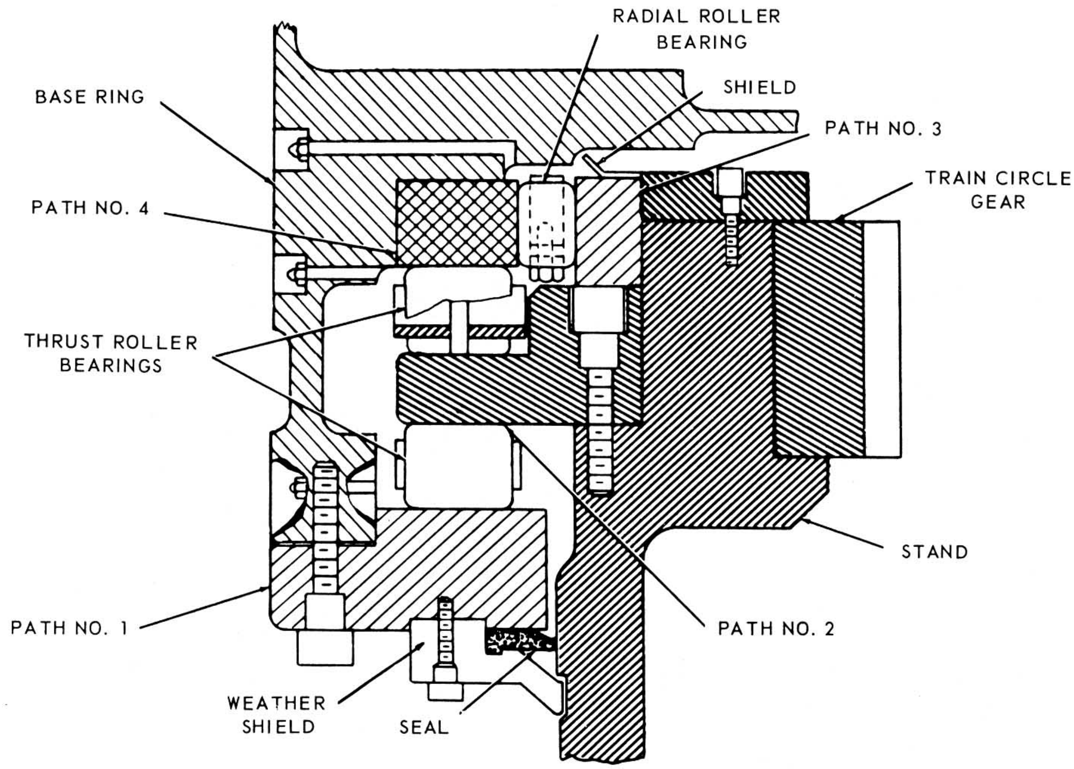


83.41
Figure 5-20.—The launcher stand and its main parts.

vertical upward thrust (force) on the base of the carriage. Essentially, the way this is prevented is to connect the carriage to the stand through a lower thrust bearing assembly. This arrangement also reduces frictional forces as the carriage is trained. The upper and lower bearing assemblies pretty well restrain the rotating structure in the vertical direction. But what about in a lateral or horizontal direction? The radial bearing assembly takes care of this problem. This assembly prevents lateral movement between the carriage and stand, and also decreases frictional forces between the carriage and stand.

Now look at figure 5-21 again. The big gear with teeth on its inside face is the training circle. This gear is classed as an involute gear, an internal ring gear, or an internal spur gear. A small pinion gear meshes with the training circle. The pinion gear is part of the carriage, and is driven by the train power drive. As the power drive motor rotates in response to an electrical order from the computer to move the launcher, the pinion gear rotates and walks around the ring gear, carrying the rotating structure (carriage and guide) With it. Look back at figure 5-19 and you can see how the pinion gear meshes with the training circle.

The weather shield and seal (Fig. 5-21) prevent water or spray from getting into the bearing assemblies. The shield is metal, and the seal is synthetic rubber. Both are attached to the carriage. The shield supports the seal and keeps it pressed against a smooth surface on the stand. The shield and seal form continuous rings which rotate as the carriage turns. Notice that the shield fits into a groove cut in the outside of the stand. Most of the water or spray will be kept out of the bearing assemblies by the shield; the seal is designed to stop the rest. But don't count on this; seals wear out or tear, and must be replaced periodically. All launcher stands, regardless of Mark or Mod, have the same component assemblies we have covered here. It is true



83.42
Figure 5-21.—Sectional view of train bearing assembly (launcher stand).

that these assemblies are different in construction in various stands, but their function remains the same. Gun mounts are placed on the same type of stand; in fact, some missile installations have made use of the already emplaced stand formerly used for a gun. The anti-icing units shown in figure 5-20 have pipes that extend to the blast doors up on the deck at the launcher, through various internal passages in the launcher, and to emergency igniter units. All launchers that are exposed on the deck have anti-icing systems so they will be ice-free and operable in the most severe weather.

Carriage Assembly

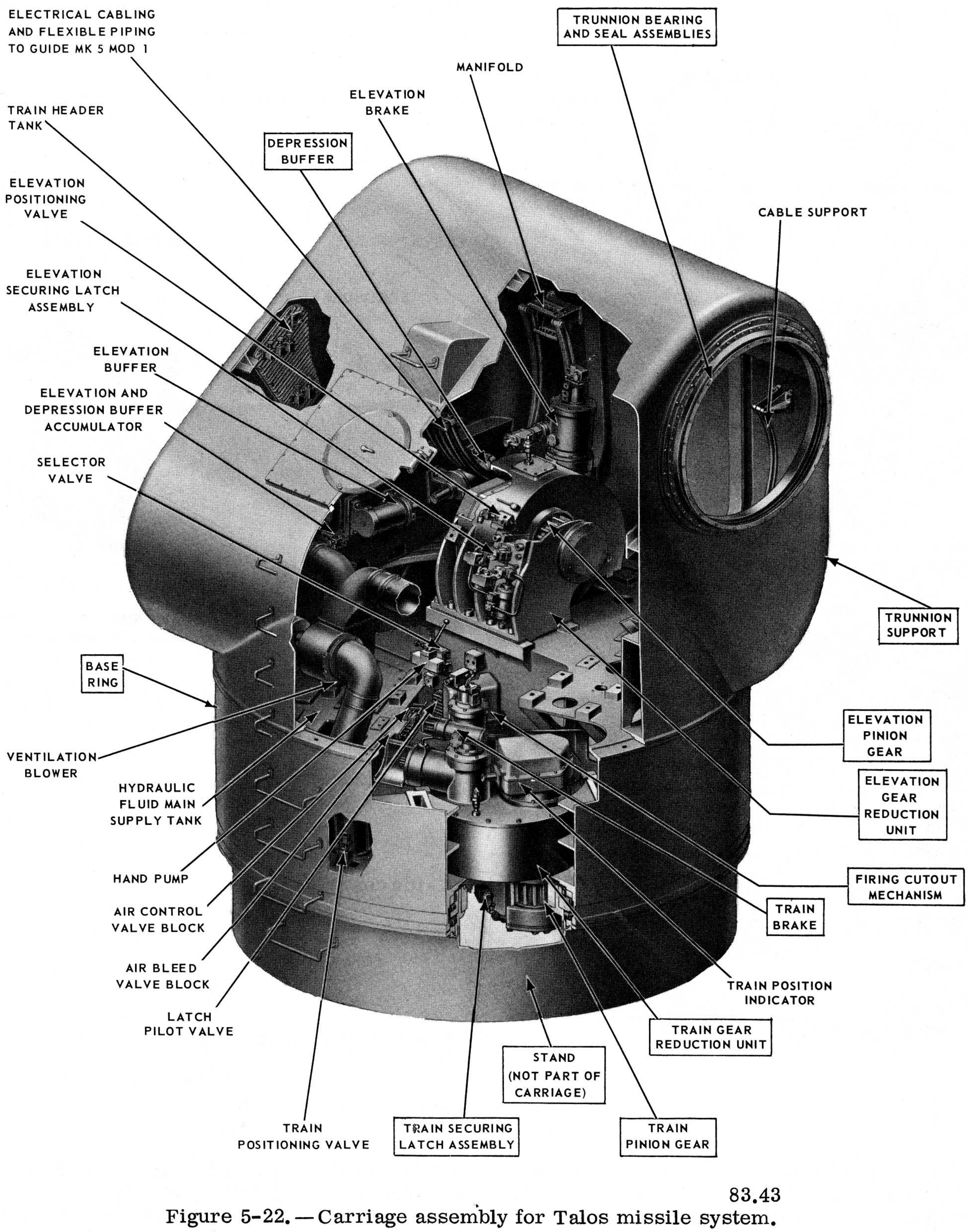
The carriage (see fig. 5-22) is the part of the launcher that trains. As we said before, the missiles must be aimed before they are fired. This means the launcher guide must be trained and elevated to point the missiles in the right direction. Since the carriage is trainable, it meets the first aiming requirement. Later you will see how the missiles are pointed in elevation by the guide.

The carriage consists of two basic parts: the base ring, and the trunnion support. The base ring makes up the lower part of the carriage. The trunnion support fits on top of the base ring. The stand and carriage are joined together by the base ring, and the base ring sits on the stand.

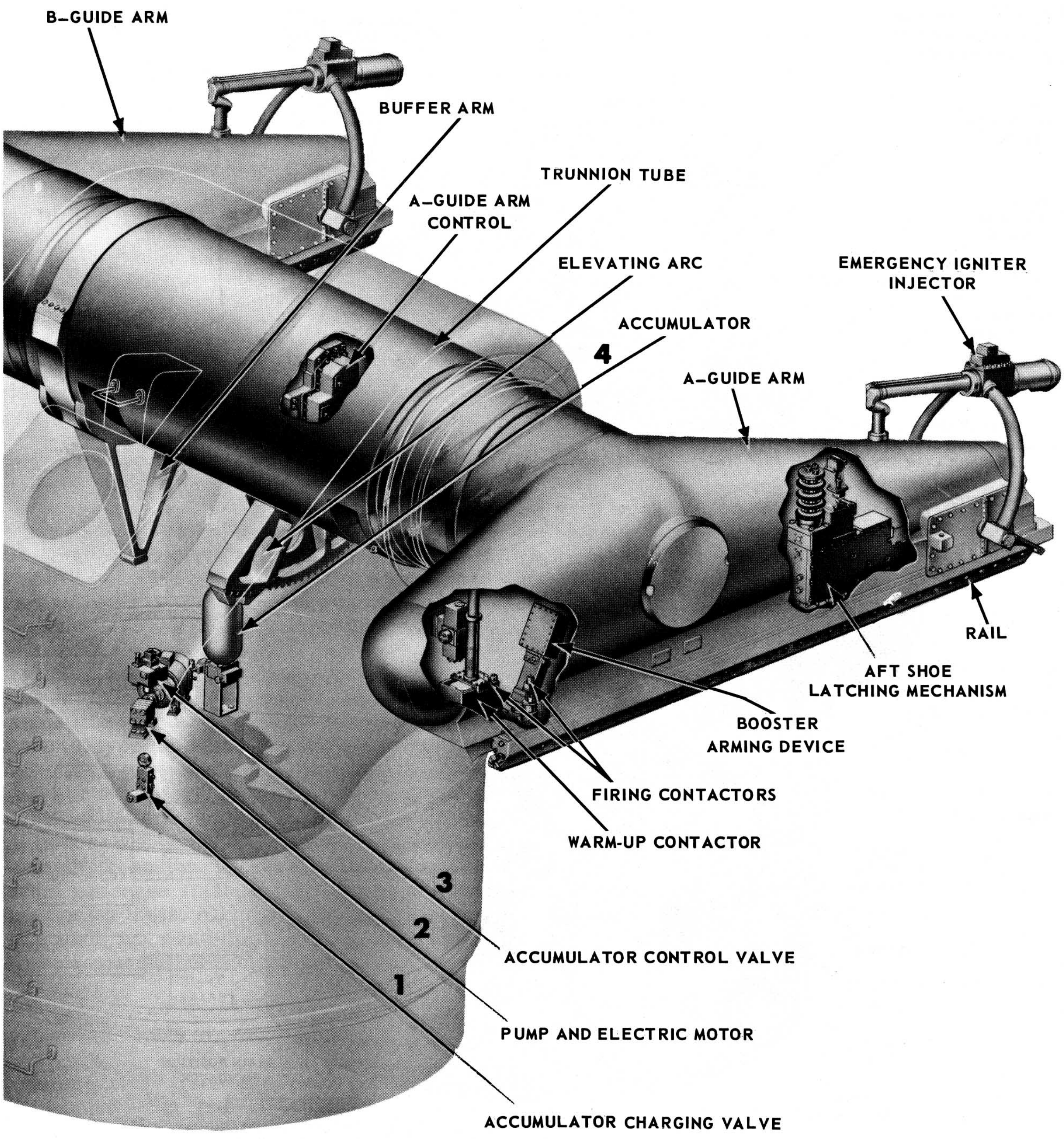
The trunnion support holds up the guide. A long hollow tube (trunnion tube) is supported in bearing assemblies of the trunnion support so that the tube can be elevated and depressed. Attached to each end of the tube is a guide arm. As the tube is rotated, the guide arms follow this motion. The inside surfaces of the carriage provide mountings for other launcher components. The shell of the trunnion support protects units in the carriage assembly from the weather.

Guide Assembly

The guide assembly (fig. 5-23) provides the platform from which the missile is launched. It consists of four major parts: trunnion tube, two guide arms, and the guide power drive. The trunnion tube is mounted in bearings. A guide arm is attached to each end of the trunnion tube. An elevating arc is located at the center of the



83.43
Figure 5-22.—Carriage assembly for Talos missile system.



83.44
Figure 5-23.—Major parts of the guide, Talos missile system.

tube. The arc is driven by the elevation power drive through a pinion gear which meshes with the teeth in the elevating arc.

GUIDE ARMS. - The guide arms are similar structures, so we will talk about only the A-arm. But what we say pertains to the B-arm also.

The bottom of the arm is flat, and contains the rails. The weapons are suspended from the rails by shoes on the booster. At launch the rails provide guidance for a short distance.

The main operating (moving) parts of the guide arm (fig. 5-24) are:

1. Guide arm control (not shown in figure 5-24).
2. Aft shoe latching mechanism.
3. Warmup contactor.
4. Firing squib contactors.
5. Arming device.
6. Emergency igniter injector.

Guide Arm Control. - This is an electro-hydraulic assembly that controls the operation of the arming device, warmup contactor, and aft shoe latching mechanism. The emergency igniter injector has its own control assembly.

Aft Shoe Latching Mechanism. - The aft shoe latching mechanism (see the simplified diagram in fig. 5-25 is located at the aft end of the guide arm. The latching mechanism positions and retains the weapon on the guide arm by the aft booster shoe. The latching mechanism consists of two major parts: a forward motion restraining latch, and a reverse motion latch. The two latches simply pinch the aft booster shoe between them. The forward motion latch prevents the missile from moving forward until it is ready for launching. The reverse motion latch prevents the missile from falling off the rear of the launcher. During firing, the forward motion latch holds back the missile booster combination until the booster has developed enough thrust to overcome the restraining force of the latch. When this happens, the latch buckles (trips) and the weapon leaves the guide arm.

Other missile systems use the same type of mechanism for the same purpose.

Warmup Contactor. - Another component of the launcher guide arm, called the warmup contactor, prepares the missiles for flight. This device is located in the front of the guide arm. The expression "prepares the missile for flight" is very general; so we will explain it. Most Navy surface-to-air missiles contain some vacuum tubes. As you know, it takes time for vacuum tubes to heat up and to reach the temperature at which their operation becomes stable. To illustrate, it takes your home vacuum tube radio or TV set 20 or more seconds to warm up after you turn it on. Of course, a transistor set is in operating condition almost immediately after it is turned on. But RIMs are not completely transistorized, and they will have at least a few filament type tubes which require a warmup period.

Warmup power is also required for gyros. All Navy RIMs have gyros. These units must have their rotor wheels spinning at a specified number of revolutions per second to be effective. Otherwise the gyros will provide inaccurate

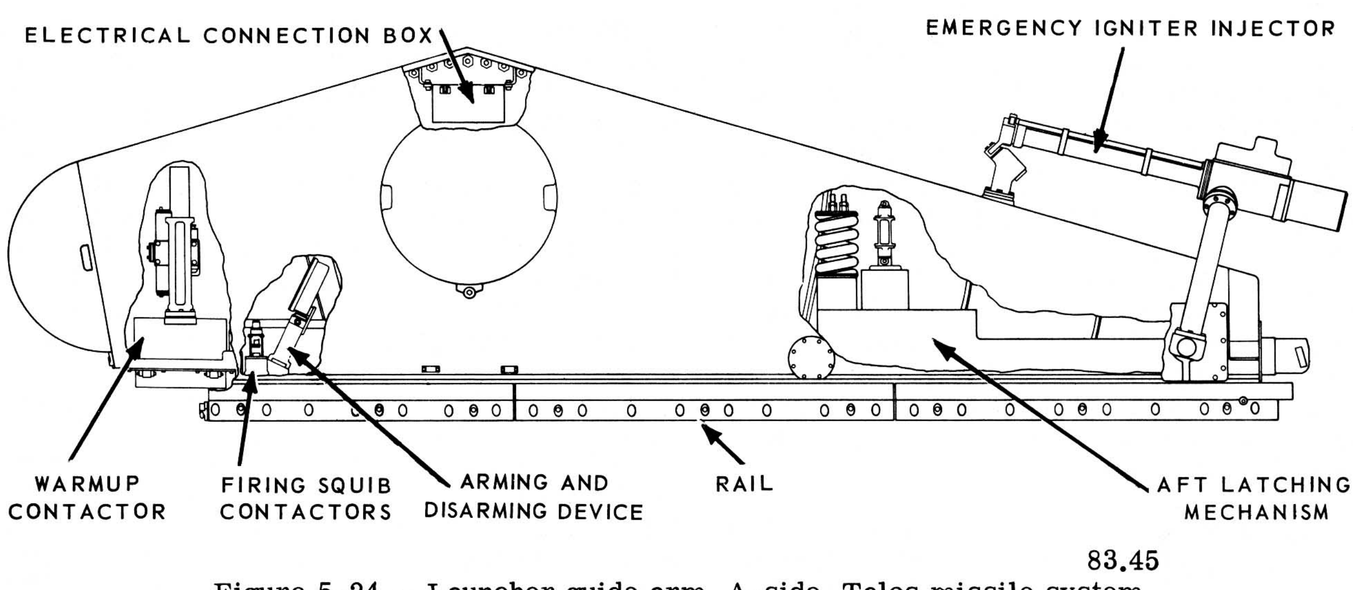
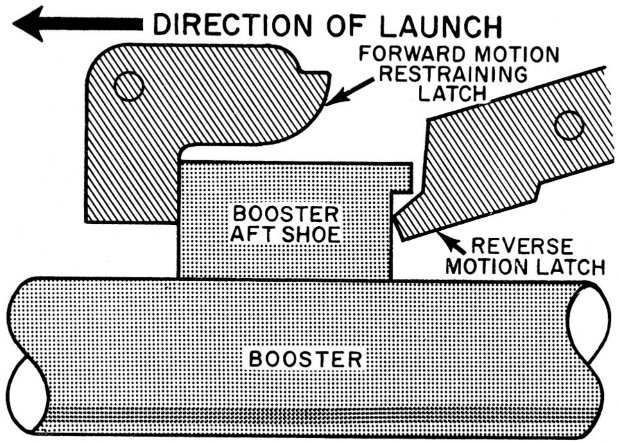


Figure 5-24.—Launcher guide arm, A-side, Talos missile system.



83.46
Figure 5-25.—Simplified diagram of the aft shoe latching mechanism.

references or information. If the gyro wheels are not spinning fast enough, the rotors will wobble.

The warmup voltage is supplied from a source outside the missile because we don't want to use up the power source inside the missile. The missile internal power supply is limited as to how long it will furnish power, and it would be foolish to use up any of its energy before flight.

Now back to the contactor. It applies external warmup electrical power to the missile while the missile is supported on the launcher guide arm. The contactor can be extended and retracted. When it is extended, a series of points on the contactor fit into a pad on the top rear of the missile. Current then flows through the contactor-missile connection to the missile electronic and gyro components.

The warmup contactor also provides an umbilical connection to pass information back and forth between the missile and the weapon control system.

Warmup contactors were mentioned several times in the discussion of the Terrier system, and you will also find them mentioned in regard to the Tartar system. Essentially, they are all electrical contacts to the ship's electrical system to warm up gyros and electronic components in the missile and the booster.

Firing Contactors. - All RIM booster propellants are ignited electrically and use igniters to start the propellant burning. Basically, an igniter (figs. 3-27, 3-29) consists of a charge of black powder and a small electrical heating element called a squib. When electricity passes through the heating element, enough heat is generated to start the black powder burning. The flame from the black powder shoots down the hollow center of the propellant grain and ignites it.

When a missile is on the launcher and the intent is to fire it, some device is necessary to bridge the gap between the launcher arm and the missile booster so the booster igniter firing circuit will have a circuit from the firing key to the squib. Look again at figure 5-24. It shows a cutaway view of the A-arm of the Talos launcher. Notice the booster firing contacts at the arm's forward end. These contacts engage similar contacts (called ignition contacts) on the top of the forward booster shoes. Electrical wires run from the booster contacts to the squib electrical heater. Thus when the firing key is closed, and all other required circuit closures are made, an electrical circuit is completed to the squib which ignites the booster propellant.

Firing circuits are interlocked mechanically and electrically. This means that certain events must take place in the weapon system, in the correct order, before the firing circuit will work. The fact that the events took place, and in their proper sequence, is indicated by the operation of electrical and mechanical devices. You are going to learn more about interlocking and firing circuit operation later in this course; but for the present just take our word that firing circuits are interlocked.

Booster Arming Device. - Another reason for interlocking firing circuits is for safety. Consider the booster. Boosters are not ready to fire when they are stowed in a magazine, or even when they are first put on the launcher. There is a chance that they might be accidentally set off. So boosters are put in a safe condition until immediately before firing. And how are they made safe? Just by the simple technique of opening the firing circuit inside the booster. Generally, the igniter is mechanically rotated in such a manner that the squib element's electrical contacts are physically disconnected from the rest of the firing circuit.

When a missile is to be launched, some device must be used to move the igniter back into its firing position. You can see now that another device is needed to bridge the gap between the launcher arm and the booster. The launcher we have used as a study example has a plunger type mechanism in the launcher arms. The plunger, when it is extended, connects with a system of levers and gearing in the booster in such a way as to rotate the igniter assembly into the proper firing position. This process is called booster arming.

In case it is decided not to fire the missile, the booster arming and disarming device can be used to disarm the booster before it is unloaded and then placed back into stowage.

Emergency Igniter Injector. - A hydraulically operated emergency igniter injector is mounted on the after end of each launcher guide arm, see fig. 5-23. This device inserts a high-explosive cartridge into the missile booster. The arrangement of injector and cartridge permits electrical firing from the control station when a misfire occurs.

The operation of the emergency igniter injector is normally controlled by the launcher captain from the EP2 panel.

The Talos system is the only one that uses this method of disposing of duds or misfires. Terrier and Tartar systems use the dud jettisoning device to place dud or misfire missiles overboard when it is necessary to dispose of a missile that cannot be fired from the launcher.

TRAIN AND ELEVATION POWER DRIVES

Two electrohydraulic power drives (fig. 5- 19) position the launcher. One trains the launcher by rotating the carriage, and the other elevates the guide arms by rotating the trunnion tube. Both the train system and the elevation system receive orders in the form of electrical signals, and act on these orders to position the launcher and guide arms accordingly.

The launcher can be positioned by either of two methods of control: remote order control, and local order control. In remote order control, signals are received from a missile fire control computer. Local order control is used to position the launcher from a local station in the launching system.

The train and elevation systems operate in a similar manner. In most cases they contain the same operating components. These components, with the exception of the magnetic amplifiers, are located within the launcher carriage.

The simplified schematic in figure 5-26 is provided to promote a general understanding of how the train drive responds to an input signal. Only the basic drive components are pictured.

Two channels of control signals are fed to the drive. One is a position order. This one will be discussed first. The order is a velocity order.

We will start with the synchro transmitter in the computer. It transmits a position order to the IXCT in the receiver regulator of the launcher. The stator of this CT is geared to the B-end of the hydraulic transmission. If the launcher is not positioned at the same bearing as the transmitted order, a voltage is developed on the rotor of the CT to represent launcher position error (angular difference between actual launcher position and ordered launcher position).

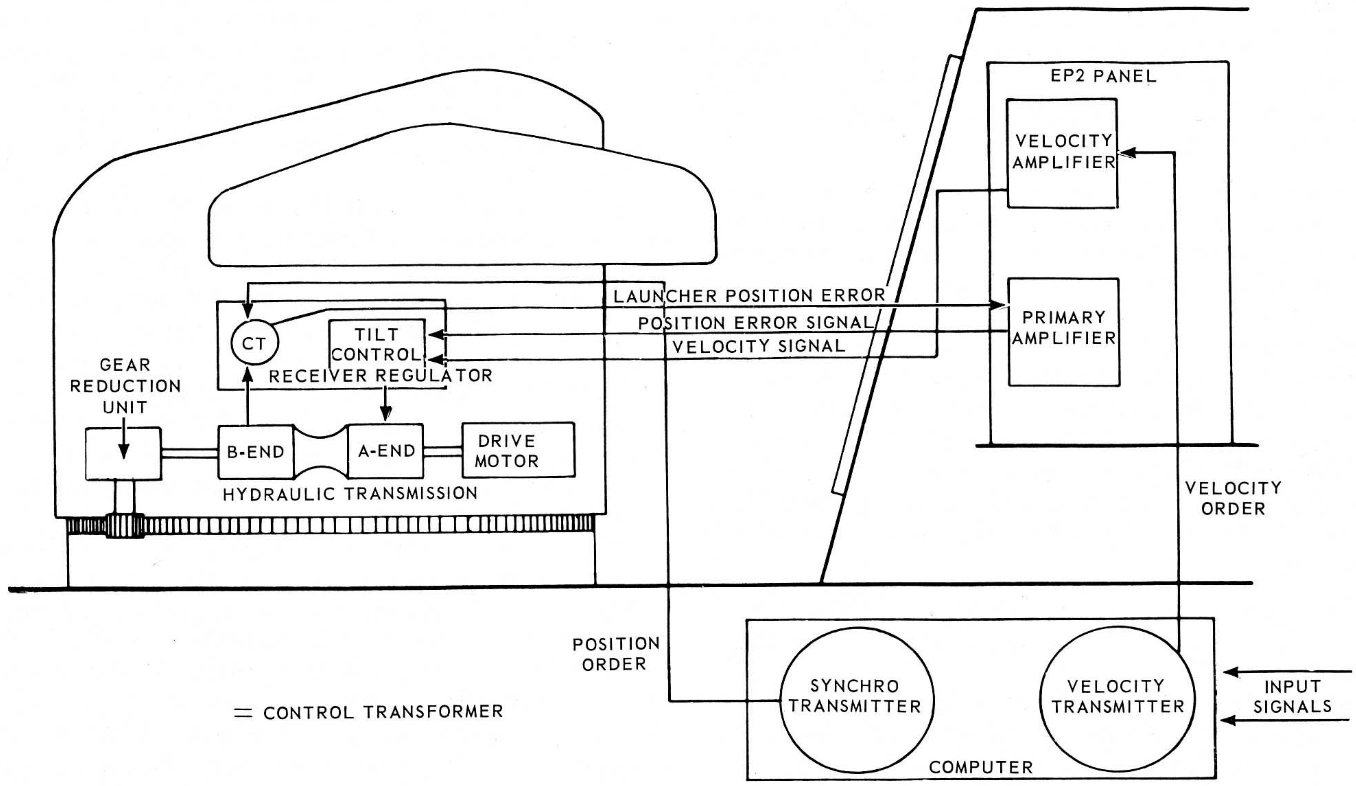
This error voltage is placed on the input terminals of a magnetic amplifier. The output position error signal of the amplifier is sent back to the receiver regulator. Through the receiver regulator, tilt is applied to the A-end of the hydraulic transmissions by an amount that corresponds to the strength of the error voltage. The receiver regulator, which is primarily a device to change an electrical input into a corresponding hydraulic output, is used to obtain the hydraulic pressure needed to stroke the A-end.

The A-end is driven by an a-c electric motor. The speed of the B-end rotation, which is governed by the amount of A-end tilt, is reduced by a gear reduction unit and applied to a drive pinion to rotate the carriage.

As the carriage rotates toward the ordered position, the launcher error, and therefore the error signal, decreases. When the launcher reaches the ordered position, the error will no longer exist and the A-end tilt will be reduced to zero.

Consider the situation where the position order is not static but is continually changing. This would be the case when the director is tracking a moving target. Here, movements of the director must be followed by the launcher with a minimum of error. This would be difficult to accomplish with only a position order channel, because an error would have to be developed to move the launcher. This problem is greatly reduced through the use of a velocity channel as an additional means of stroking the A-end.

The velocity order is a voltage received from the computer, which corresponds to the rotational speed of the director. This signal



83.49
Figure 5-26.—Block diagram of train drive system.

is amplified by the velocity amplifier, and then sent to the receiver regulator in the launcher. The regulator acts on the signal by applying a proportional amount of tilt to the A-end.

With both channels controlling the launcher during a dynamic (moving) signal condition, the position channel is used to reduce the initial error.

The velocity channel is used to maintain rotation of the carriage so the position error will have little or no chance to develop. The small amount of position error that does develop is reduced by the position channel.

In the interest of simplicity, many refinements of the train drive system have not as yet been discussed. These refinements will be discussed through the remainder of this section which will deal with power drive refinements.

The refinements include the automatic tracking cutout system, the firing cutout system, and the limit stop system. These refinements impose limitations on the power drives when they respond to input orders.

The limit stop system restricts launcher movement to definite established limits, and prevents launcher components from being damaged. The system also halts the launcher if it loses power. The limit stop system is designed with a lead input which is proportional to launcher velocity. Therefore, the launcher movement can be stopped at the established limit regardless of its speed.

The automatic tracking cutout system works with the power drive to prevent the launcher from pointing into areas where a fired missile would hit the ship's structure, masts, or other parts of the ship.

The firing cutout system disables the firing circuit whenever the launcher moves into areas where a fired missile could cause damage to the ship structures.

The Terrier and Tartar systems also have these "refinements" in their train and elevation systems so the missile cannot be fired into own ship's structure.

GUIDED MISSILE LAUNCHER FEEDER MK 11

Figure 5-1 shows the Launching System Mk 12 of which we have discussed the launcher. All Talos systems make use of the Mk 7 launcher, and there has been only one modification, Mod 1. The launching System Mk 12 Mod 0 and Mk 12 Mod 1 are identical except for the size of the two hoist magnetic controller panels (they are larger on the Mod 1) and the arrangement of cabling for the panels.

If you think about the name of this equipment group, you can get a picture of its main function. It simply feeds the missiles to the launcher. Of course, the feeder has other functions too, but we'll talk about them later.

Figure 5-27 A shows a pictorial view of the major units that comprise the Mk 11 feeder; figure 5-27B shows a block diagram of the feeder. Note that there are three main components; the magazine, the loader, and the assembler, each with its components.

The feeder is composed of two separate but similar parts. One part is associated with the A-arm of the launcher and the other part is associated with the launcher's B-arm. The part of the feeder that provides missiles to the A-arm is called the A-side, and the part that feeds the B-arm is called the B-side. (You can tell the side of the launcher or feeder by the conventional way. Just look in the direction of missile flight from the launcher or from the after end of the system, and the A-side is to your left. The B-side is to your right. This identification technique works regardless of the launching system's location on the ship.)

Although each side of the feeder operates independently, both sides usually work simultaneously, so that both launcher arms can be loaded at the same time. Since the A- and B- sides are almost identical, we shall describe only the A-side.

Guided Missile Magazine Mk 7

The components in this equipment group provide the stowage space for the missile- booster combinations. The magazine equipment also transfers the missile-booster combinations from their stowage positions to the loader, and puts them on it. Figure 5-27A shows the below-deck location of the magazine. It is placed below deck to prevent the entry of salt water and spray into the magazine spaces. Also, this location affords some protection from enemy gun and missile fire.

The main components of the magazine are:

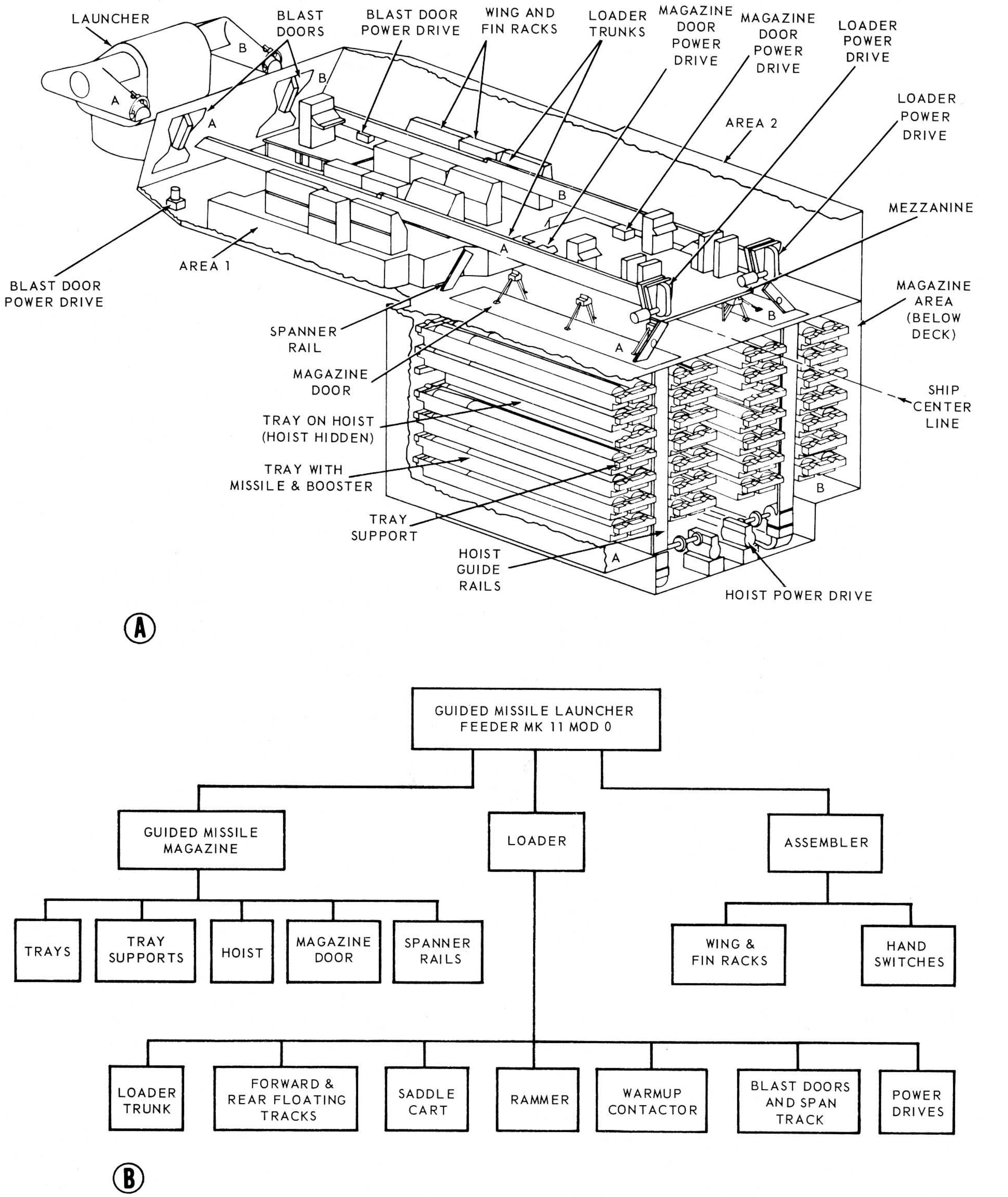
1. Trays.
2. Tray supports.
3. Hoist and its power drive.
4. Lower buffers.
5. Magazine door and its power drive.
6. Spanner rails.
7. On-hoist power drive.

The magazine (A- and B-sides combined) can hold 52 missile-booster combinations. Keep in mind that a combination is a missile and booster' connected together and handled as a single-unit. The A-side magazine has 7 layers with space to stow four weapons at each level. Each weapon is placed in a long rectangular box called a tray. A hoist divides the magazine so that two trays are on either side of the hoist at each level. Vertical rails guide the hoist as it moves up and down. The vertical rails are at each end of the hoist. The hoist is used to raise a weapon and its tray up to the loader and to return an empty tray to the magazine. Notice the magazine door that separates the magazine from the loader. The door is a safety device. It is a flame and gas seal between the magazine and the deckhouse. Hoist spanner rails are linked to the door. When the magazine is opened, the spanner rails connect with the hoist vertical guide rails. Thus the spanner rails provide a vertical extension of the guide rails up to the loader. In other words, they span the gap between the magazine and the loader to give the guide rails a continuous track.

Now that you have a general idea of what units make up the magazine and what they do, we'll cover them in more detail.

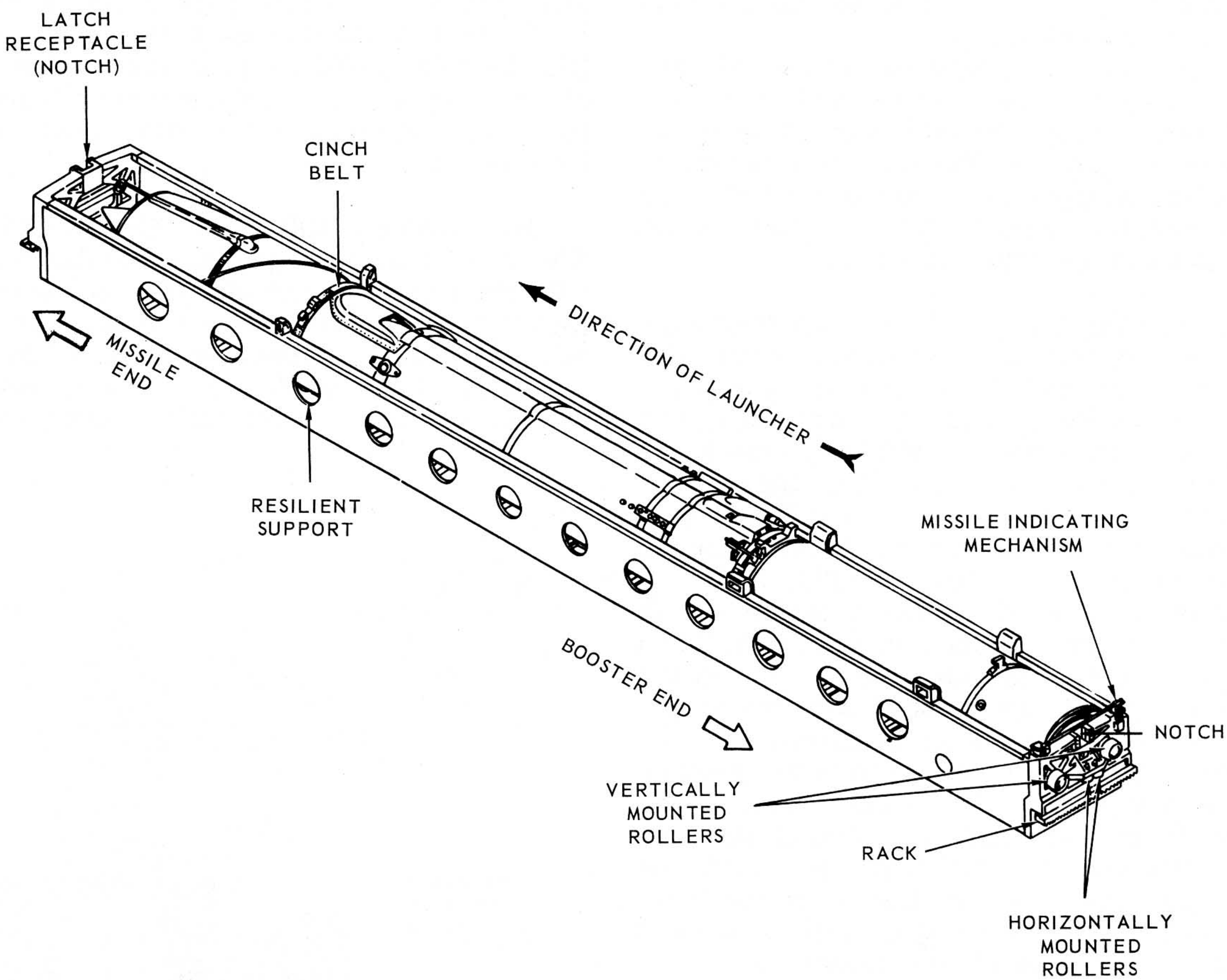
TRAYS. - A typical tray is shown in figure 5-28. There are 26 of them in our magazine, one for each missile-booster combination. Each tray has a device for locking the weapon in the tray. Also, the tray is equipped with parts that help transfer the tray on or off the hoist.

In figure 5-28 you will see four rollers at the booster end of the tray. These four rollers engage the associated tray support. The two large rollers are mounted with their axes horizontal. They support the booster end of the tray. The two small rollers prevent the tray from moving back and forth. At the launcher end of the tray there are only two large rollers and these support that end. You can't see them in figure 5-28 but they are similar to the large rollers at the booster end.



83.50

Figure 5-27.—The Mk 11 launcher-feeder system for Mk 12 launching system: A. Components of the launcher-feeder system; B. Block diagram of the feeder system.



83.51
Figure 5-28.—Tray with Talos missile in it.

A shoe latch secures the missile-booster combination to the tray. The latch is inside the tray at the booster end. The latch is spring loaded and engages the bottom rear booster shoe. This prevents the missile from shifting its position within the tray. A hydraulic actuator on the hoist releases the latch when a weapon is to be transferred from the tray. The missile part of the combination is also secured to the tray. A cinch belt does this. It is located at the end of the tray that points in the direction of the launcher. When ramming action moves the combination forward, the cinch belt is automatically released. You'll see this action later when ramming in the tray takes place.

Now the missile is securely placed in the tray, but what prevents the trays from falling off their supports? On the top edge of each end of a tray is a notch. Latches on the tray supports fit into these notches (latch receptacles). This prevents the trays from rolling off the tray supports. The same type of arrangement is on the hoist. Both the tray support and the hoist latches are operated hydraulically. Each tray is kept latched in place, except during the time it is being transferred from the tray supports onto the hoist and from the hoist to the tray supports.

A rack, used for transferring the tray on or off the hoist, is located at each end of the tray. Pinion gears located on the tray supports and hoist mesh with the racks to provide necessary horizontal movement for affecting tray transfer. As the gears rotate, the tray moves linearly to transfer the tray to or from the hoist. These gears are driven by a hydraulic unit on the hoist. This unit is referred to as the on-hoist power drive (fig. 5-27A).

Missiles are not particularly rugged, and must be protected from shock and vibration. So each tray has a resilient support on which the missile portion of the combination rests. The resilient support is composed of hydraulic dampers and mechanical springs. This device acts like a shock absorber on a car.

TRAY SUPPORTS. - It takes two tray supports to hold up a tray, one at the launcher end of the tray and one at the booster end. Each set of tray supports holds up two trays. The tray supports are bolted to the magazine bulkhead. Each support contains the means for transferring trays to and from the hoist. Fig. 5-29 shows a tray support. Its location in the magazine is shown if figure 5-27 A. The on- hoist drive is coupled to the transfer clutch to provide a means for moving the trays. When the on-hoist drive moves, the pinion gears turn. These gears are meshed with the tray's racks. As the inboard tray is moved onto the hoist, the outboard tray is moved to the position originally occupied by the inboard tray. If you look closely at the right-hand end of the tray support, you can see the track in which the tray rollers ride. Similar tracks on the hoist line up with these, so a tray with or without its weapon can be taken off the supports.

HOIST. - The hoist (fig. 5-30) spans the length of the magazine. It is used to move trays up and down between the loader and the individual levels. The hoist is guided in its vertical travel by guide rails (fig. 5-27A). Each end of the hoist is fitted with rollers to make sure the hoist moves freely up and down the guide rail. A roller track at each end of the hoist receives tray rollers. When a tray is slid over onto the hoist, the tray is latched to the hoist so it won't falloff.

The hoist itself is latched when it is at the correct transfer position. This is the position where the hoist and a selected tray support are in almost perfect alignment, and a tray can freely move back and forth between hoist and support. Two locks at each end of the hoist hold it at the transfer position.

A power drive on the hoist provides hydraulic power to transfer a tray on and off the hoist, to lock the hoist to the guide rails, to latch a tray on the hoist, and to unlatch a missile- booster combination from the tray.

An electromechanical power drive lowers and raises the hoist. This drive is not on the hoist, but is located at the bottom of the magazine (fig. 5-27 A). Buffers on the hoist and at the base of the magazine prevent equipment damage when the hoist reaches either its upper or lower limit of travel.

MAGAZINE DOOR - AND SPANNER RAILS. - The door acts as a gastight and flametight seal between the magazine and the deckhouse space. (See figs. 5-31 and 5-27 A.) The spanner rails are not part of the door, but they are linked to it. When the door is opened, the spanner rails form extensions of the hoist rails. This permits the

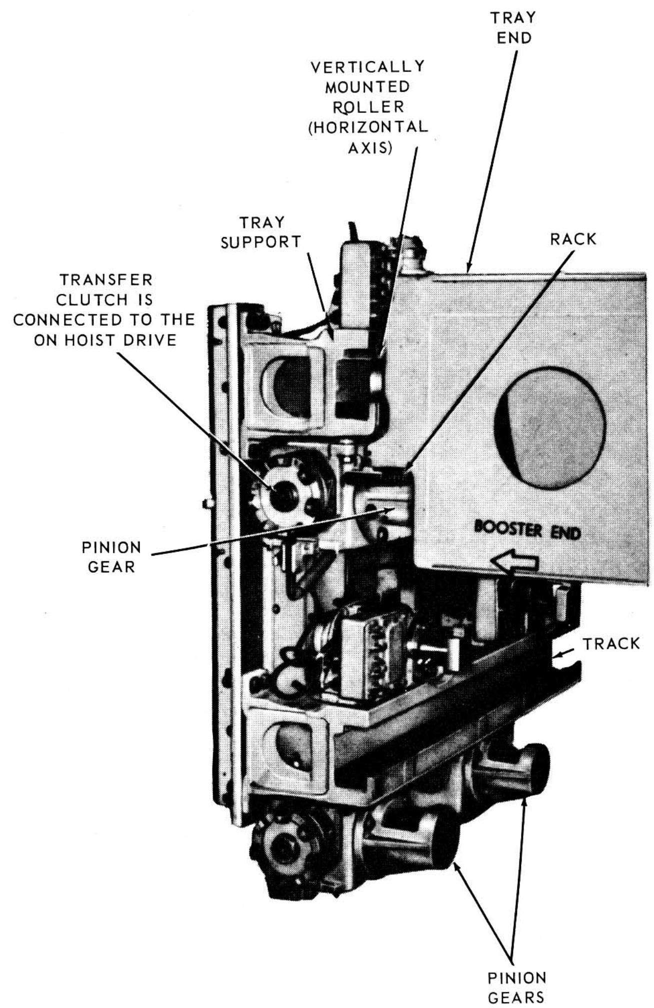
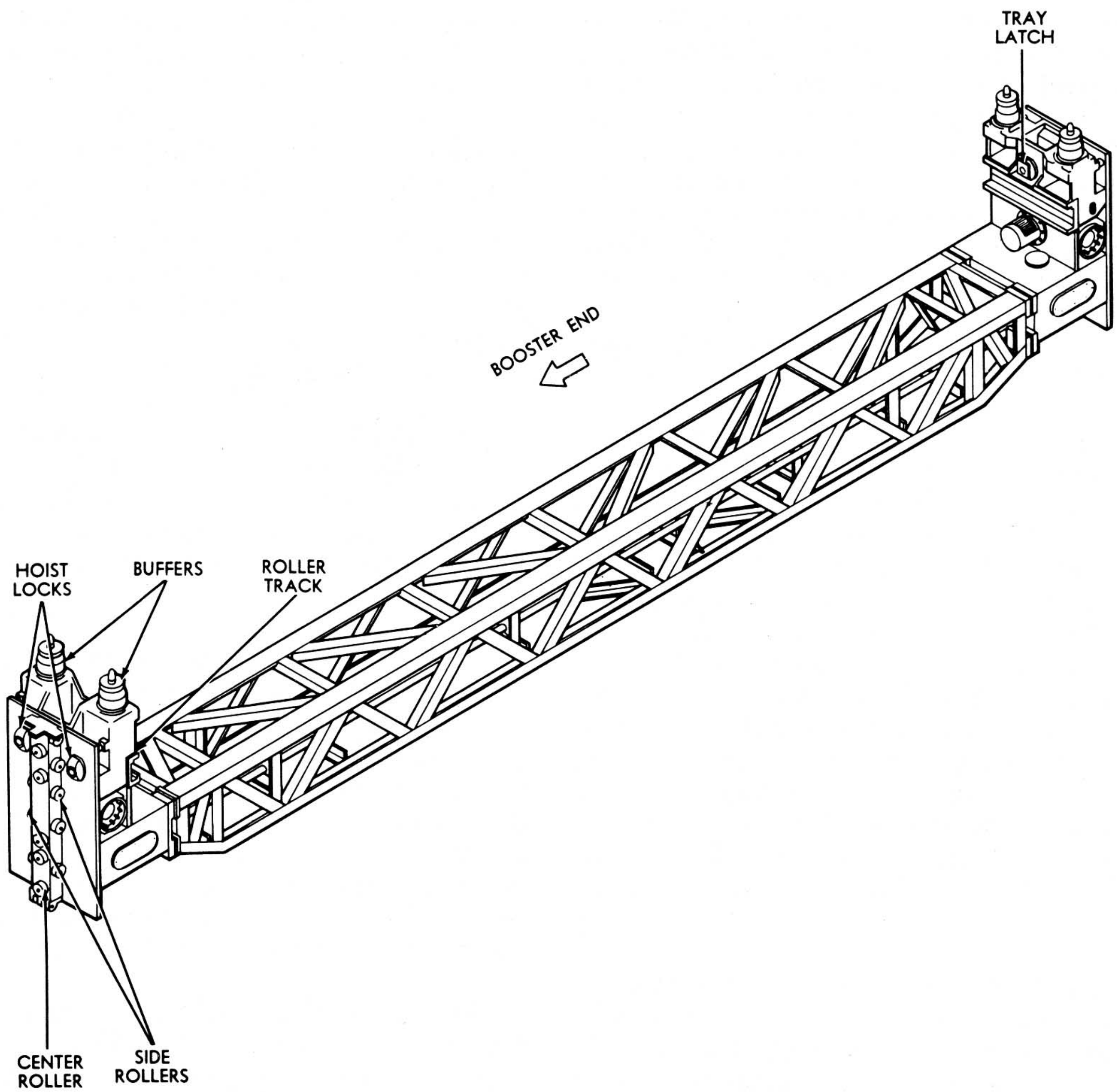


Figure 5-29.—Tray end and tray support in Talos magazine. 83.52



83.53
Figure 5-30.—Hoist in Talos magazine.

hoist to travel through the door opening to the loader. A hydraulic power drive (fig. 5-27A), provides the power to open and close the magazine door.

We have now brought the missile up from the magazine and are ready to move to the next area and the next steps in preparing the missile for firing.

Guided Missile Loader Mk 5

The loader is located in the deckhouse. You can see the loader in figures 5-1 and 5-27A, and in figure 5-32. The loader equipment transfers the weapon from the tray to the launcher. During the transfer operation a device in the loader applies warmup power to the missile. The main components of the loader are:

1. Loader trunk
2. Forward and rear floating tracks
3. Saddle cart
4. Rammer
5. Positioners
6. Warmup contactor
7. Blast doors and span track
8. Power drives

When the hoist raises a weapon to the loader level, three units put the weapon on the loader trunk. These units are the floating tracks, saddle cart, and rammer. A power drive pushes the weapon along the loader trunk and stops it in the forward part of the deckhouse (the assembly area). Here, warmup power is applied and wings and fins are put on the missile. Just fins are attached to the booster. Then the blast doors are opened and the weapon is rammed onto the launcher guide arms. Now let's talk a little more about the principal units in the loader.

LOADER TRUNK. - This is a long metal structure composed of sections butted together and bolted to the underside of I-beams on the overhead of the deckhouse. The weapon is horizontally suspended from a rail on the loader. The top set of shoes on the booster are used to hang the weapon from the rail. You learned about these shoes in chapter 3. The forward handling shoe slides in skid tracks cut in the rail. The after handling shoe is retained in a saddle cart which also travels in the rail skid tracks. The cart is connected to a drive chain. The chain provides the means for moving the cart and weapon along the loader rail. A sprocket drives the chain. Connected to the sprocket is a drive motor. The drive motor is part of the loader power drive which controls the movements of the saddle cart and therefore the weapon.

FLOATING TRACKS. - Two floating tracks, (fig. 5-32) the magazine end of the loader trunk, raise the missile out of the tray and place it on the skid tracks. The floating tracks are designated as forward and rear to coincide with the forward and rear booster shoes on the Talos weapon. The tracks are designated "floating" because they can be raised and lowered.

When the missile-booster combination is ready for transfer to the loader, the floating tracks are lowered. Before the tracks are lowered, the forward part of the saddle cart is positioned on the rear floating track and is lowered with it. When the hoist raises the weapon to transfer it to the loader, the forward booster shoe projects through slots in the skid tracks and slots in the forward floating tracks.

The weapon is not on the loader yet. A rammer moves the weapon in the direction of the launcher while the weapon is still in the tray. Now the forward booster shoe is in the skid tracks and the rear booster shoe is moved forward onto the saddle cart.

After the ramming operation, the forward and rear floating tracks raise. The weapon is lifted out of the tray. Then the floating tracks are aligned with the loader trunk and the weapon can be moved along the loader trunk.

SADDLE CART. - The saddle cart (fig. 5- 33) rides in the loader skid tracks. Two metal latches on the cart hold the top rear booster shoe between them. These latches are called the reverse motion pawl and the forward motion pawl. The saddle cart is connected to the loader drive chain and provides the means of moving the weapon along the loader.

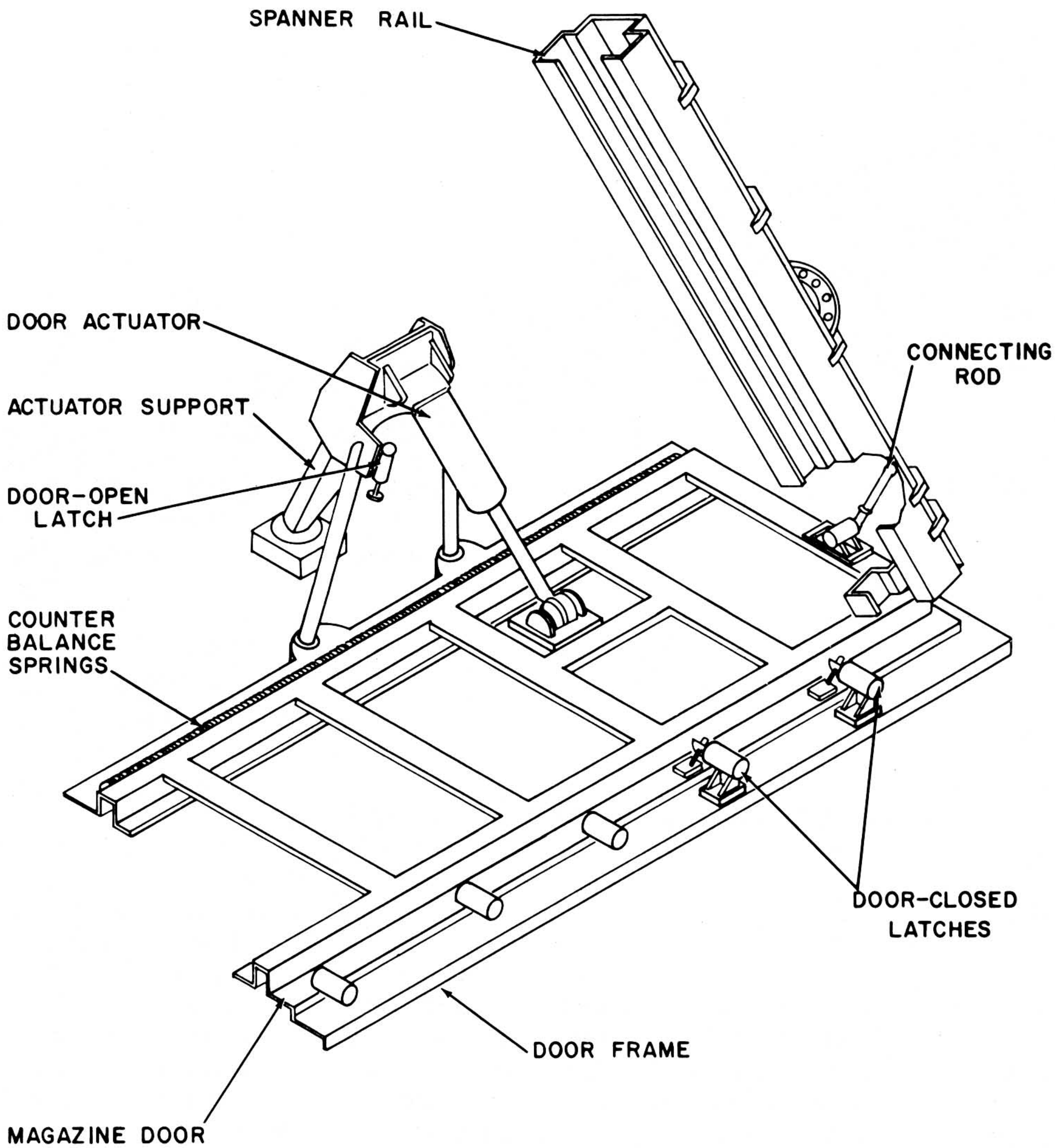
RAMMER. - This is essentially a hydraulically operated piston which is raised and lowered to transfer the weapon on to the loader. It pushes the weapon forward 4 inches, enough to slide it into receiving slots in the saddle cart and the track.

POSITIONERS. - Two hydraulically operated devices called positioners are on the loader. One is at the sprocket housing end of the loader; the other positioner is near the center of the loader trunk. Both of them position and lock the saddle cart. The positioner in the sprocket housing positions and holds the weapon on the rear floating track. The other positioner places the saddle cart so that the warmup contactor can mate with the booster warmup pad.

WARMUP CONTACTOR. - The warmup contactor is located near the center of the loader trunk in area 1 (figs. 5-1 and 5-27). The contactor applies electrical warmup power to the missile while the wings and fins are being put on. The contactor is controlled hydraulically so it Can be lowered to contact the pad on the booster.

BLAST DOORS AND SPAN TRACK. - There are two blast doors, one for the A-side and one for the B-side. Blast doors prevent hot gas and flame from fired boosters from entering the missile deckhouse. Of course, they also keep water from entering. When they are opened, they allow Talos weapons to be transferred from the loader to the launcher guide arm. Each blast door is composed of an upper and lower door. A span track is attached to the inside face of the upper door.

Both blast doors are mounted in a slanting bulkhead which forms the end of the deckhouse. You can get a general idea of what they look like in figure 5-27. When the doors are opened, the tracks connect the launcher rails with the



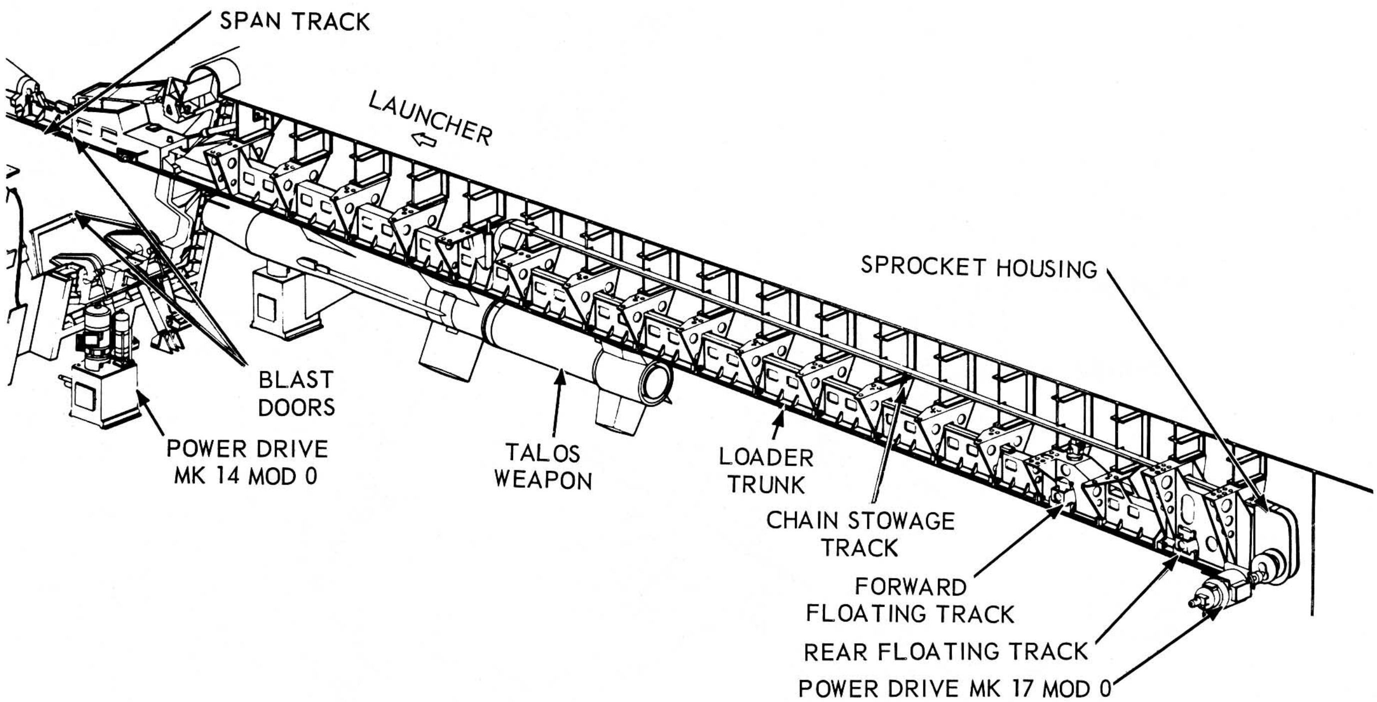
83.54
Figure 5-31.—Magazine door and spanner rail, Talos launching system.

loaders. This permits Talos weapons to be loaded on (or unloaded from) the launcher.

The upper and lower doors are hinged. The lower door is hinged to the bottom of the frame and the upper door to the top. Each door is opened and closed by two hydraulic pistons. The two doors do not open or close simultaneously, but act in sequence. The lower door opens first. When it is fully open, the upper door opens. When closing, the upper door closes and then the lower. Latches secure the door in the open or closed position. A deicing system prevents frozen water or spray from sealing the doors shut. A power drive on the main deck near the doors provides the power to operate the doors.

Guided Missile Assembler

Guided missile assembler is a fancy name for wing and fin stowage racks. The work done in this area is like that done in the Terrier assembly area.



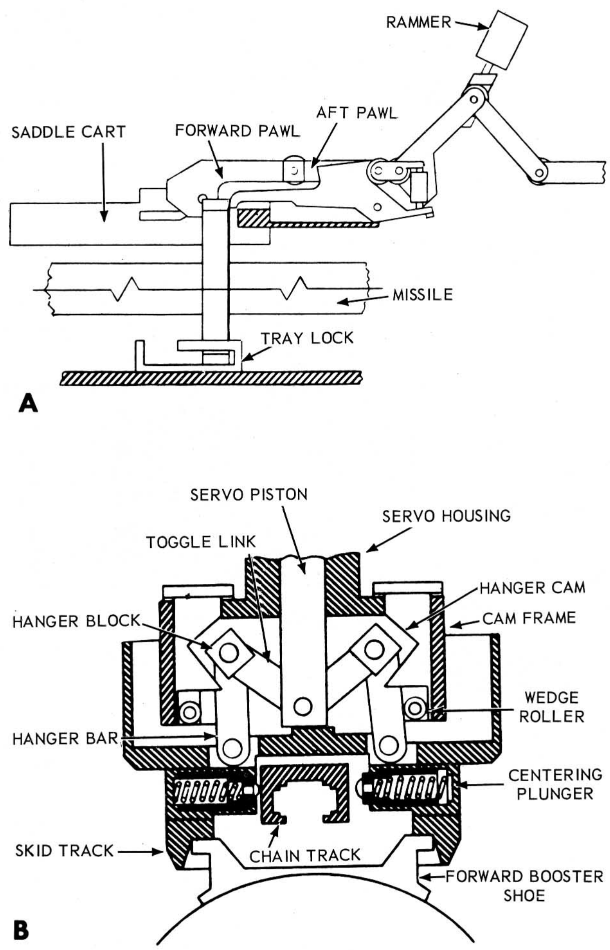
83.55

Figure 5-32.—Loader, B-side, Talos launching system.

MISSILE LAUNCHING SYSTEM CONTROL

A guided missile launching system is made up of many interrelated parts. All of these parts must work together as a whole to accomplish the purpose of the system - in this case, to stow, load, and fire missile weapons. To perform its mission, the system goes through a predetermined sequence of operations. For example, consider briefly how the loader works during loading. Loader equipment picks up the weapon from the tray and puts it in the loader skid tracks and saddle cart. Then the weapon is moved to the assembly area, where wings and fins are put on the missile-booster combination. Now the weapon is completely assembled. It is then rammed and attached to the launcher. The hardware that did the loading operation is brought back (retracted) and put into a position where it will grab another weapon and prepare to load it on the launcher. You can see that many events occur just in this small portion of the loading operation. Also, these events occur in a set sequence. If the equipment is working properly, nothing can happen out of step. But failures occur, and the launching system senses them when they happen. For instance, we forgot to open the blast doors in the above description of a loading operation. Well, a properly operating loader won't forget. It has electrical interlock circuits that indicate when a blast door is open or shut. If a door is open when it should be shut and the GMLS is ordered to load a weapon, the system will not obey the order. And you will agree this is a logical decision. Since the system as a whole must make thousands of logical decisions, electrical circuits have been designed to make them. These decision- making circuits are part of the system control. Also, the launching system control contains circuits that "keep tabs on" (monitor) the operation of the complete system. When an event takes place in the system, say the blast doors are opened, the completion of the event is indicated on a display panel. Almost every event that happens in the system is displayed visually on a panel. These panels are also part of the launching control.

Missile Launching Control Mk 10 consists of electrical switches, circuit breakers, relays, and other electrical devices that make up control circuits. Consoles and power distribution panels are also included.



83.171
Figure 5-33.—Mechanics and hydraulics of the loader: A. Engagement of the aft booster shoe with the saddle cart; B. Floating track aligned to shoe.

Types of Control

The missile launcher train and elevation power drives are controlled through the launching system control. Also, the system control permits step and automatic control of the rest of the system. We had better define what we mean by "step" and automatic operation.

In step control each individual operation is started by a switch or pushbutton. In automatic control each step of an operation is performed automatically. Once a process has been started, it follows through without interruption; whereas, in step control the operation is performed in discrete steps.

Control Panels

The GMLS Mk 12 has 13 control panels. We are going to talk briefly about the more important ones. All of these panels together control, monitor, and test system operation. Also they provide a means for distributing electrical power. The location of these panels is shown in figure 5-34. These are in areas 1 and 2, or feeder and assembler areas.

POWER PANELS. - Panel EP-1A provides power distribution for the launcher power drives, missile warmup power, and electrical power to the launching system control circuits.

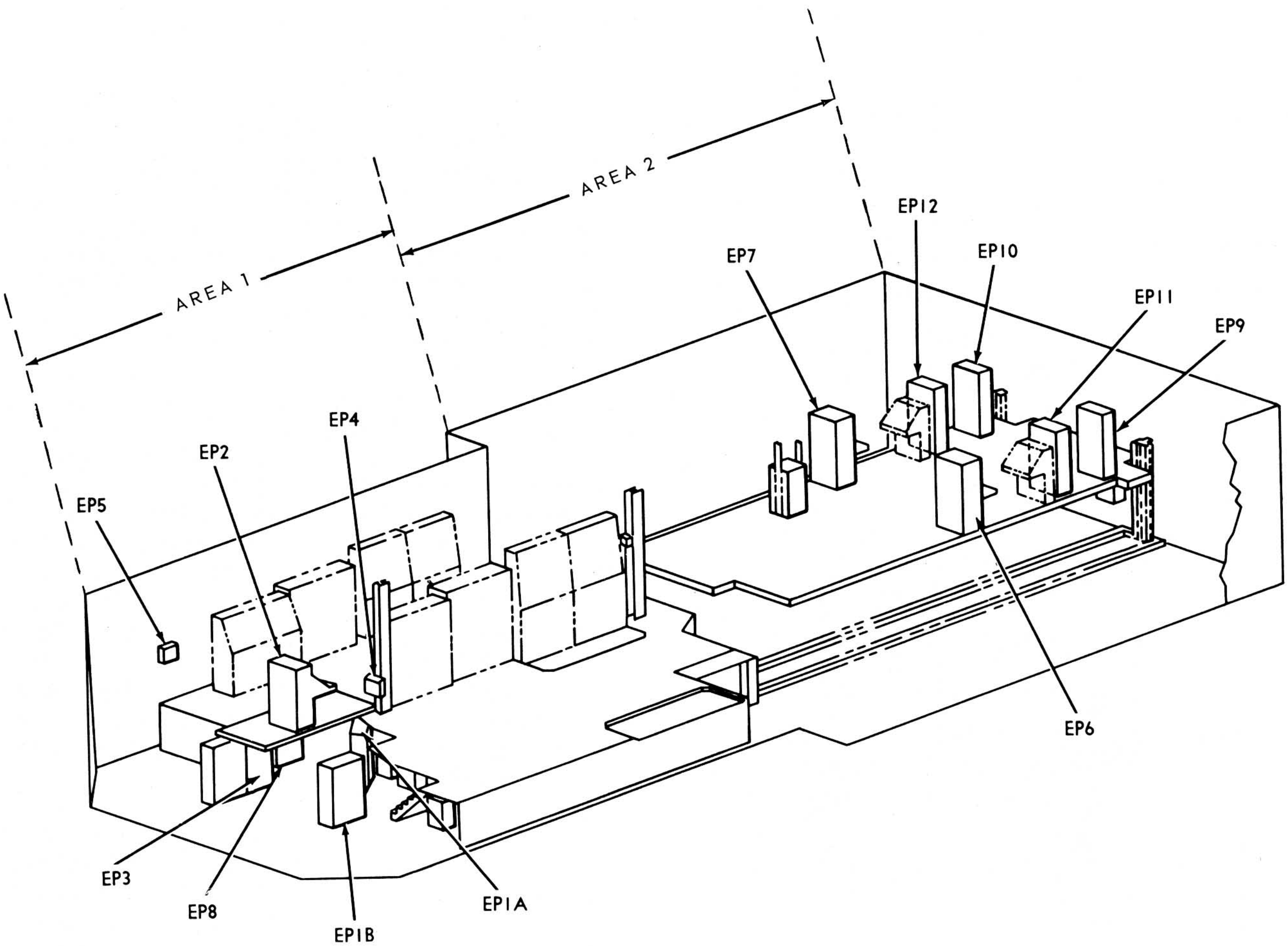
Power panel EP-1B distributes power to the magazine equipment, loader power drives, and the anti-icing equipment. The reason for two separate power distribution panels is that you don't want all your electrical eggs in one basket.

Launching System Panel EP2 contains switches, indicators, amplifiers, and relays needed to operate and control the launcher and feeder. Following are some of the functions that can be performed through the EP2 panel:

1. An operator, called the Launcher Captain, can select the launchers train and elevation signal source. If you want to control the launcher in train and elevation from a signal source other than the computer, you just throw a switch on the face of the EP2 panel to the appropriate position. You would do this if you wanted to test how well the launcher power drives were operating.

2. There are many lights on this panel. Some are red, some are green, and others are amber when lighted. A red indicator light might indicate there is a casualty in a hydraulic system, or that an electric motor is stopped. A green indicator light shows that a motor: is running. An amber indicator light might glow to show that a launcher rail has a missile on it and what type of Talos missile. A series of lights is used to monitor the movements of a missile as it flows through the launching system.

3. By throwing the right switches you can start electric motors as you need them. Under certain conditions you don't need all of them running at the same time, so independent start control is provided.



83.58
Figure 5-34.—Control panels in the Talos missile launching system control.

4. The launcher captain can select one of several ways of operating the system. With switches he can put the system in the load method of control. In this operation the system takes a missile out of the magazine and puts it on the launcher. Sometimes it is necessary to remove a missile from the launcher. By throwing switches, this unloading operation is started. Then the system takes the missile off the launcher.

TEST PANEL EP3. - This panel contains switches, synchros, and jack plug connections to perform complete tests on the launcher power drives and to operate the launcher in local control. Dummy directors, signal generators, recorders, and other test equipment may be plugged into the panel to conduct tests.

ASSEMBLER PANELS. - Panel EP4 contains switches, relays, and indicators for monitoring and controlling the operation of the A-side of the assembler. EP5 panel is identical to, and has the same function as EP4 except that it controls the B-side of the assembler.

MAGAZINE PANELS. - EP6 panel provides for monitoring and controlling the" A" magazine mechanisms while in step control. Magazine Panel EP7 is the same as EP6 except that it controls the B-side magazine.

RELAY PANEL EP8. -This panel contains relays associated with launching system control.

LOCAL CONTROL PANELS.-EP9 panel contains the equipment for the local control operation of the A-side loader power drive. The loader can be operated at variable speeds through controls on this panel. Panel EP10 is identical to Panel EP9 except for the fact that it controls the B-side loader power drive. Local Control Panel EP11 contains the equipment for local control operation of the A-side magazine hoist drive. The velocity and movement of the hoist can be controlled through this panel. Panel. Panel EP12 is identical to the EP11 except that it controls the B-side magazine hoist drive.

LAUNCHING SYSTEM FUNCTIONING

Now let's follow the functioning cycle of the Mk 12 launching system as it fires a round. Except for installing wings and fins, the cycle is completely automatic.

We begin the firing cycle when the weapon control station (WCS) gives the order for system alert followed by a load launcher order. The wing and fin assembly operators (12 of them) are alerted and the decision is made in WCS as to whether the first load to be put on the launcher is a double- or a single-rail loading and, when a single-rail loading is chosen, which side (A or B) is to be used. The launcher area is checked to see if it is clear, and the load launcher switch is moved to the load position. The WCS also selects the type of missile to be fired.

When the load order is given, the magazine hoist automatically indexes (moves up or down) to the selected tray position and removes around and its tray. With the round and tray on the hoist, the hoist moves upward to the standby position. The magazine doors open and the hoist rail spanner sections rotate to align with the hoist rail. The magazine hoist raises the round in the tray from the standby position to the load position, and the floating section of the loader rail lowers. The rammer retracts, engaging the aft booster handling (upper) shoes, and the missile unlatching actuator is extended, causing the shoe latch to retract. When the shoe latch has retracted, the rammer moves the round four inches, and the top booster shoes engage the floating rail portion to the loader track. As the missile-booster combination is moved forward by the rammer, the cinch belt (fig. 5-28) which holds the missile to the forward end of the tray is released automatically. The missile unlatching actuator retracts, and the floating rail elevates the round to the loader rail, about 2 inches.

When the floating rail has fully elevated and latched, the hoist lowers the empty tray into the magazine, the hoist rail spanner sections retract, the magazine doors close, the loader moves the round to the wing and fin assembly area (area 1), and the loader chain positioner locks the chain. The empty magazine tray is returned by the hoist to the stowage position, and the hoist returns directly to a standby condition, or it selects another round when ordered, and then returns to the standby position until the next cycle.

When the weapon arrives at the wing and fin assembly area, the positioner latches, and the electrical contactor extends to start missile warmup. When the magazine doors are closed, the blast door may be opened. However, normally the blast door opening is delayed for five seconds by a time delay relay, thus making sure that the door is open a minimum amount of time. Interlocks insure that the launcher is in the load position before the blast. doors open. The lower blast doors open first, and the upper doors and spanner rails raise and latch into the launcher rail, forming an inline extension of the launcher loader (feeder) rail system. Wing and fin installation (this operation should require a maximum of ten seconds) is completed, the arming plug installed, and 12 operators actuate their individual safety (hand) switches, indicating that each operator is clear of the round. External warmup power is removed, the missile switches to internal power, the electrical contactor retracts, the assembly area positioner retracts, and the round moves onto the launcher.

As the round reaches the launcher, the reverse motion latch extends and, when it is fully extended, the loader saddle cart returns to a position above the magazine, and the launcher electrical contactor extends. After the contactor is in place, missile internal power is removed and external power is again applied to the missile. The contactor also completes circuits for missile identification and type of warhead indication. As the loader saddle cart retracts past the upper blast door, the blast doors close. When the upper blast door is clear of the launcher, the train and elevation latches retract, and the launcher remains at the load position awaiting assignment; or it synchronizes with the launcher order signals from the computer if these signals are present (assignment has been made). After assignment has been made, the launcher trains and elevates to the firing position. The missile may now be fired by the WCS. The first loading operation requires approximately 57 seconds.

Subsequent salvos usually require less time. The exact time varies with the location of the missile required.

TARTAR LAUNCHING SYSTEM

The Tartar missile launching systems are installed on guided missile destroyers. Tartar missiles are also used as backup missiles for the Talos systems aboard heavy cruisers. The Tartar Mk 11 launching system is used on DD3- and CG-class ships. This system has a two-arm launcher located over two rings of vertically stowed missiles. The Mk 13 launching system is used on small ships. It has a single launcher guide arm that loads in the vertical position. The missiles are stowed vertically in two rotatable ready service rings.

Tartar Launching System Mk 22 was developed for use on small ships where space and weight allowances were too limited to permit the use of the Mk 11 or the Mk 13 system. The Mk 22 system was designed to replace a 5"/54 gun mount. A single ready-service ring is located directly below the launcher with the missiles stowed vertically.

The main components of the Tartar launching system are the launcher, the missile magazine, and the missile launching control system. As Tartar missiles are completely assembled before stowage, and the folded tail surfaces are erected automatically after the missile is on the launcher, there is no need for an assembler. This also eliminates the space for the control panels, which have to be placed outside the launching system.

Figure 5-35 shows the Mk 11 launching system.

The launcher and magazine require no operating personnel; three men are required for the control panels.

During automatic operation, the launching system control initiates and controls the loading cycle, but the launcher is positioned and the missile is fired by the ship's fire control system

LAUNCHER

The Mk 11 launching system uses Launcher Mk 8, Mods 0, 1, and 3. The Mk 13 launching system uses Launcher Mk 116 Mod 0. Launching System Mk 22 uses Launcher 123 Mod 0. Figure 5-35 shows the Mk 8 launcher in the vertical position with a missile on each guide arm, before the launcher is trained and elevated to the correct launching position as ordered by the fire control system on the ship.

Guided Missile Launcher Mk 8 Mod 0

The missile launcher consists of a dual- arm launching guide, a rotating carriage with trunnions, a supporting stand structure, and a combination electric and hydraulic slipring assembly. The general layout is much like that of a gun mount. Both guide arms can be loaded from either the inner or outer ring of the magazine. The two arms are similar in construction, except for right- and left-hand parts. The launcher is remotely controlled by Missile Launching System Control Mk 9 Mod 0.

The major components of the launcher are the stand, the carriage, the missile launcher arms or guides, and the slipring assembly. The train and elevation power drives are components of the carriage.

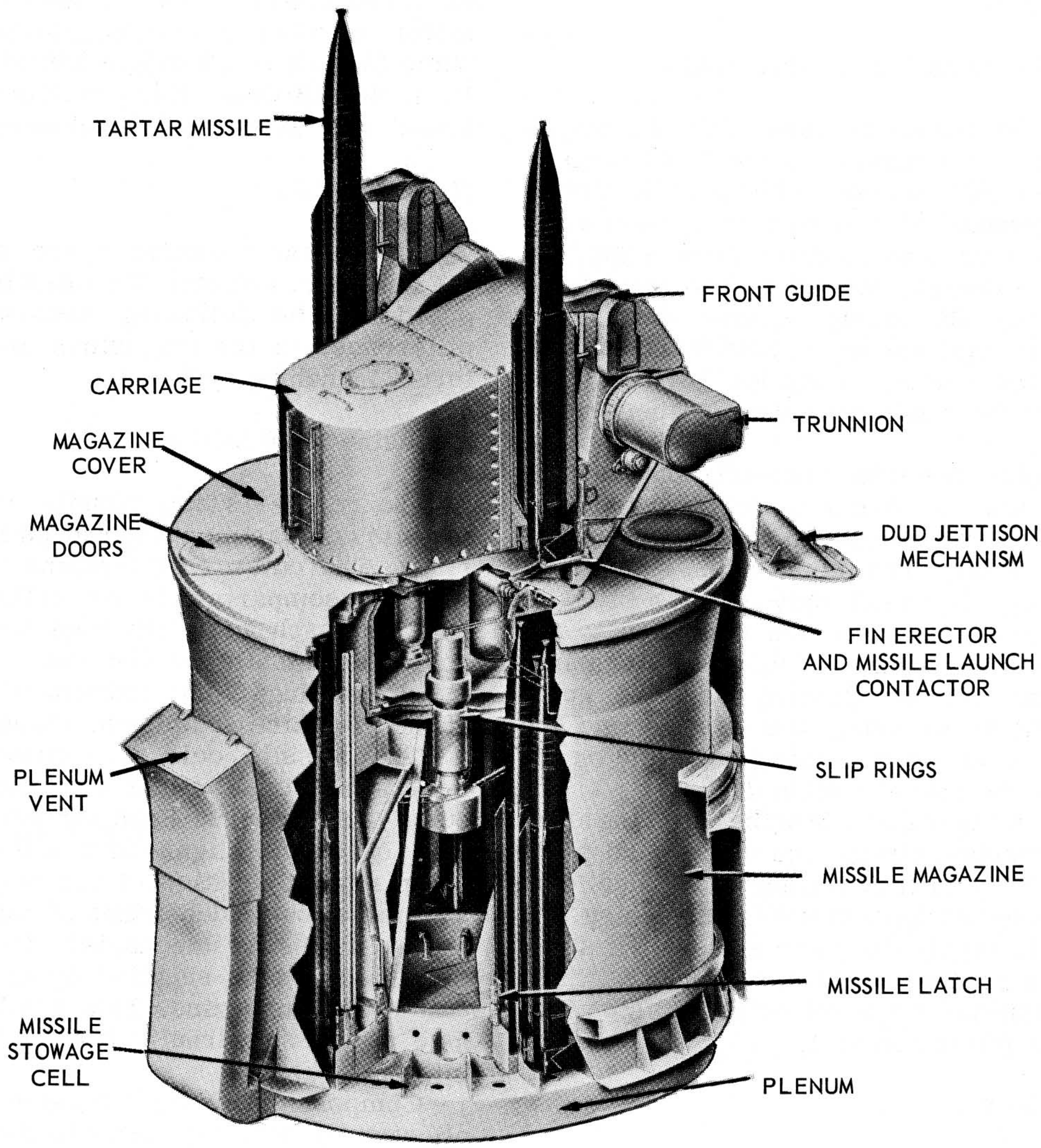
The stand assembly includes a stationary training rack and hydraulic and mechanical components required to rotate and index the magazine cover.

The carriage is bearing mounted in the stand, is capable of unlimited train in either direction, and supports the bearing-mounted torque tube. Besides the carriage structure, the carriage assembly includes a hydraulic system, train and elevation power drives with associated control equipment, latches and securing pins, and the blast door operating mechanisms.

The train and elevation power drives are independent hydraulic drives each with its own electric motor. The pinion of the train power drive meshes with the stationary training rack of the stand and rotates to move the carriage in train. The pinion of the elevation power drive meshes with the gear of the elevation segment to rotate the torque tube in elevation.

The missile launcher includes the torque tube assembly, two guide arms, and a guide hydraulic system. The guide arms can extend for outer magazine loading and retract for inner ring loading. Launcher firing is always accomplished from the retracted position; dud jettisoning is always accomplished from the extended position. Each guide arm includes a missile ramming mechanism" Each rammer is a hydraulically operated chain hoist that can be extended into the magazine cells to hoist a missile to the arm. The rammer mechanism includes a hand drive for manual operation in the event of failure of hydraulic pressure.

Each guide arm incorporates a front, center, and rear guide. During loading or unloading, the missiles ride on a continuous rail from the magazine to the guide arm, composed of rails



141.83

Figure 5-35.—Guided Missile Launching System Mk 11 (Tartar).

in the magazine cell, a segment of rail on the underside of the blast door, and the three guides on the guide arm. The rear guide extends and latches to the blast door when the door is opened. It is extended to latch to the transfer dolly during transfer operations. In automatic loading the rear guide remains extended until the missile is within a few inches of final rammed position. At this point the rear guide retracts and connects an electrical connector from the launcher to the missile. The rear guide incorporates four fin erectors for erecting the missile fins.

The slipring assembly is located on the vertical centerline of the launcher. The assembly transfers electrical power and signals, as well as hydraulic pressure and anti-icing circulating fluid between the rotating launcher and fixed structure of the missile launching system,

You will recognize many of the launcher parts which have the same names as in the Terrier and Talos systems. Some new names here are plenum and plenum vent, magazine cover, and fin erector. They are only on the Tartar system. The plenum and plenum vent are part of the safety system to carry off dangerous fumes in case of an accidental firing in the magazine.

Guided Missile Launcher Mk 116 Mod 0

This is the launcher used with the Mk 13 Tartar launching system. As you have seen in figure 5-2, it has but one guide arm for firing missiles. However, it can fire at a rapid rate. The missile magazine is directly beneath, and it holds 40 missiles, stowed in two concentric circles, called the ready service rings. The ready service rings can be indexed to the position beneath the blast door, ready for hoisting. The launcher can be positioned over either ready service ring.

The launcher assembly consists of the carriage and guide. A base ring and two trunnion supports form the structural units of the carriage (fig. 5-36). The blast door is part of the base ring. It opens only when a missile is being transferred from the magazine to the guide arm or is being put into the magazine. The carriage rotates (trains) and the guide pivots (elevates) to bring the missile into the ordered fire position. The missile is held on the guide arm by the retractable rail.

Mounted on the underside of the base ring are a power unit, cables, piping, and mechanical parts for electrical, hydraulic, and anti-icing functions, Inside the trunnion supports are cables, piping, and connections to supply the guide arm. In the righthand trunnion are the final drive components which include a chain-and-sprocket drive, a pinion, and a sector gear (elevation arc).

Mk 123 Launcher

The Mk 123 Mod 0 launcher is used with the Mk 22 Mod 0 launching system. It has a single guide arm, which is identical to the guide arm of the Mk 13 system. The base ring, on which the launcher is mounted, rotates to position the launcher over the selected missile in its cell. Within the carriage are the train/hoist and elevation power drives, a center column, service platform, train and elevation fluid supply tanks, and the hoist. The trunnion supports are on top of the base ring. The ship's ventilation system is used in the carriage to keep the air circulating.

The train/hoist power drive has a single electric motor-driven hydraulic transmission with separate controls and gear reducers for either training the launcher or driving the hoist chain.

The train/hoist system and the elevation system each have a receiver-regulator with a servoamplifier. Each system has an electric motor coupled to a variable-stroke hydraulic pump (A-end) which drives a fixed-stroke hydraulic motor (B-end). Each system has a power-off brake and associated mechanical drive trains.

MAGAZINES

All Tartar magazines are directly beneath the launcher, and stow the missiles in the vertical position. The following discussion points out differences in the magazines used with the different launching systems.

Magazine Mk 6 Mod 0

The ready-service missile magazine has 42 missile compartments arranged in two concentric rings. The outer ring contains 24 and the inner ring 18 compartments or cells. A set of two rails in each cell fits lugs on the missile to hold the missile in the cell. Latches secure the lower lugs. The individual cells are parts of the magazine and plenum structure.

The missile cells are closed at the top by a rotating cover, fitted with two inner and two outer blast doors. Each diametrically opposite pair of doors aligns with either an inner or outer ring. Operation of the magazine cover is automatic but independent of the launcher. The cover operating mechanism is driven by hydraulic pressure supplied by an auxiliary power unit in the magazine. This auxiliary power unit also supplies hydraulic pressure to operate the missile latches.

Components of the magazine control the application of warmup power to the missiles in the cells. The magazine includes a ventilating system, a sprinkling system to cool overheated missiles, an anti-icing system. and a CO_2 system for fire protection. The magazine has a flame barrier to isolate the missiles, and arrangements for safe collection and exhaust of resulting propellant gases if a missile ignites in its cell. This arrangement consists of the plenum chamber and plenum vent, shown in figure 5-35 and described later in this chapter.

Magazine Mk 8 Mod 0

The construction of the Mk 8 magazine, used in the Mk 13 launching system, is similar to the Mk 6, but is smaller since it serves only one launcher arm. The ready service rings, in two

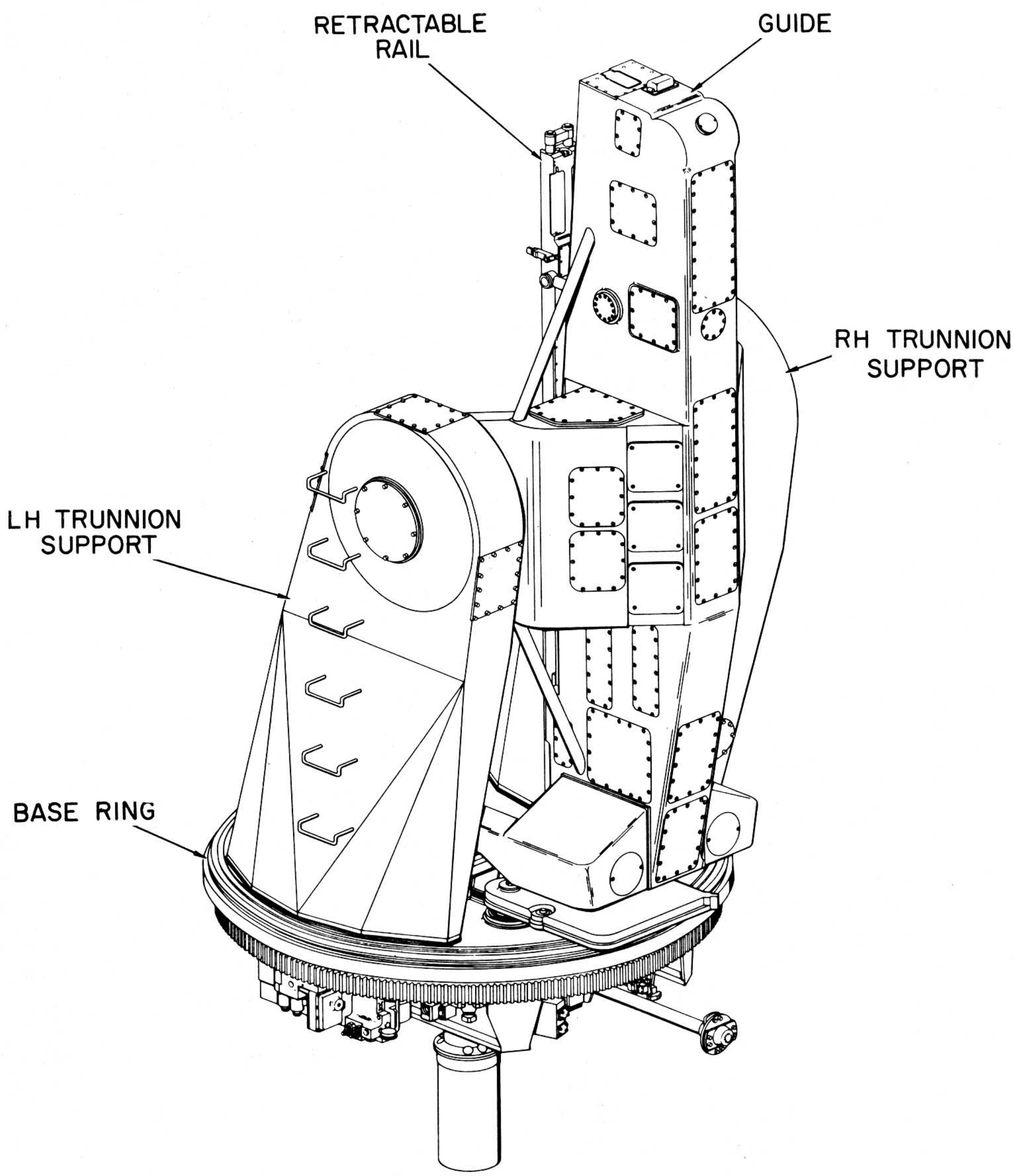


Figure 5-36.—Launcher Mk 116, Mod 0 (Mk 13 Tartar Launching System).

concentric circles, hold 40 missiles. In operation, the ready service ring rotates between the outer shell of the magazine and the inner structure to position the missiles at the hoist station for loading into the launcher. Each ring of missiles has a retractable rail just above the ready service ring. During the hoist cycle, the retractable rail extends and serves as a guide for the hoist chain and missile shoes. The magazine power supply, located in the inner structure of the magazine, rotates the ready service ring to the selected position, and drives (raises or lowers) the hoist.

Magazine Mk 9 Mod 0

The magazine for the Mk 22 launching system has a fixed single ring of 16 missiles. Instead of moving the selected missile to position beneath the blast door, the cover (mounting the launcher) is rotated until the blast door is directly above the selected missile, and then the hoist raises it to the launcher.

Associated Equipment

Some of the associated equipment in the launching system for the Tartar missile has been mentioned in the course of the discussion thus far.

WARMUP. - Warmup power is applied to the missiles while in the magazine, so the electronic tubes will be ready to operate when the missile is launched. The main components carrying the warmup power supply to the missile are the warmup contactors and the electrical contact -ring. As each missile is loaded into the magazine during strikedown, a warmup contactor in the cell enters a socket in the missile, establishing the circuit through which power will be applied when the missile is being readied to fire.

PLENUM CHAMBER. - Under the space or cell for each missile in the magazine is a space called the plenum chamber. If a missile should accidentally be ignited while in the magazine, the plenum chamber receives the exhaust gases and conducts them to the plenum vent to escape to the atmosphere. No matter where the missile is stowed, there is always a plenum compartment beneath it. Each compartment has a blow-in plate. Near the top of the magazine are four blowout plates, which release if pressure in the magazine builds up too much.

WATER INJECTOR. - Another system used only in the Tartar launching system is that of injectors. A total of 96 injectors are used, inserted into the base of the stand. Each injector is a standpipe threaded into the base, and a water injection detector nozzle. If a missile were accidentally ignited in the magazine, only the injector located under the missile will actuate to douse the ignited one. There is also a sprinkler system in the magazine to shower down water from above.

DUD JETTISON. - The dud jettison device used with the Mk 11 launching system is similar to that used with Terrier missiles. On the Mk 13 and Mk 22, however, the jettison mechanism is on the launcher arm, and can be operated by remote control from the EP2 panel.

CARBON DIOXIDE SYSTEMS. - An additional means of fire protection provided in the Tartar launching systems is carbon dioxide, supplied by two independent systems. One system protects the area where the missiles are stowed and the other protects the inner or center compartment of the magazine where the power units, receiver-regulators, and electrical units and cables are mounted. The carbon dioxide is supplied from pressurized cylinders of liquid carbon dioxide, secured in an off-mount location. Heat-sensing devices in the magazine detect overheating when a rapid rise in temperature causes the system to activate. Normal changes in temperature do not cause tripping of the actuating levers. Release of the carbon dioxide rapidly vaporizes it and it spreads all through the magazine and reduces the temperature rapidly and smothers any fire.

WARNING. - Although carbon dioxide is not poisonous to breathe, it shuts off all supply of oxygen and quickly smothers all oxygen-breathing life. Observe the precautions posted in and on the magazines wherever carbon dioxide is used.

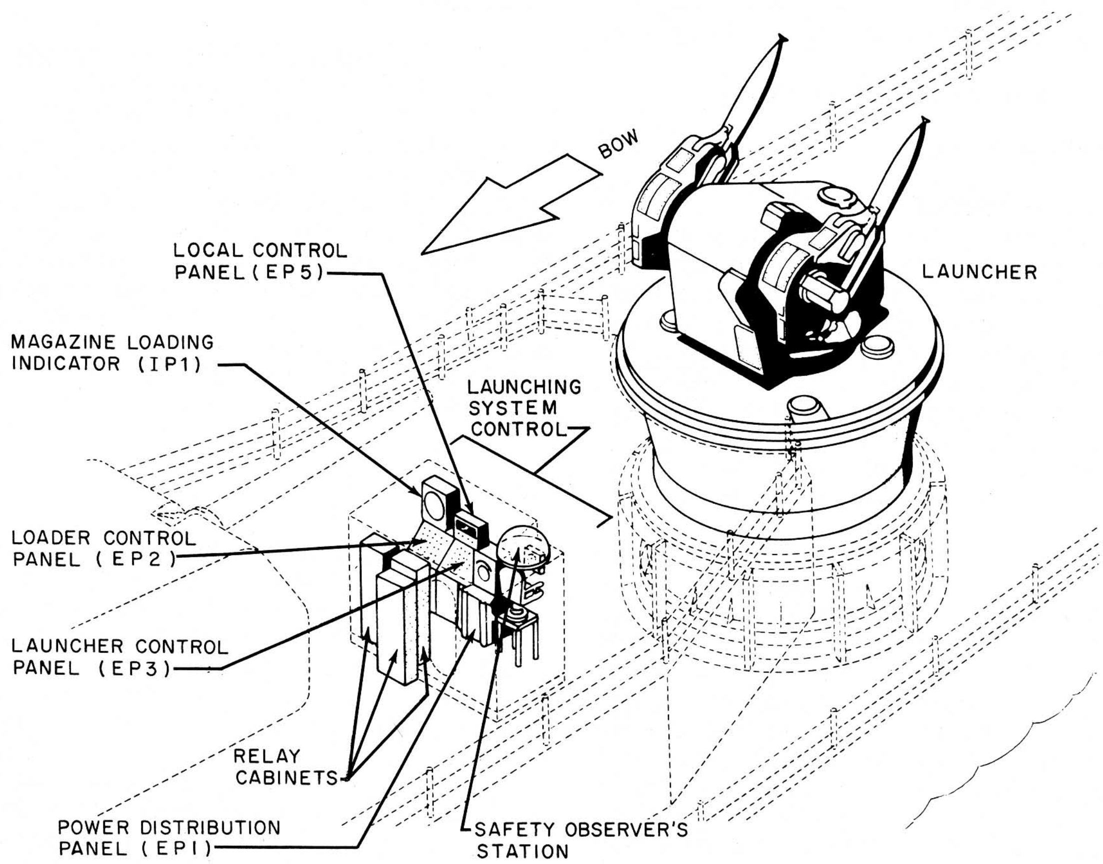
ANTI-ICING SYSTEMS. -Anti-icing equipment is not unique to the Tartar launching system; Terrier and Talos launchers are similarly equipped to ensure operation of the launcher under low temperature conditions. Pipe lines for the circulation of heated fluid are attached to the launcher and exposed portions of the magazine, such as the blast doors. The anti-icing fluid is pumped from a reservoir tank heated by the ship's steam system.

LAUNCHING SYSTEM CONTROL PANELS

The compactness of the Tartar launching system installation leaves no room for the control panels and therefore they must be mounted nearby. Figure 5-37 shows the location of the control panels for the Mk 11 launching system. The control panels for the Mk 13 and the Mk 22 systems are similarly located in a control station off mount but as near as possible to the launcher and magazine.

Missile Launching System Control Mk 9 Mod 0

The missile launching system control (fig. 5-37) regulates and directs operation of the missile launching system. The power distribution panel (EP1) controls the ship power inputs to



141.87
Figure 5-37.—Mk 11 (Tartar) launching system control station.

the missile launching system. The loader control panel (EP2) controls the movement of missiles between the magazine and the launcher guide arm. The launcher control panel (EP3) controls the launcher in loading, unloading, transfer, exercise, firing, and jettisoning. The local control panel (EP5) trains and elevates the launcher manually and displays an error indication to the launching system captain.

The magazine loading indicator (IP1), shows whether cells are loaded, if the warmup power is on, and if the missiles are latched or unlatched in their cells.

Control System Mk 13 Mod 0

The Mk 13 Mod 0 launching system has three remotely located control panels that are the control centers for the electrical circuitry. The EP1 panel is the basic distribution panel for all electrical power for the launching system. It contains circuit breakers, contactors, overload relays, fuses, switches, etc., for the electric motors and the supply circuits.

The EP2 panel is the operation control panel for the launching system and is manned by the launcher captain. It contains the switches and relays to select and control the type of operation, the lights to indicate the phase or sequence of operation, synchros for launcher load, dud jettison, strikedown and checkout positions, and amplifier and error meters for train and elevation.

The EP3 panel is primarily a test panel and is not manned during normal automatic operation. The launcher can be operated in local control from this panel and it contains the switches and jack plugs to perform tests on the launcher train and elevation systems.

Control System Mk 21 Mod 0

The control station of the Mk 22 Tartar launching system also has three control panels: EP1, EP2. and EP3. These have the same functions as the comparable panels in the Mk 13 system.

LAUNCHING SYSTEM FUNCTIONING

Mk 11 Launching System

In automatic operation, the launcher guide arms are elevated to vertical position and the launcher is rotated to position the arms over the selected missile compartments. A chain hoist rammer on each guide arm extracts a missile from the magazine compartment and raises the missile to the arm. On the arm, the folded tail surfaces of the missile open automatically, and connections are made automatically to transfer warmup power and control information to the missile, arm the missile, and complete the firing circuit.

In continuous operation the system is capable of firing a salvo every 20 seconds. Although ordinary operation is automatic, the system can be operated in manual step control. Safety and other interlocks ensure proper sequence of operation. The launcher and magazine require no operating personnel. The launching system control requires three men. Dud jettisoning units. one for each guide arm, are installed adjacent to the launcher. Auxiliary equipment provides for checkout, strikedown, and servicing of the missiles. The system, excluding missiles and auxiliary equipment, weighs approximately 66 tons.

Mk 13 Launching System

Like the Mk 11 launching system, the Mk 13 launching system can be operated in automatic or in step control. Automatic control, with orders coming from the weapons control station, is normally used for firing procedures, while step control is used for exercise, strikedown, and checkout procedures. Automatic control may also be used for unloading the missiles. Except for the fact that there is only one guide on the launcher, the steps in the loading and launching operation match those in the Mk 11 system. It has the same system, unique for the Tartar, for automatic erection of the fins on the missile after it is on the guide. When the missile is to be returned to the magazine, the fins must be folded before it can pass through the blast doors. The fins are folded by sending a crewman out on the launcher to do it; they are not folded automatically.

Mk 22 Launching System

A major difference between the Mk 13 and the Mk 22 is that the magazine structure of the Mk 22 is nonrotating, and the launcher is the rotating part. The launcher is positioned over the cell of the selected missile, which is then hoisted to the guide, and the launcher trains and elevates to the position ordered by the weapons control station. Operation can be automatic from the weapons control station or in step control from the control panels near the launcher, The launcher is activated from the EP1 power panel, and then it can be operated in automatic or step control.

SAFETY

The primary reason for the vast amount of information available on the subject of safety precautions is simply the desire to prevent accidents. Research has shown that a majority of all accidents come about through sheer carelessness. Not only is there a loss of time involved in an accident, but also there is an accompanying loss of either equipment, material, or, in the extreme case, life itself. Aside from these important considerations, there is a vast amount of money wasted in replacing damaged equipment, making investigations, paying for hospitalization or funerals, and for man-hours not worked during convalescence. These are but a few of the problems faced every day by the Navy because personnel fail to heed the posted and required safety precautions.

Practical safety features are incorporated into Navy equipment to eliminate potential hazards to personnel. Since familiarity with equipment leads to carelessness, observation of all safety notices and rules is mandatory. NO RELAXATION OF VIGILANCE SHALL EVER BE PERMITTED,

All personnel taking part in and observing operation of power equipment shall remain alert, keep clear of moving parts, and be thoroughly familiar with the safety precautions applicable to that equipment. At no time will skylarking be allowed in the vicinity of operating power equipment.

The following summary of safety precautions is intended to be general in nature but their importance should not be misunderstood.

Do not service or adjust live equipment without the presence of another person capable of rendering first aid.

Never measure potentials over 600 volts by means of flexible test leads.

Do not tamper with interlocks or any other equipment safety feature.

If possible, use only one hand when working on live circuits.

Never use electrical or electronic equipment known to be in poor condition.

Do not allow unqualified personnel to operate the control panels. Trainees or other persons undergoing instructions shall operate only under the strict supervision of a qualified and responsible operator.

Except for General Quarters, always sound the train warning bell and get an all-clear signal before training and/or elevating the launcher (before each time the equipment is to be moved); likewise sound the loading horn before moving any of the feeder components (before each time equipment is to be moved).

Whenever any motion of a power drive unit is capable of inflicting injury to personnel or material, not continuously visible to the person controlling such motion, the officer or petty officer authorizing the unit to be moved by power shall insure a safety watch. The safety watch shall be omitted in general quarters, but must be maintained in areas where such injury is possible, both inside and outside the unit being moved. There shall be telephone or other effective voice communication established and maintained between the station controlling the unit and the safety watch.

Do not enter the train circle when the launcher train motor is running.

Do not load a live round for a nonfiring exercise.

Be sure that all personnel are located in safe areas before proceeding with such operations as extending or retracting a loader chain (when loaded), opening or closing either the blast doors or magazine doors, indexing a ready service ring, and transferring missile-boosters.

Do not enter a magazine while loading or unloading procedures are under way.

Be thoroughly familiar with all posted safety precautions and those listed in the OP pertaining to the equipment to which you are assigned.

SUMMARY

As you study the different missile systems you will notice that many of the mechanisms and the electrical and electronic components are the same and operate in the same manner. Not that knowing one system means you know them all, for there are differences, but by making comparisons and noting the ways in which systems are different, you will find it easier to understand the operation of the several systems.