CHAPTER 14

LAUNCHER CHECKS, MISSILE REPLENISHMENT AND SERVICING

INTRODUCTION

The material in the preceding chapters, pertaining to guided missile launching systems and their component parts, serves as background information for the GMM in the performance of his primary technical duties. Among the more important of classes duty which we have not covered are power drive performance tests, missile handling, and missile component replacement, which are discussed in this chapter.

Launcher performance testing and the basic principles behind this process is the subject matter of the first section of this chapter. In the second section we will cover missile replenishment in port and at sea. The last section describes the preparations required for missile operational tests and the replacement of missile components.

POWER DRIVE PERFORMANCE TESTS

The automatic control equipment discussed in this section comprises the train and elevation power drives for launchers. A power drive is a part of the basic automatic servosystem. Power drives can be automatically controlled from a remote station which consists of a director or computer.

The automatic control equipment is designed to comply with the nature and source of the signal, the weight of the load to be moved, and the type of damping required to eliminate random movements and to ensure accuracy and rapidity of response. Automatic control is used in ordnance equipment for light loads (computers and indicators) and for heavy loads (gun mounts, turrets, fire control directors, and missile launchers).

You learned in chapter 7, Fundamentals of Servomechanisms, that the output of a perfect servo (one which responds instantaneously to an input signal) is an exact duplicate of its input. If, for example, the input shaft is rotated 10°, the servo output shaft will rotate through an angle of 10°. Assuming both shafts are in agreement and that the input shaft will rotate at, say, a constant speed, the output shaft will follow this constant speed input and will stay synchronized with it. In a perfect servo the output would never fall out of step with the input, regardless of the kind of input shaft motion. But, as you know, power drive servos are not perfect, and the output position and motion do not always represent the input. So, there will always be some angular difference between the two shafts. For example, they may not be at the same angular position, or one may be rotating faster or slower than the other. But if the error between the input and output remains within certain limits under all types of input conditions, then we can say that a particular power drive servo is performing properly.

Who determines what these prescribed limits are? NAVORDSYSCOM does. When the engineers in NAVORDSYSCOM set down specification for private contractors to build a power drive servo, the engineers define the limits. For example, the specifications may say that the launcher must follow a constant velocity signal of 10° per second and stay synchronized with 5 minutes of arc. This means that the output shaft position must not go beyond ± 5 minutes of the input shaft position. Now, to make sure that the launcher manufacturer has built the power drive to meet this specification, NAVORDSYSCOM engineers will go aboard the ship on which the launcher is installed and run a series of tests. One of these tests will determine if the launcher follows a 10°/sec constant velocity signal and does not lag or lead it by more than 5 minutes. If the launcher power drive servo does not meet this particular requirement, NAVORDSYSCOM engineers will not accept the drive until it does.

So, the contractor adjusts the servo until it follows the constant velocity signal with an error of 5 minutes or less, and a permanent record in the form of a tape is made to prove this fact. This record (called an acceptance test) is kept aboard the ship as evidence that the power drive servo can and has met this particular performance standard. It gives you something to shoot for, and also a record for later comparison. You can run the same test later and then compare your test results with those of the acceptance test. When yours are as good or better than the acceptance test results, then the power drive servo is performing at its best.

How can we tell whether a power drive is in top working order? By looking at it? NO. That is not the correct answer. However, it is an answer of sorts because many technicians (GMMs, GMGs, and FTs) use this "eyeball" technique for checking power drive performance. You can tell if a power drive is working at its worst, however, by watching the action of the load. For example, if the launcher overtravels three or four times when synchronizing to a fixed order signal, the most casual observer will notice that something is wrong with the drive. Or, if the launcher hunts as the director tracks a target, you know immediately something is wrong. But how can you tell from looking at the launcher if the source of trouble is in the tracking radar, director, computer, or in the power drive itself? The only way you can isolate the source of trouble is to disconnect the launcher from the computer (and the rest of the weapon control system) and run a test on the launcher drive itself. A dummy director is used to run the test. The dummy director provides an alternate source of signals, thus bypassing the FC system.

From what we've just said, you can see that it is impossible to tell if a power drive servo is working at top efficiency just by watching it operate. We must have some means of measuring its performance and then comparing this with a set of standards.

Dummy directors and error recorders are the test instruments used for dynamic (motion) testing of train and elevation power drives. Dummy directors are sources of electrical signals that are fed into the power drives under test. Figure 14-1 shows schematically how these two test units are hooked up. The error recorder makes a record of the test on a pair of paper tapes. One tape indicates the difference (error) between the signal from the dummy director and the power drive response. The other tape records the velocity of the power drive.

To test a launcher in remote control, electrical signals which represent constant velocity I simple harmonic motion, or a fixed position, are transmitted from the dummy director to the power drive servo under test. The error recorder receives a signal corresponding to launcher response, velocity, or position, depending on the type of test. As the launcher moves in answer to the changing test order signal, the error recorder makes a permanent record of the instantaneous difference between launcher order and the power drive output. The magnitudes of the errors are determined by measuring from a reference line the displacement of the curve produced by the error recorder.

The curves obtained from a dynamic accuracy test should be compared with the curves taken when the equipment was accepted by NAVORDSYSCOM. These records are kept on the ship, to be used for comparison. If the curves from the performance tests show rough response action, or a velocity or position lag in excess of that specified for the particular launcher, the power drive should be checked for malfunctioning parts. Also, the controls should be adjusted to bring the dynamic accuracy tests within allowable limits of error.

These tests are performed quarterly, during shipyard overhaul, and whenever the- launching system seems not to be operating properly. The dummy director and the error recorder are normally used together and are kept aboard repair ships and in Navy shipyards. The Mk 1 Mod 6 dummy director and magnetic oscillograph originally were issued as standard test equipment to all missile ships.

Error recording by means of magnetic oscillograph (direct writing on graph paper) can be performed by using either a stylus which writes with ink or an electric stylus which writes on special magnetic paper. In conjunction with a magnetic oscillograph, a limiter-demodulator unit must be used to calibrate, attenuate, balance, limit, and filter the error signal before it is fed to the recorder.

The instruments necessary for error recording on a missile launching system are connected into the test panel without changing the normal wiring between the fire control system and the missile launching system. Switches on the test panel are marked so the operator can see which ones to use. Receptacles on the test panel receive the cables from the test instruments.

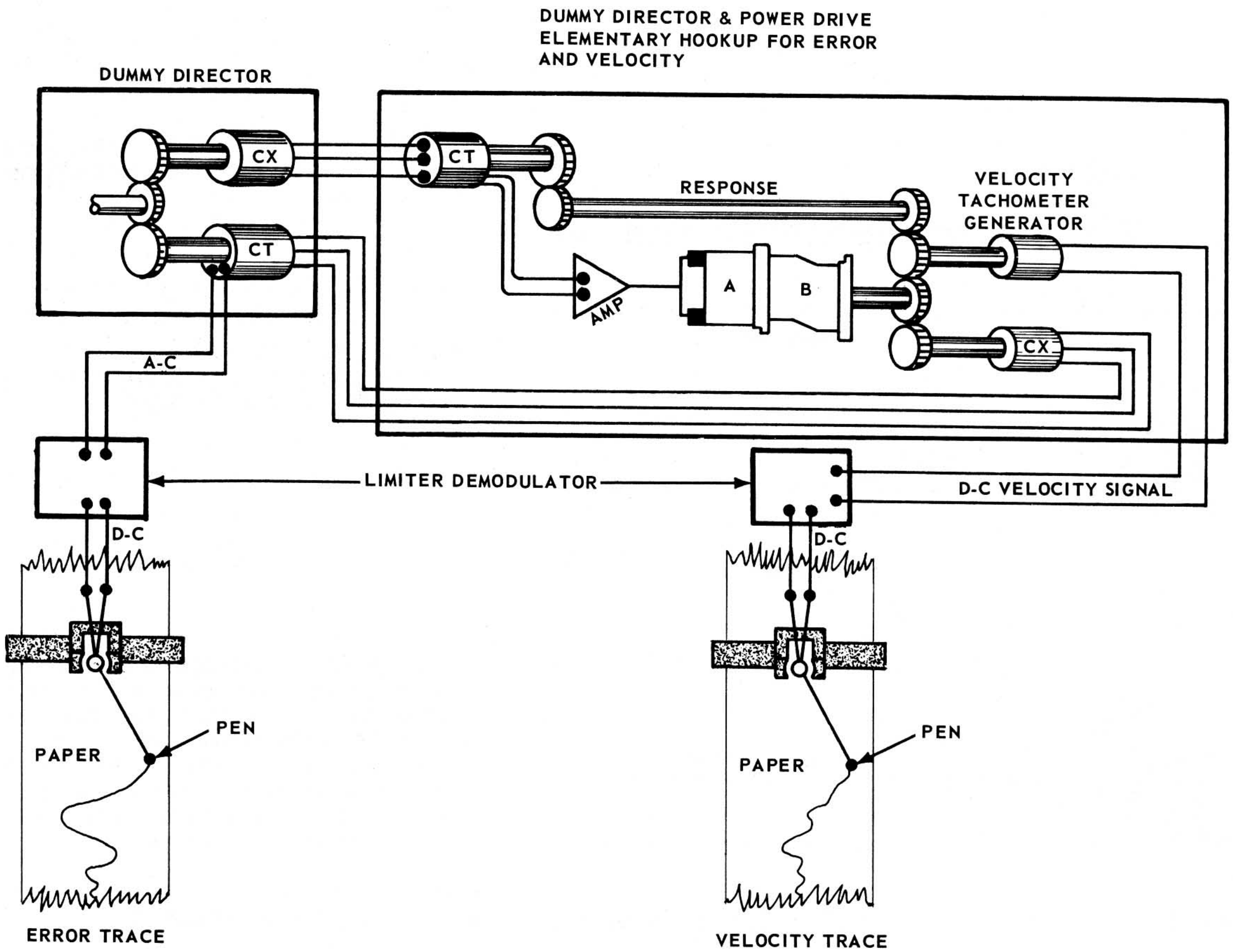

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Figure 14-1.—Simplified schematic of power drive performance test hookup.

TYPES OF TEST SIGNALS

The order signals that are supplied to power drives can be classified as being of three distinct types:

1. Simple harmonic motion (SHM) orders.
2. Constant velocity (CV) orders.
3. Fixed displacement (FD) orders.

Simple Harmonic Motion (SHM)

Figure 14-2 shows a ship making a simple harmonic motion, or roll. In the diagram you can see that ship's roll swings the launcher line of fire away from the aiming point. Pitch will cause this, too. To compensate for rolling and pitching motion of this ship, correcting signals are generated in the fire control computer. These are added to the launcher lead angles to make up launcher orders. The effect of these roll and pitch compensating signals is to keep the launcher line of fire fixed in space as the ship's deck moves beneath the line of fire. (Review ch. 2 on this.)

A dummy director can be considered a motion simulator which can reproduce electrical order signals that represent motions such as roll and pitch. And these dummy signals can be controlled. You can pick the size of the signals (magnitude), how long they take to complete a cycle (period), and also their starting point (reference). To see what the terms in parenthesis mean, look at figures 14-3A and 14-3B. The illustrations show the motion of a launcher in response to a SHM signal. The dummy director is putting out a roll signal that is fed to the train power drive servo. We have picked out 45° launcher bearing as a reference from which to move the launcher. We could have chosen any bearing. We have also set up the dummy

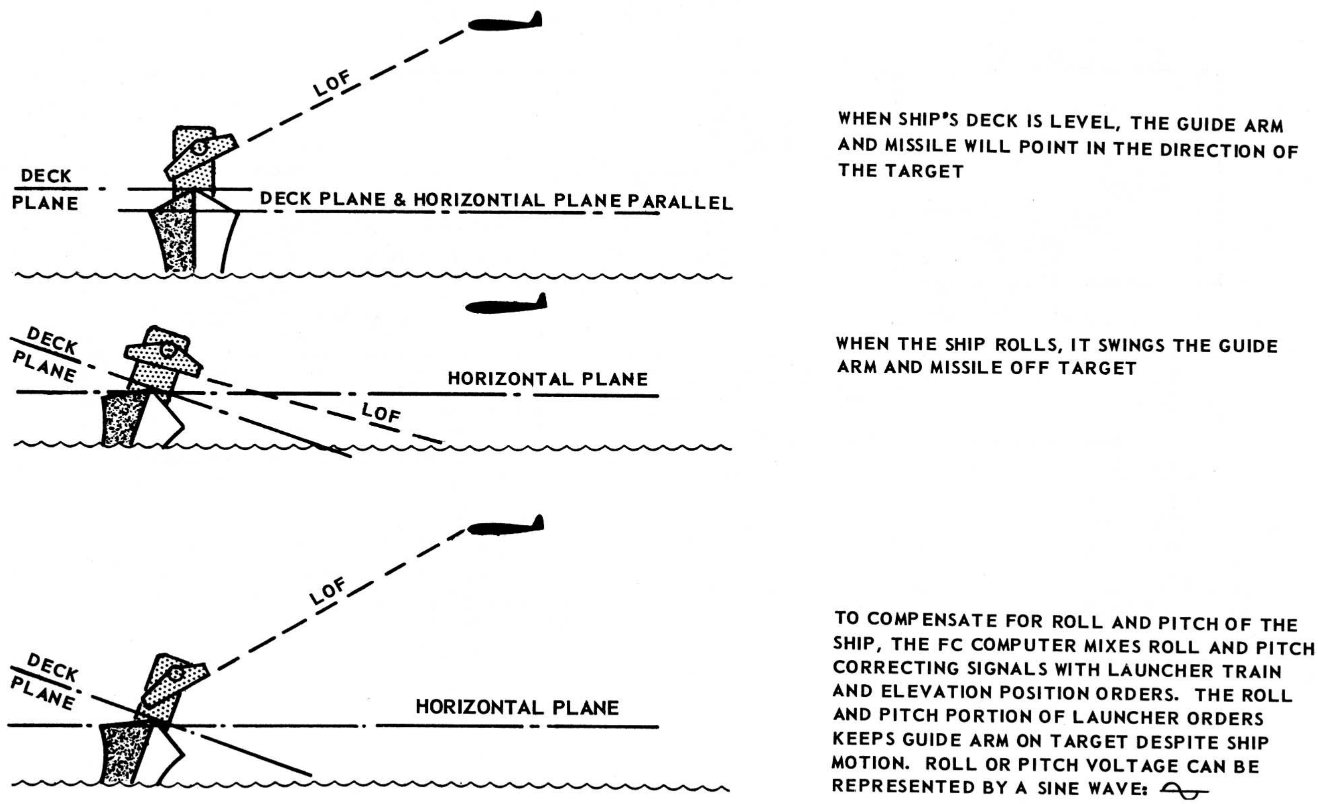

Figure 14-2.—Effects of ship's roll and pitch on launcher line of fire, and corrected line of fire.

director to put out a 30°, 9-second SHM signal. This means that the signal will drive the launcher {once it is synchronized at 45° from this point to 75°, then back to 45°, then to 15°, and back to 45 degrees. It will keep up this oscillatory motion. until we deenergize the setup. Notice that the signal and the motion of the launcher describe a sine wave. You will remember that the period of a sine wave is the time it takes to complete one cycle. The same idea holds for our signal and the motion of the launcher. It takes 9 seconds for the signal and launcher to go to the right from 45° and then back to the left through the reference point to 30° on the other side of 45°, and back to the reference point. This is a fairly slow roll, and it simulates the kind of roll a ship may experience in ground swells. But you can select a variety of SHM signals. Dummy directors have controls by which you can change the amplitude and period of the output signals.

SHM signals are used to check how accurately a power drive servo follows this type of input signal. The error trace on the error recorder indicates how well the servo performs under these conditions. If the servo under test performs perfectly, a straight line shows up on the error trace. A straight line indicates that there is no error between the input signal (SHM) and the servo output (response). In practice you will never get a perfectly straight line, but the trace should be close to one.

Constant Velocity Signal (CV)

A CV signal approximates a launcher order (train or elevation) which is produced when the FC tracking radar is following a target. Figure 14-4 shows train constant velocity motion pictorially. If the tracking line of sight rotates at a train angular velocity of 10°/sec to stay on the target, the launcher must rotate at this same angular rate to maintain its line of fire on target. And over a period of, say, 5 seconds, both the director and launcher will have moved 50 degrees from a given point so long as the tracking velocity remains at 5 degrees per second.

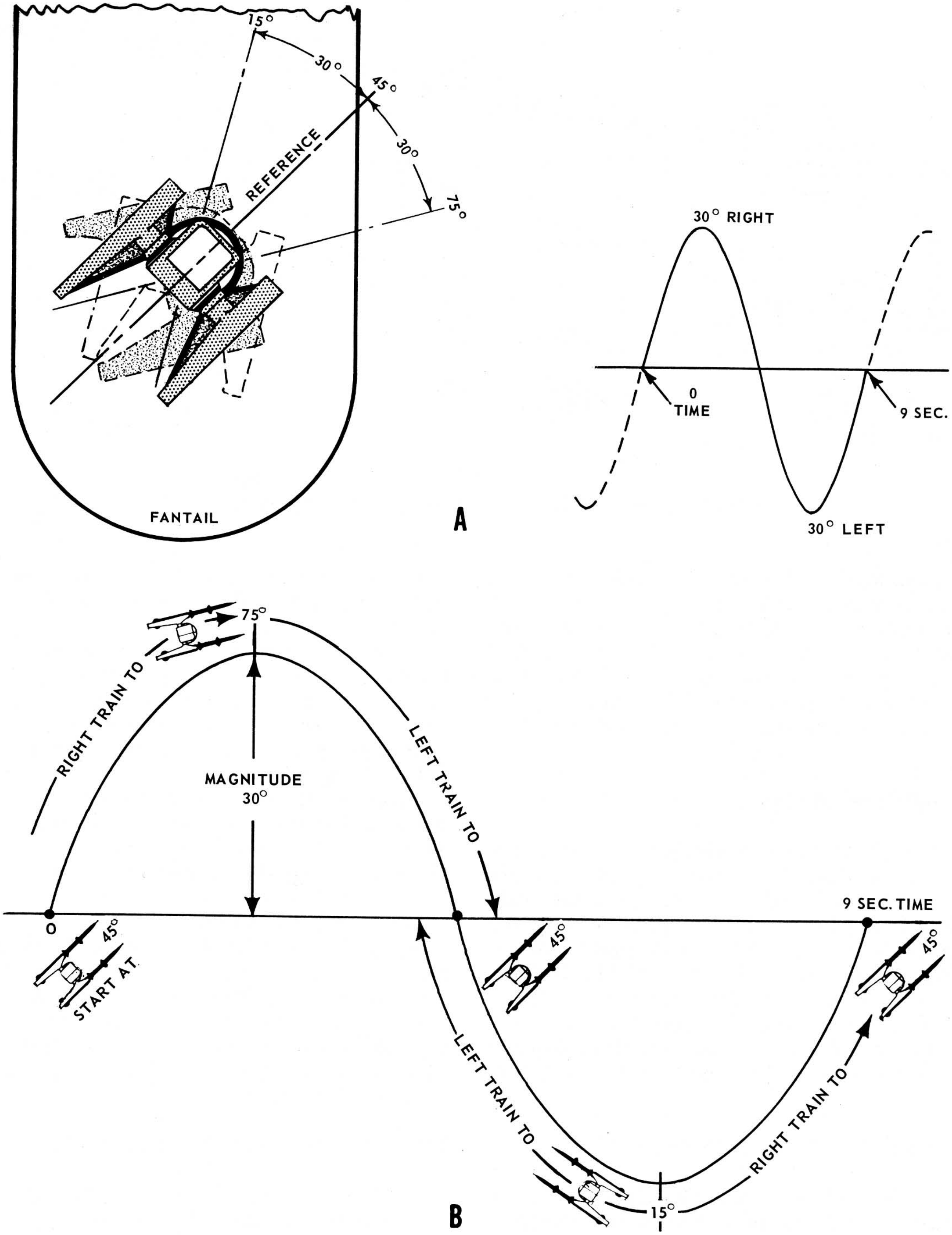

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Figure 14-3. — Simple harmonic motion (SHM): A. Motion of launcher in response to SHM signal describes a sine wave; B. The magnitude, period, and reference of SHM signal.

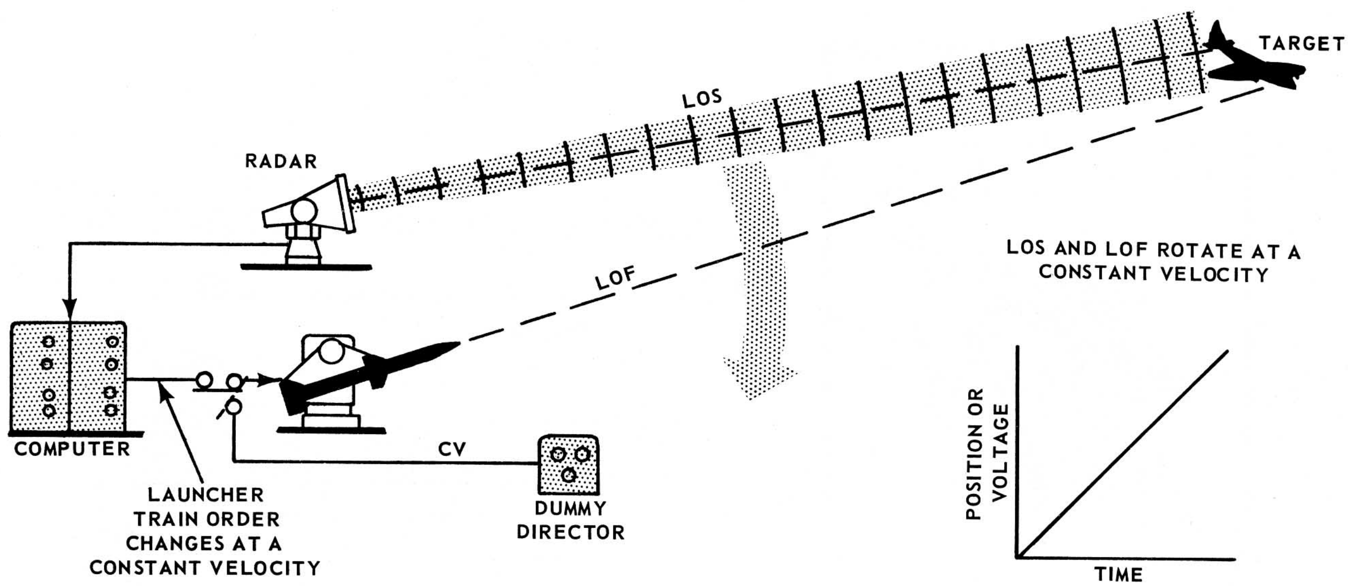

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Figure 14-4.— Following constant velocity signals.

The dummy director in figure 14-4 is shown putting out constant velocity signals to simulate director tracking motion which is reflected in the launcher orders. When the launcher is switched to dummy director control, the entire fire control system and the transmission lines between that system and the launcher are isolated from the launcher.

Fixed Displacement Signal

The dummy director is also used as a source of fixed signals (fig. 14-5). These signals simulate the kinds of signals that are present at the train and elevation power drive inputs when, for example, the launcher is switched from REMOTE to STOW, LOAD, DUDJET, or LOCAL. A fixed displacement order usually involves a large change. The fixed position input results in a large instantaneous error which must be reduced by movement of the launcher to the ordered position.

DUMMY DIRECTOR COMPONENTS

Figure 14-6 shows the basic parts of a dummy director. The main servo drive controls two synchro transmitters which are the sources of 1- and 36-speed train or elevation order signals. The main servo also drives a 36-speed control transformer which is used as an error detector. It measures the difference between the input of a power drive servo under test and its output.

Missile launcher power drive servos, as you know, have a velocity input as well as position inputs. Therefore, the dummy director must provide a source for velocity signals. A tach generator geared to the main servo provides velocity signals.

Another servo, called the auxiliary servo, is connected to the main servo. The auxiliary servo and its associated controls generate simple harmonic signals at selected frequencies and periods.

Figure 14-7 shows the outside appearance of Dummy Director Mk 6 Mod 0 and Error Recorder Mk 12 Mod 0, with their carrying cases and plug-in cables. The dummy director has an auxiliary power conversion unit (auxiliary servo, fig. 14-6), which Some older models do not have. The error recorder is a modified, dual-channel commercial instrument.

THE PAPER TAPE ERROR RECORDER

The error recorders used with dummy directors contain two galvanometers and two motor-driven paper rolls. This arrangement of parts enables the unit to record two electrical values simultaneously; thus, it is called a two-channel recorder. The error recorder can be compared

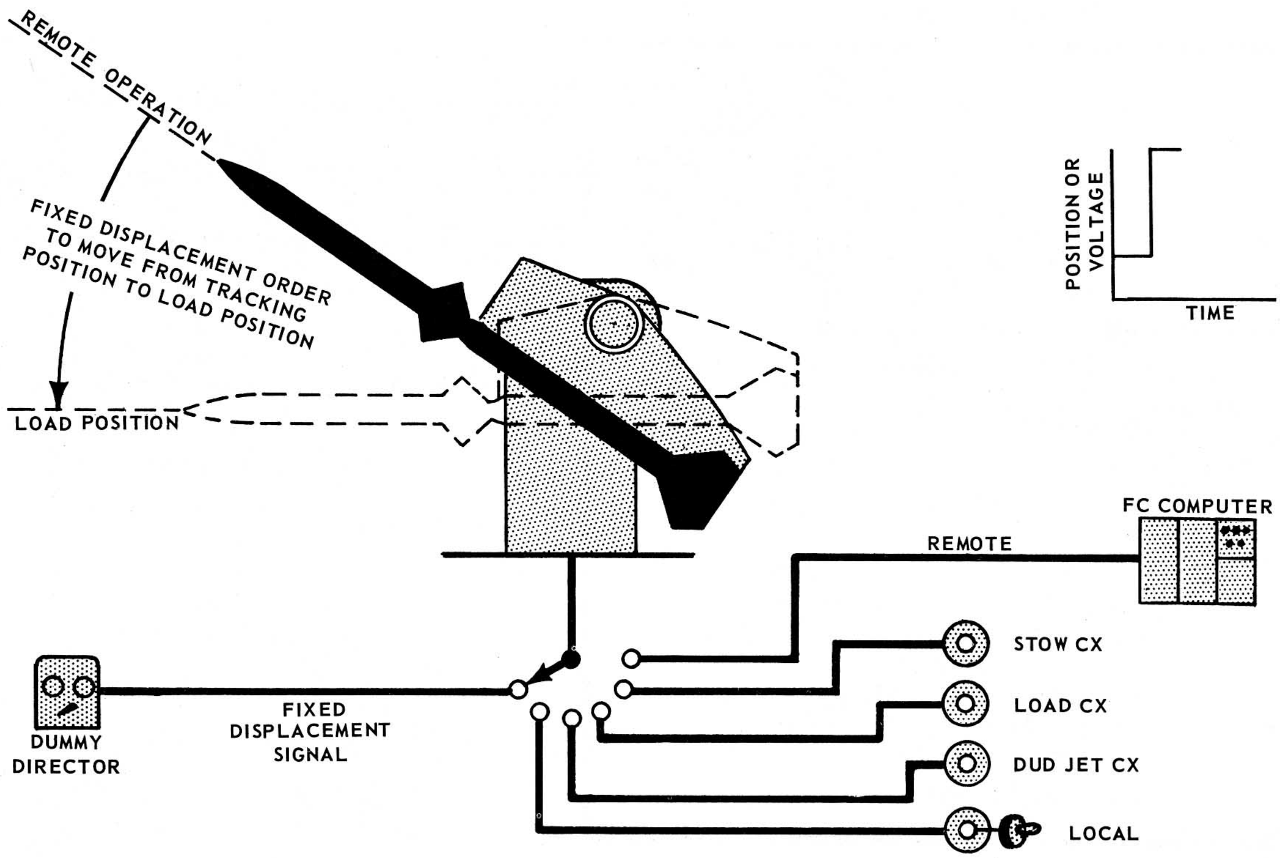

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Figure 14-5. — Fixed displacement signal.

to another recording device, the oscilloscope. Look at figure 14-8. A roll of paper, feeding past a fixed point, is similar to the sweep of the scope, while the speed of the paper corresponds to the speed of the electron beam. The galvanometer (D'Arsonval) movement provides the amplitude deflection. The galvanometer is mounted so that deflection causes the pointer to move at right angles to the direction of paper travel. Writing on the paper is done by an inking pen which is attached to the galvanometer movement.

The operating principle of the galvanometer is the same at that for the galvanometer described in Basic Electricity, NAVPERS 10086-B, chapter 15. If you have forgotten how a galvanometer works, you should turn to the basic course and review this principle.

Since a galvanometer is a d-c operating device, and because the error signal is in alternating form, limiter-demodulator units are provided to change the a-c error signal to direct form. The limiter section of the unit cuts down (attenuates) the size of the input signal so that it won't drive the pen off the paper. In other words, the limiter limits the signal strength at a value which will give full deflection of the pen.

Usually, the velocity of the power drive output is measured at the same time that the error between the launcher order and launcher power drive response is measured. Since the velocity of the output is measured by a d-c tach generator, its output does not need to be demodulated, but can be fed directly to the galvanometer. But the size of the d-c velocity signal is, nevertheless, fed into the limiter section of a limiter-demodulator where the signal is attenuated.

LAUNCHER SYNCHRONIZING INDICATION SYSTEM

The launcher receiver regulator is part of the basic power drive servoloop, and includes the hydraulic pump (A-end), hydraulic motor (B-end), and the A-end and B-end response linkage. Figures 8-13 and 8-14 show the location and appearance

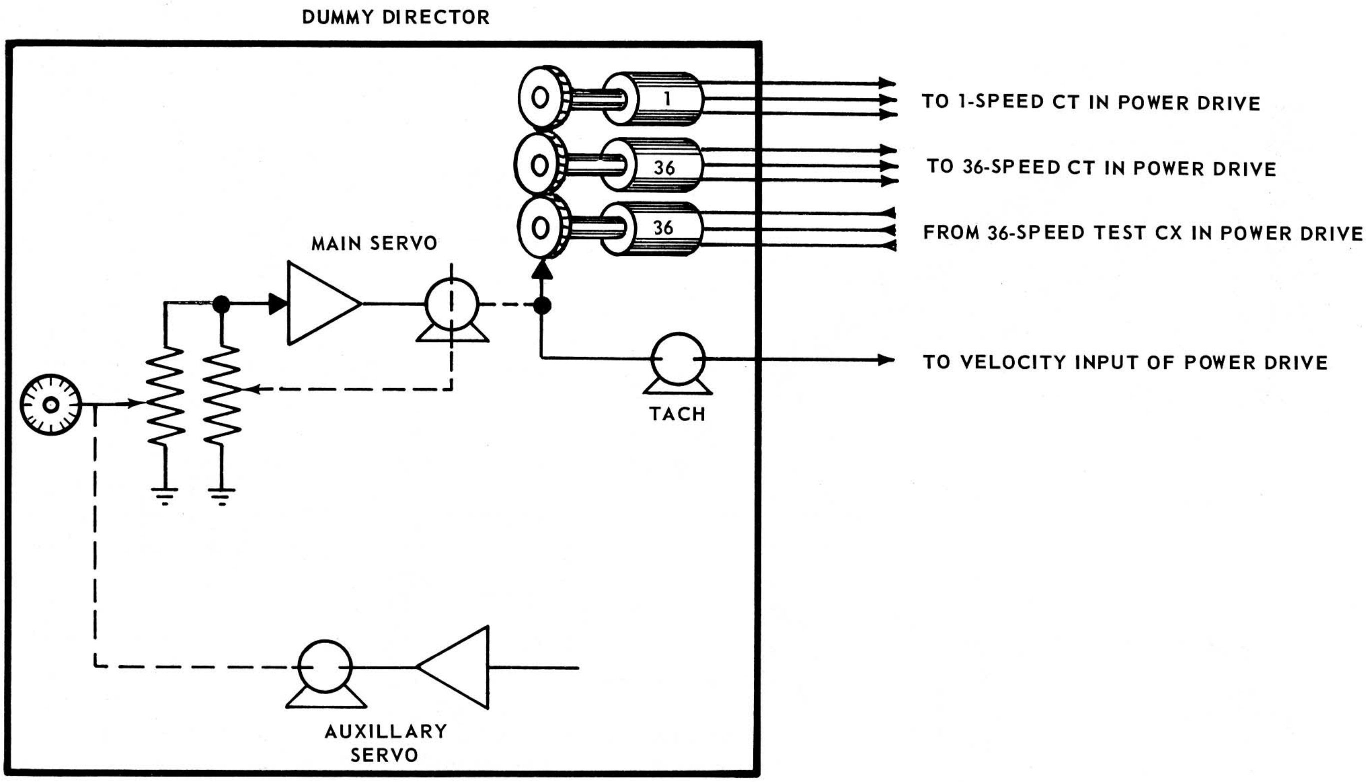

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Figure 14-6.—Basic parts of a typical dummy director.

of a receiver regulator. The operation of servoloops was described in chapter 7. Actually, four separate servosystems within the receiver regulator function together to position the A-end tilt plate when it receives an error signal. Each servosystem has its own feedback; therefore each can be considered a servoloop. These four servosystems are: stroke servosystem, primary servosystem, velocity servosystem, and integration system.

The stroke servosystem is used by the other servosystems to control the A-end tilt. The primary servosystem receives the remote order signal and supplies the position input to the power drive system. The velocity servosystem receives the signal, from the remote control station, which is proportionate to the velocity order input. The purpose of this signal is to increase the speed and accuracy of the launcher as it synchronizes with the dynamic signals.

The integration system signal originates in the regulator. The purpose of this signal is to improve the launcher performance when the launcher is following small dynamic signals.

PURPOSE OF INDICATION SYSTEM

The servos mentioned above all work toward synchronization of the launcher with the signals sent from the fire control system. The men in weapons control and the launcher captain cannot see if the launcher is in the desired position, and is not pointing where a missile could be fired through part of the ship's structure. They must have some indication of the position of the launcher before the order to fire can be given. The launcher synchronizing indication system prevents the launcher from firing unless the launcher is synchronized with the director to within 60 minutes for 0.25 second and then indicates (by means of lights) to Weapons Control and to the launcher captain when the launcher is synchronized. This system also provides a method of checking synchronization during tests.

COMPONENTS OF INDICATION SYSTEM

Figure 14-9 shows the system indicating that the launcher is synchronized. It consists of valves,

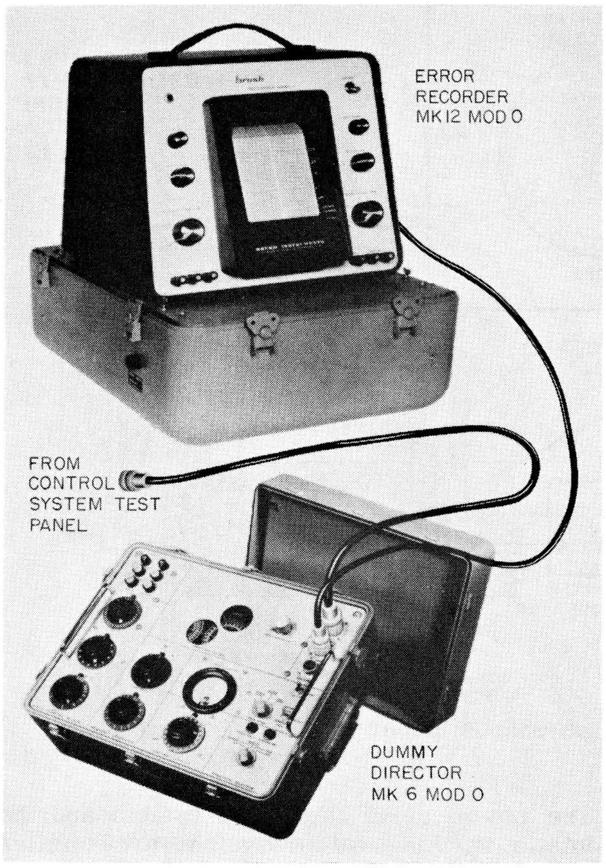

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Figure 14-7.—Dummy director Mk 6 Mod 0 and Error Recorder Mk 12 Mod 0.

levers, pistons, and a switch, actuated by a rotary piston cam and transmitting motion produced by it. They are located in the receiver regulator. Indicator dials on the face of the receiver regulator show the position of the launcher, and indicating lights in Weapons Control and on the EP2 panel tell the operating personnel when the launcher is synchronized to the orders from the fire control system.

OPERATION OF THE SYNCHRONIZING INDICATION SYSTEM

As the launcher synchronizes to the remote orders, the train and elevation limit-stop system, the automatic-pointing cutout system, and the firing cutout system assure safe proper operation. When the power drives have complied with the train and elevation orders supplied by the director, the launcher-synchronized relay energizes if the train and elevation error is within the prescribed limit and the stroking pistons are receiving the train and elevation orders. When the relay closes, the launcher synchronized lights go on.

When the train and elevation power drives are synchronized to the remote orders, the launcher guide and carriage are positioned so the missile can be launched in the proper flight attitude.

Although figure 14-9 shows only a few of the valves and pistons involved and only hints at the connections to other components in the receiver regulator and the power drives, we will use it to follow through on the operation of a launcher synchronizing indication system.

The launcher synchronizing actuating lever (fig. 14-9) transmits the primary stroke motion produced by the rotary piston cam to the synchronizing indication valve, UVTD4.

UVTD4 is mechanically controlled by UVTD2 and hydraulically controls the train launcher-synchronized indication piston, UCTD23. When the error between the launcher and the order signal is less the 61', UVTD4 blocks the port from UCTD23. When the error is greater than 61' (and the launcher is therefore not synchronized), UVTD4 connects UCTD23 to tank.

The launcher synchronizing indication piston, UCTD23, actuates switch SITD26A when the launcher is synchronized. Whenever the power drive is running, servo pressure (400 psi) is ported to the small area end (top) of the piston and then is transmitted through the drilled passage and orifice to the large area (bottom) end of the piston. When the servo pressure on the large area end of the piston is blocked by UVTD4, and the launcher is within 61 minutes of synchronization for 0.25 second, the piston moves up to contact the actuating arm of SITD26A. This action closes the switch contacts of SITD26A causing the light on the EP2 panel in the Weapons Control room to indicate launcher synchronization.

NOTE: The 0.25 second delay required to extend UCTD23 and actuate SITD26A, prevents firing when the error fluctuates in and out of the 60-minute error zone.

LIMIT-STOP AND AUTOMATIC TRACKING CUTOUT SYSTEMS

The limit-stop assembly and the nonpointing zone valve block are in the receiver regulator. The limit-stop assembly is located in the lower

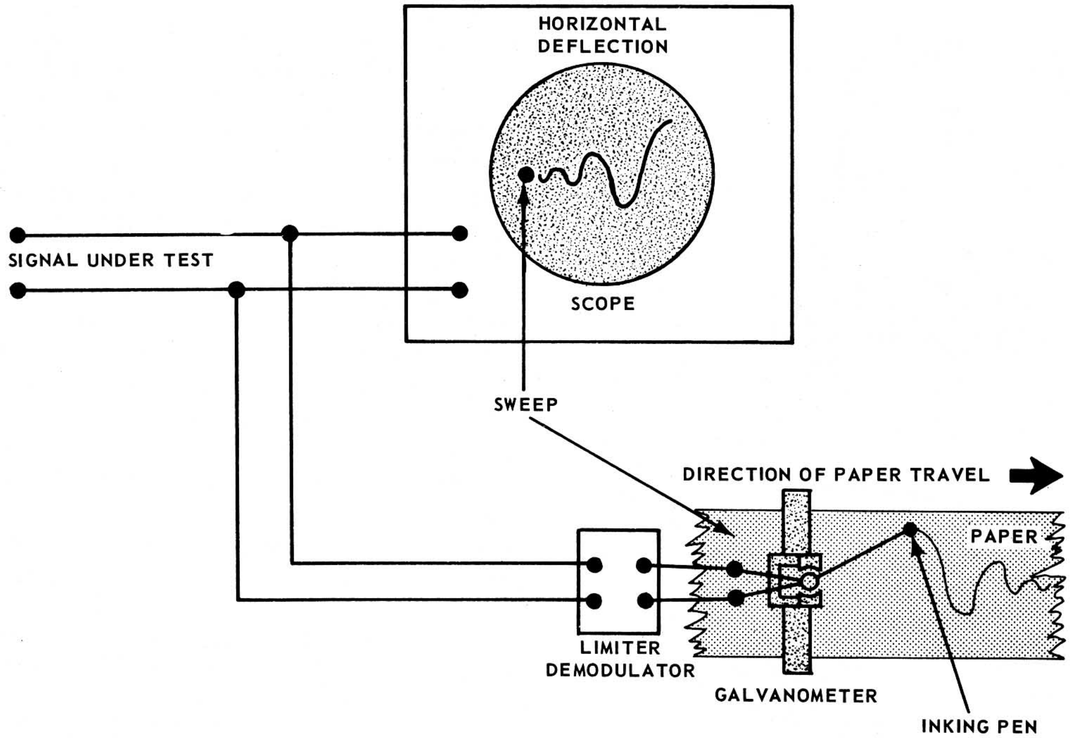

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Figure 14-8.— Error recorder, one-channel paper tape.

center section of the regulator and includes the position-plus-lead (P+L) switch cams and nonpointing zone came The nonpointing zone valve block assembly is located in the lower righthand corner of the regulator. The location of components is identical in train and elevation receiver regulators. (See chapter 8, figure 8-14).

PURPOSE

The purpose of limit-stop systems and tracking and firing cutout systems is to impose limitations of the train and elevation systems when they respond to input orders. The automatic tracking cutout system tracks launcher movement and prevents the launcher from pointing into certain areas (nonpointing zones) wherein a fired weapon would be hazardous to ship structures. The firing cutout system opens the firing circuit whenever the launcher moves into areas where a fired weapon would cause damage to ship structures.

A nonpointing zone is a certain area where a missile on a launcher guide arm could be damaged by contacting the ship's structure, or could be fired from and hit the ship's structure, or could be fired from and hit the ship's superstructure.

The power drive limit-stop system and the automatic tracking cutout system are similar in certain regards since both are used to stop the launcher, if the situation warrants, and both employ the same method of bringing the A-end to neutral.

The train limit-stop system restricts the launcher movement in train; the elevation limit-stop system restricts launcher elevation and depression movements. The two limit-stop systems can function simultaneously or individually. Each receives its own actuating orders which can originate from the fixed elevating and depression stops, the automatic tracking cutout system, and the elevation limit-stop brake, for the elevation limit-stop system; and for the train limit-stop system, from the automatic tracking cutout system, and the train limit-stop brake.

The firing cutout system is an added safeguard that opens the normal and emergency firing circuits whenever the launcher enters a nonfiring area. Although the automatic tracking cutout system normally prevents the launcher from training or elevating into a nonfiring zone, the firing cutout system assures that the firing

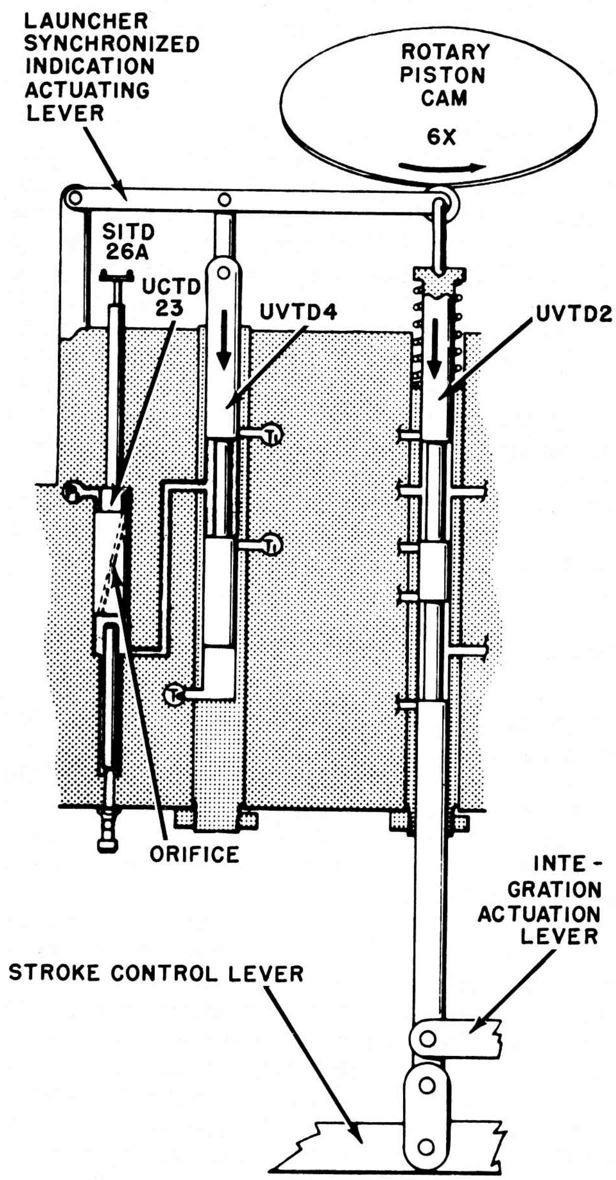

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Figure 14-9.—Launcher synchronizing indication system (B-end error less than 21').

circuit is open if a malfunction should occur and the launcher would enter a restricted area. Nonfiring zones are areas which are designated as unsafe for missile firing. The nonfiring zones are enclosed by train and elevation angles that are identical to the nonpointing zone train and elevation angles.

Nonpointing zones have been called "interference" or "blind" zones. You may find these terms used in some texts.

COMPONENTS AND LOCATION

Although the train and elevation limit-stop systems are very similar in function and in components, there are Some differences.

The train limit-stop system includes the limit-stop assembly, the nonpointing zone valve block, and part of the A-end response assembly. The train limit-stop assembly consists of a differential, a limit-stop brake, a nonpointing zone cam, and four switch cams. The train nonpointing zone valve block consists of a limit-stop brake solenoid and valve, two nonpointing zone solenoids and valves, and two nonpointing zone pistons.

The elevation limit-stop assembly is similar to the train limit-stop assembly except that instead of a nonpointing zone cam, it has a gear and rack which cause the elevation power drive to elevate the launcher guide arms over the nonpointing zones, when necessary.

The elevation nonpointing zone valve block differs from the train valve block. The elevation block has three nonpointing zone pistons and three nonpointing zone solenoid-operated valves. The pistons act as the normal automatic depression stop for the elevation power drive. They actuate a gear rack instead of a plunger, as in the train valve block.

The base plate of the receiver regulator serves as the mounting base for the components.

OPERATION

Nonpointing Zones The nonpointing zone valve block is located in the lower right-hand corner of the receiver regulator.

Figure 14-10 illustrates typical nonpointing zones. Zone 3 is the highest and represents the ship's mast, bridge, and stacks. Zone 2 includes the superstructure directly behind (or in front) of the launcher. On the majority of missile launching systems with Mk 5 launchers, zone 2 represents the missile house. Zone 1 is the lower zone which comprises certain structures on the aft of the ship. If a loaded guide arm enters a nonpointing zone, the elevation automatic tracking cutout system goes into action. The elevation nonpointing zone pistons use the limit-stop rack

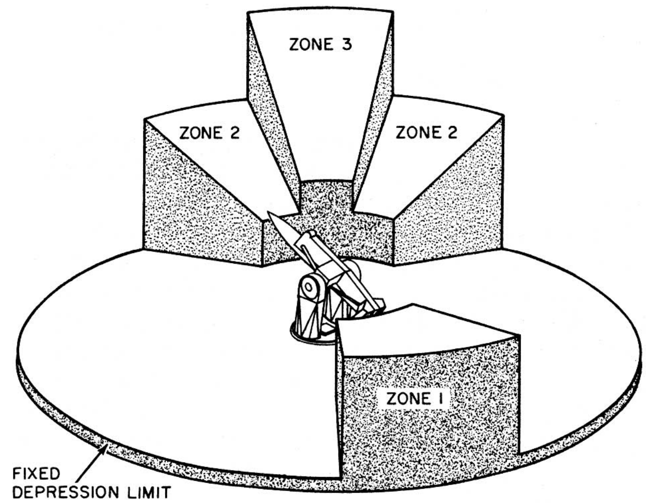

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Figure 14-10.— Nonpointing zones.

to cause the launcher to elevate over the nonpointing zone, or to stop it from depressing into a nonpointing zone. As soon as the launcher trains clear of the nonpointing zone, the elevation power drive can continue to depress the launcher to the angle required for hitting the target with the missile (as determined by the fire control system).

Train Limit Stop

A train warning bell, mounted on the trunnion support housing of the launcher carriage, is used to warn personnel on the exposed deck when the launcher is being rotated. This is a safety device installed on gun mounts and turrets and on launchers. Some grisly accidents pointed out the need for such warnings.

An earlier chapter explained the operation of the electric-hydraulic system in furnishing the power to move the launcher in train (and elevation). The train limit-stop valve hydraulically controls the A-end stroke pistons during limit-stop operations. The train launcher-synchronized indication piston is controlled by the launcher-synchronized indication valve. When the launcher is synchronized, the launcher-synchronized switch is actuated and the velocity and integration signals are canceled. The switch cams (5 for train and 3 for elevation) are driven by the B-end response and are used to actuate the switches which indicate the launcher train positions. The B-end response input which is fed into the receiver regulator is led through the base plate and drives the bevel gear. The lower gear of the B-end response input shaft drives the synchro gearing, while the upper gear drives the limit-stop assembly (fig. 14-11).

The differential (fig. 14-11) constantly measures the launcher position (B-end response) and velocity (A-end tilt or lead) signals and feeds the results to the position-plus-lead (P+L) cams and to the nonpointing zone cam. Whenever a stop order is initiated by the limit-stop brake or by the nonpointing zone cam, the differential stops the launcher by positioning the crank arm. During limit-stop operation, end gear #1 (fig. 14-11) acts as the output to stop the launcher. The spider gears drive the P+L cams and the nonpointing zone came The train limit-stop system can stop the launcher by setting the limit-stop brake. However, this is done only in case of power failure. The train power drive has no fixed limit stops.

Elevation Limit Stop

The elevation power drive has fixed depression and elevation limit stops plus a limit-stop brake; that is, the launcher can never be moved 180 degrees in elevation or depression. It is possible to train the launcher full circle. The stop order for elevation is originated either by the elevation and depression fixed stops or the limit-stop brake. The limit-stop systems are also used by the automatic tracking cutout system for stopping the power drives. When the limit-stop system receives a stop order, the limit-stop cam controls the deceleration rate of the launcher as the stop order is being carried out. During limit-stop operation, the limit-stop cam transmits motion to the limit-stop lever. (See figure 14-11; the elevation limit-stop lever. as well as other components, except the limit-stop rack, are very similar to those in the train limit-stop assembly.) During limit-stop operation, the stop cam transmits stop orders from the differential to the lever (the reverse of normal operation). The differential combines the B-end response (position) with A-end response (lead) and transmits the resulting output through the limit-stop brake to the P+L shaft and to the limit-stop rack. If the brake sets or the limit-stop rack is stopped, the differential output is fed back through the stop cam to the limit-stop lever.

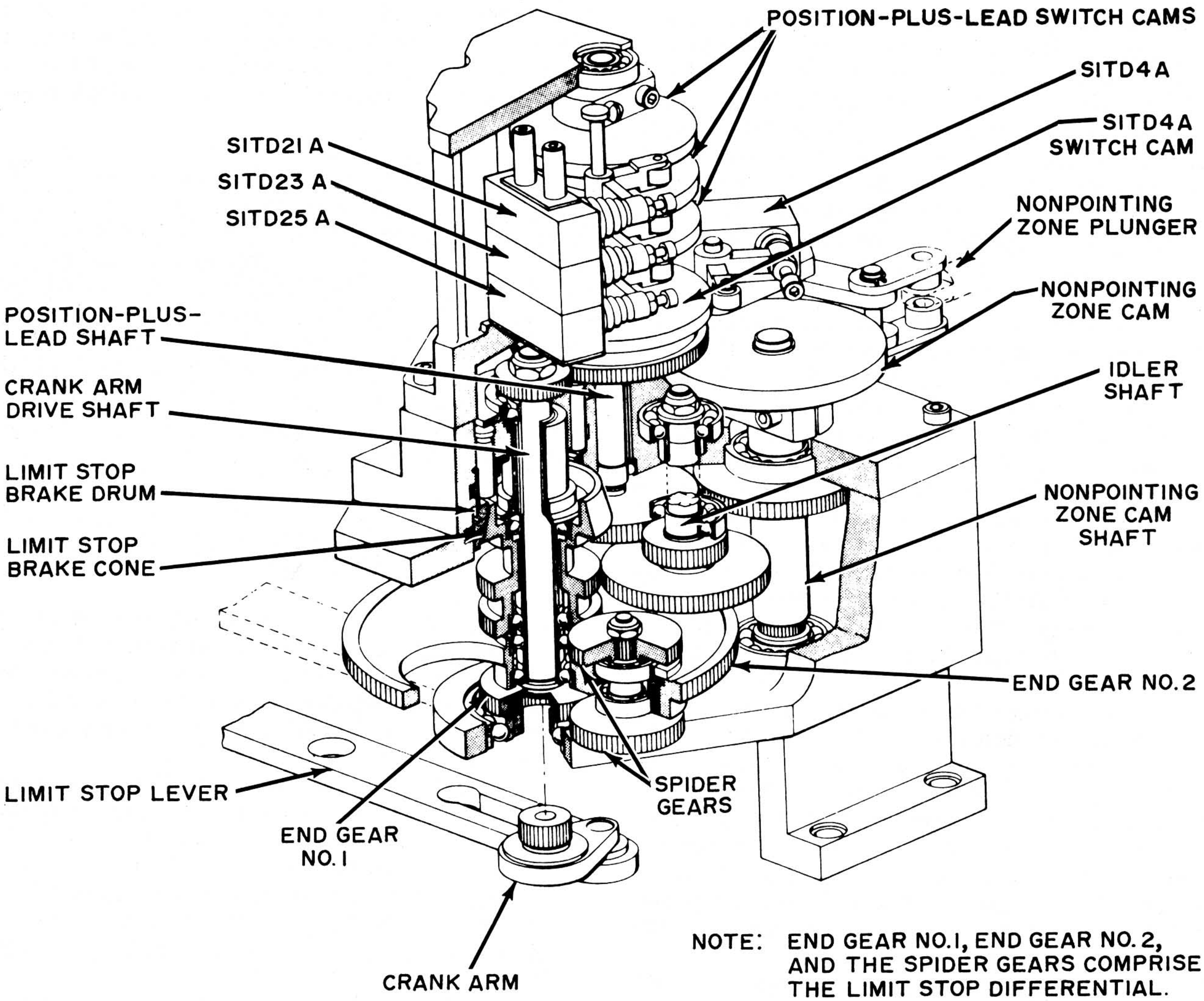

Figure 14-11.—Train limit-stop system.

Firing Cutout Systems

The firing cutout system was mentioned previously. It consists of the firing cutout switches, their associated circuitry, and a relay. The firing cutout switches are located on the train and elevation position and P+L switch stacks. They are actuated by the same switch cams as the nonpointing zone cams. A dual switch actuator, operated by a single switch cam, operates both switches (nonpointing and firing cutout) simultaneously. When the automatic tracking cutout system is set up for a particular installation and the switch cams are adjusted to the specified train and elevation angles, the nonfiring zones are established automatically. Only the depression stop nonfiring zone will have to be established and adjusted.

The firing cutout switches are wired into the launcher in the safe firing zone relay circuit. If for some reason the automatic tracking cutout system would not halt launcher movement when it is moving into a nonfiring zone, the firing cutout switch for that zone would open and thus stop the launcher.

Automatic Tracking Cutout System

The automatic tracking cutout system actuates the train and/or elevation limit-stop system whenever a nonpointing zone is encountered and the launcher is not on a return-to-lad order. The train cutout system receives mechanical inputs from the train system but is dependent on electrical inputs to indicate the elevation position. Basically, train cutout operation and elevation cutout operation are similar in function - both use hydraulic means to actuate their limit-stop systems.

The train position response, which is supplied by the train B-end, is conveyed through the gear train in the synchro gear assembly to the train position switch cams, of which there are three, one for each zone. The switches operated by these cam are wired into the elevation nonpointing zone solenoids. (The switch cam shown in figure 14-11 appear circular, but they are curved and shaped for each installation.) Whenever position-plus-lead movement drives a stop cam lobe against the stop pin (positioned by an extended piston), P+L movement is halted and a stop order is supplied to the train limit stop system.

Since the operation of the train nonpointing zone pistons is determined by the associated solenoid-operated valves and the elevation nonpointing zone switches are wired into these solenoid circuits, piston operation is actually determined by the elevation position. Therefore, automatic tracking cutout operation in train not only depends on the mechanical P+L response to the train nonpointing zone stop cam but also on the elevation position at the time.

The elevation system cutout operation is similar to the train cutout operation. Like the train system, the elevation system receives mechanical inputs from the elevation position and P+L response and electrical indication from the train system. The elevation position response drives the elevation switch cams.

The elevation automatic tracking cutout system operates by changing the position of the launcher depression limits whenever a loaded launcher guide arm enters a nonpointing zone. Nonpointing zone pistons use the limit stop rack to prevent the launcher from depressing into a nonpointing zone or to cause the launcher to elevate over the zone. The pistons are hydraulically controlled by solenoid-operated valves. The nonpointing zone solenoids are controlled by position and P+L cams in the train receiver regulator. If the launcher approaches a nonpointing zone, the solenoid for that zone in the elevation receiver regulator deenergizes. The piston then extends and contacts the limit-stop rack and stops the elevation power drive. As soon as the launcher trains clear of the nonpointing zone, the solenoid again energizes and the elevation power drive can continue.

When the launcher guide is empty and the launcher is on a return-to-load order, relays complete a bypass circuit to the train and elevation nonpointing zone solenoids. The manner in which these relay contacts are wired into the solenoid circuits allows the position and P+L switches to be bypassed on return-to-load. This permits the launcher to pass through the nonpointing zone or zones and follow the shortest route so it can synchronize to load position with the least delay.

MISSILE REPLENISHMENT AND STRIKEDOWN

A ship at sea can be loaded with missiles, boosters, and associated components from an ammunition ship. A ship can also be replenished in port from alongside a pier or from a barge. Replenishment by helicopter has been used at times.

Replenishment at sea may be accomplished by means of anyone of four transfer methods.

1. The Burtoning method.
2. The constant tension highline method.
3. The modified housefall method.
4. The Fast Automatic Shuttle Transfer method (FAST, for short).

We will cover only the modified housefall and FAST methods because they are the methods most commonly used in the fleet. Figure 5-12 in Seaman, NavPers 10120-E, shows a regular housefall rig being used for transfer of ammunition.

MODIFIED HOUSEFALL

The modified housefall rig is shown in figure 14-12. Completely assembled missiles and boosters (less wing and fins) are removed from their containers, suspended in a transfer dolly (called a grasshopper) and transferred from the ammunition ship to the missile ship. Missiles or boosters arrive on the 01- or 02-level (depending on the type of ship) atop the deckhouse

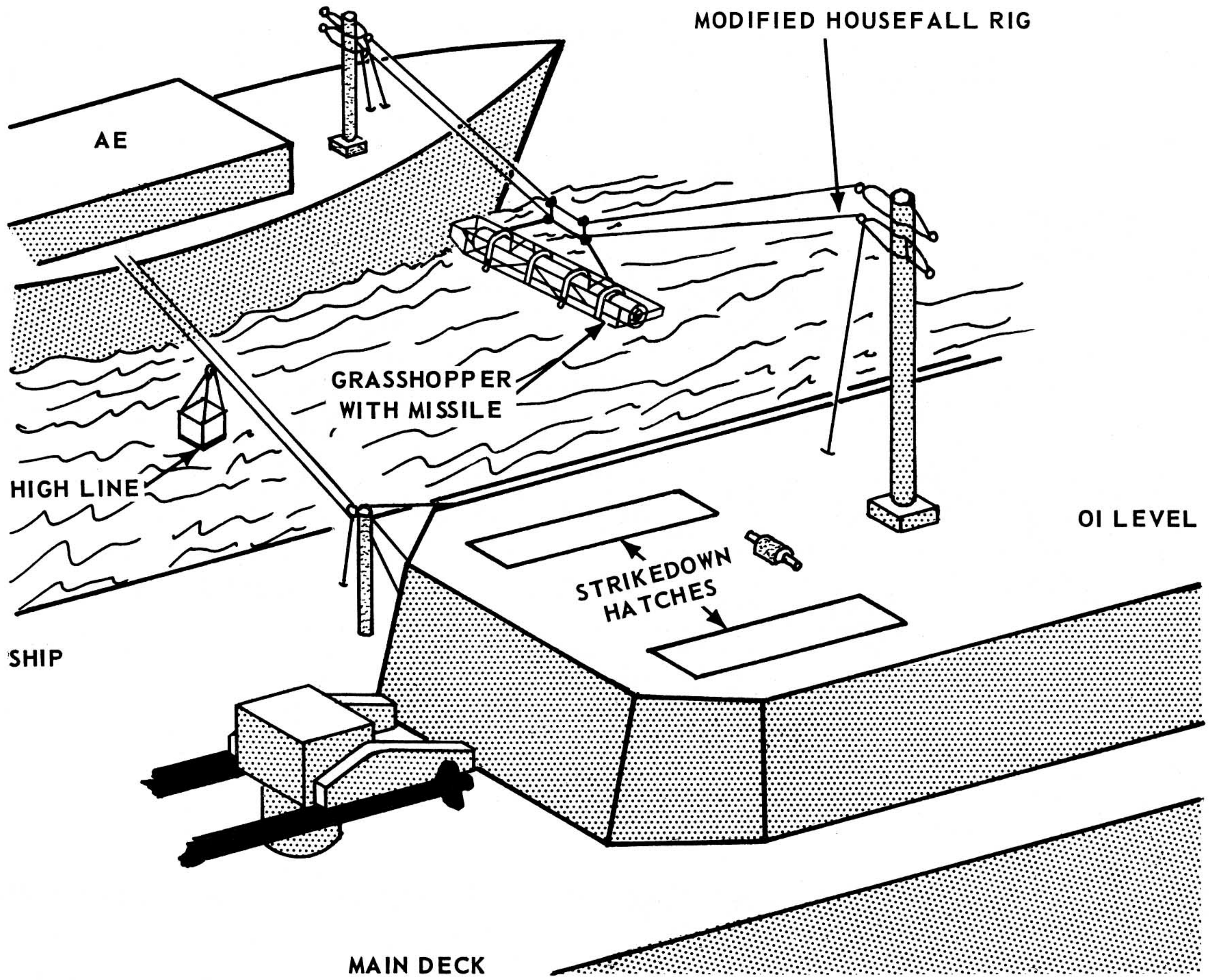

Figure 14-12. — Modified housefall method of transfer and replenishment at sea.

at a point near one of the strikedown hatches. To maintain a simultaneous port and starboard flow, missile-booster transfer is scheduled so two boosters are transferred, followed by two missiles. Scheduling of missile component transfer is arranged so that a balanced group of components will have been transferred in any given time. This is done because missiles and boosters have to be mated on the receiving ship before they can be stowed in a magazine. You have to mate a missile to a booster before you can receive the next two in the missile house. That's why they are received in the order as follows: booster, booster, missile, missile. Normally, both port and starboard strikedown hatches are used. Spare warheads and exercise heads are also transferred on the modified housefall rig.

The highline shown in figure 14-12 is used to transfer missile components such as wings fins, and spare parts (complementary items) concurrently with booster and missile transfer. The above method of missile transfer is used only if the FAST system is not installed.

FAST SYSTEM

The FAST system of missile and booster transfer uses a constant-tension highline between king posts on both the ammunition ship and the missile ship. See figure 14-13. A trolley, controlled by the inhaul lines from the ammunition ship, transfers the missile or booster, which is supported in a strongback. The trolley is engaged and held by a receiving head on top of the missile ship's king post. Next, the

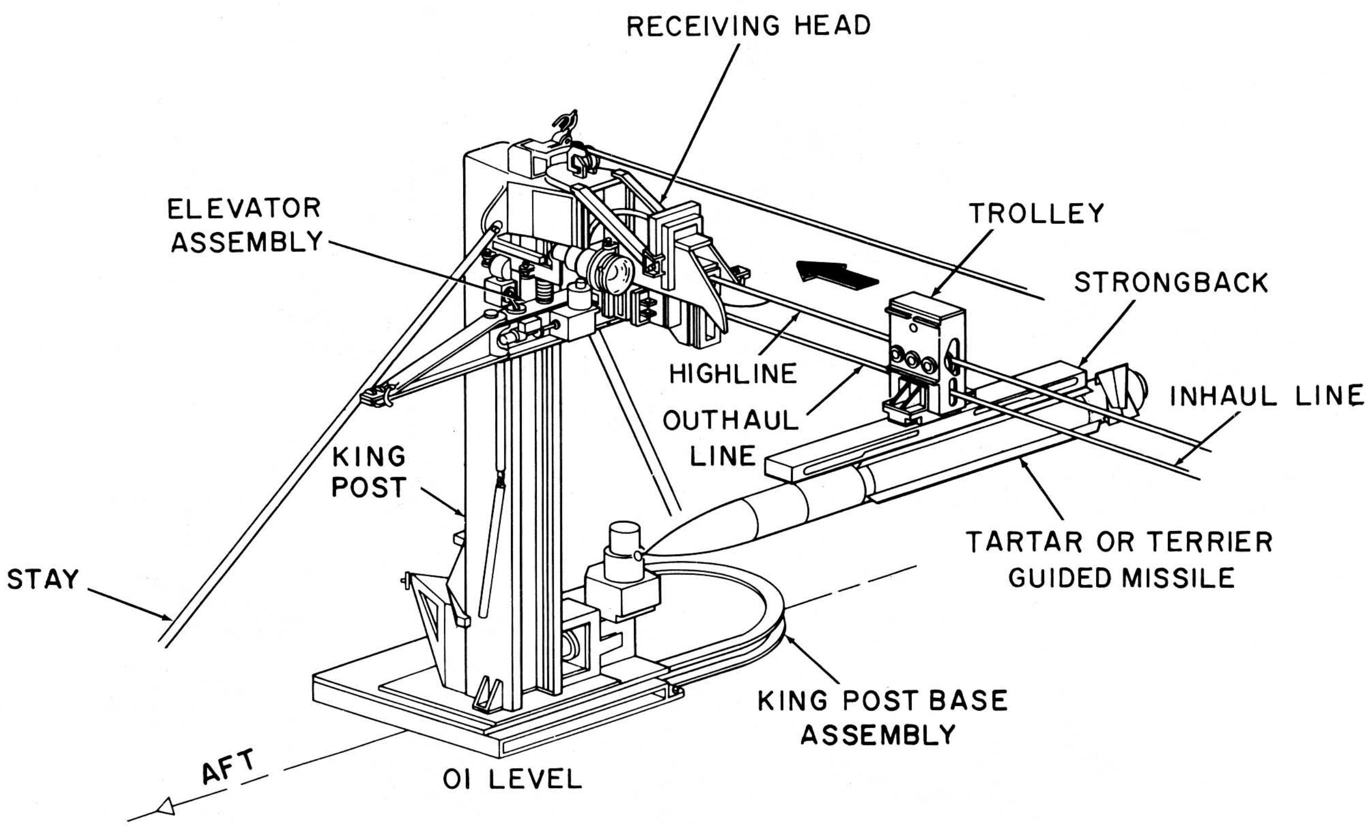

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Figure 14-13.—Fast Automatic Shuttle Transfer (FAST) method for at sea transfer of missile.

elevator arms, which are under control of a console operator, close and engage the strongback. The trolley is released and returned to the ammunition ship to pick up another booster or missile. Then the FAST elevator lowers the missile or booster to the missile ship's strikedown elevator and the strongback is removed.

What we have just described applies only to Terrier Mk 9 and Mk 10 missile launching systems. The Tartar (Mks 11, 13, and 22) launching systems use the same type of FAST king post and elevator, except that the missile is lowered to a transfer cart (dolly). However, the Talos (Mks 7 and 12) missile launching systems use a different type of king post; and they use a boom to lower the missile or booster from the king post to the strikedown elevator.

STREAM METHOD

The new Standard Tensioned Replenishment Alongside Method (STREAM) actually is not a single method but a combination of transfer systems. The only common feature of this combination is the use of a ram tension highline. The system can be broadly grouped into two headings, a cargo STREAM and missile STREAM.

The STREAM method will incorporate many of the design features currently used in the FAST system. With the FAST system, a strongback is used in base missile transfer, and standard deck handling equipment is used on the receiving ship. However, after implementation of STREAM into the fleet, a transfer dolly will be used exclusively for the transfer of missiles. For more detailed information on the STREAM method refer to NWP 38.

DOCKSIDE REPLENISHMENT

When a missile firing ship (combatant vessel) is replenished from a pier or dock, a crane normally lifts the booster or missile to the strikedown area. (See fig. 14-14). Each missile and booster is decanned (removed from

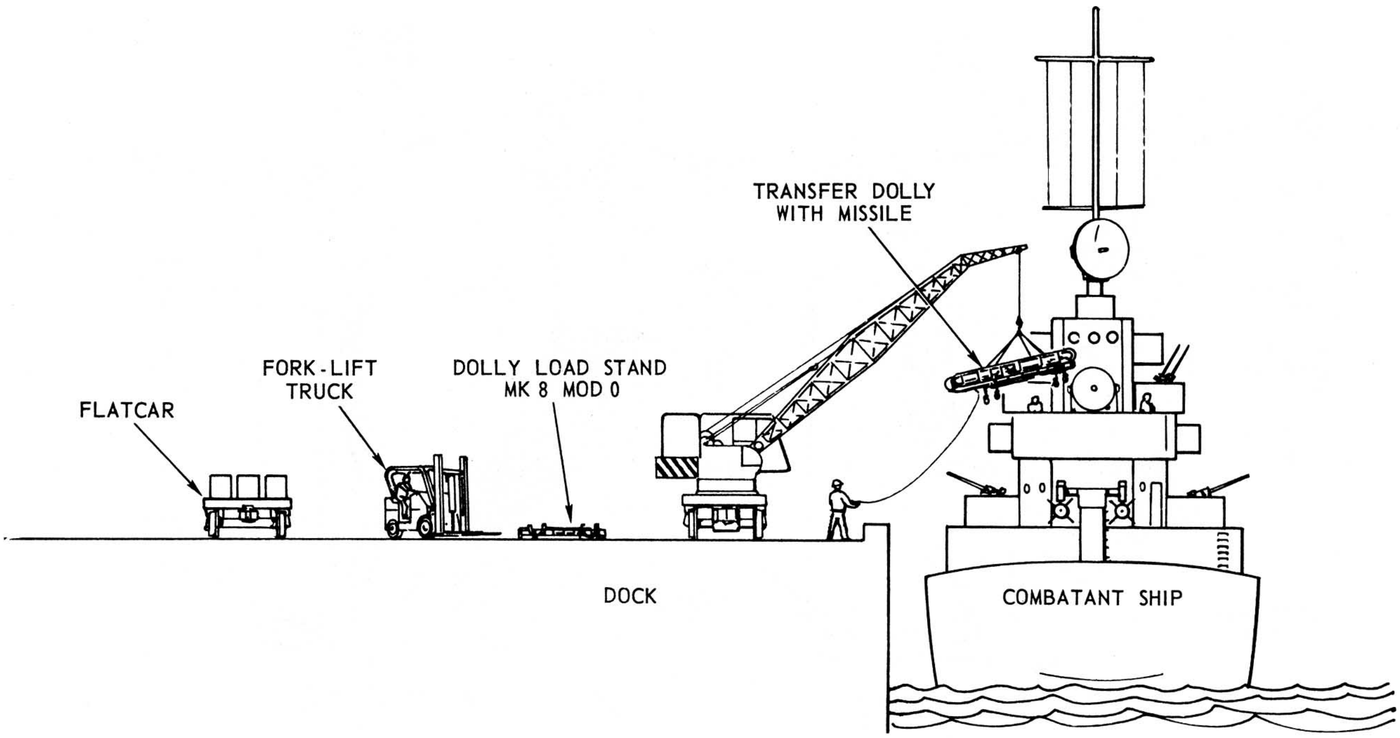

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Figure 14-14.—Dockside replenishment.

its shipping container). Then it is rotated so that its handling shoes are in the correct position for strikedown; and finally it is loaded into a transfer dolly on the pier. Incidentally, the FAST system can be used if FAST system equipment is available on the pier as well as on the ship; however, this is a very recent development.

LIGHTER REPLENISHMENT

When missiles and boosters are replenished from a lighter (fig. 14-15), a floating crane normally transfers the missile or boosters. Each booster and missile is decanned, rotated for strikedown, and loaded into a transfer dolly aboard the lighter.

SPECIAL HANDLING EQUIPMENT

ATTACHMENTS FOR EQUIPMENT. - Handling attachments (also called transfer bands) support the missile and booster during shipment and strikedown. These bands, shown in figure 14-16, consist of a base, two pivoted jaws, and a locking cable. The base and jaws are made of aluminum, and are fitted with rubber liners to protect the skin of the missile or booster. Two pins in the base align and support the missile or booster in its container. Two holes are also located in the bottom of the base to provide alignment for pins located

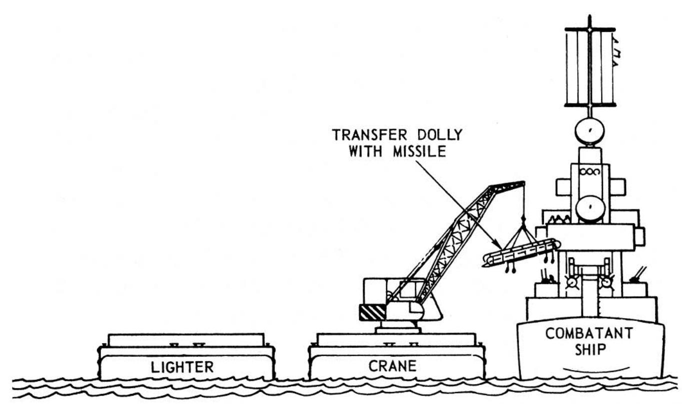

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Figure 14-15.—Missile replenishment from lighter.

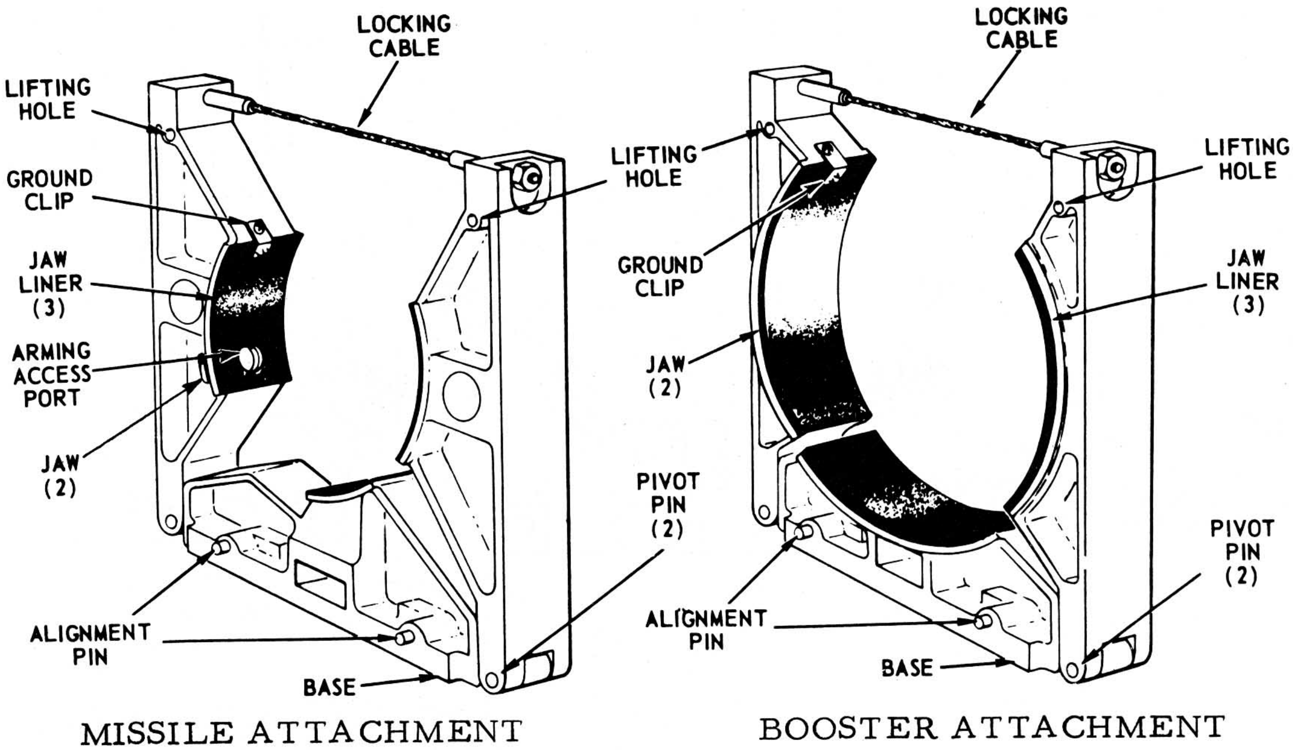


Figure 14-16.—Terrier handling attachments.

on the checkout car. During strikedown, the booster handling attachments remain on the booster until it has been placed on the loader rail, and the missile handling attachments remain on the missile until it has been mated with its booster.

TRANSFER DOLLY. - A transfer dolly (grasshopper) Mk 6 supports the missile or booster during all modes of transfer except in the FAST method. The dolly also is used to place the missile in the correct position to be received by the strikedown elevator.

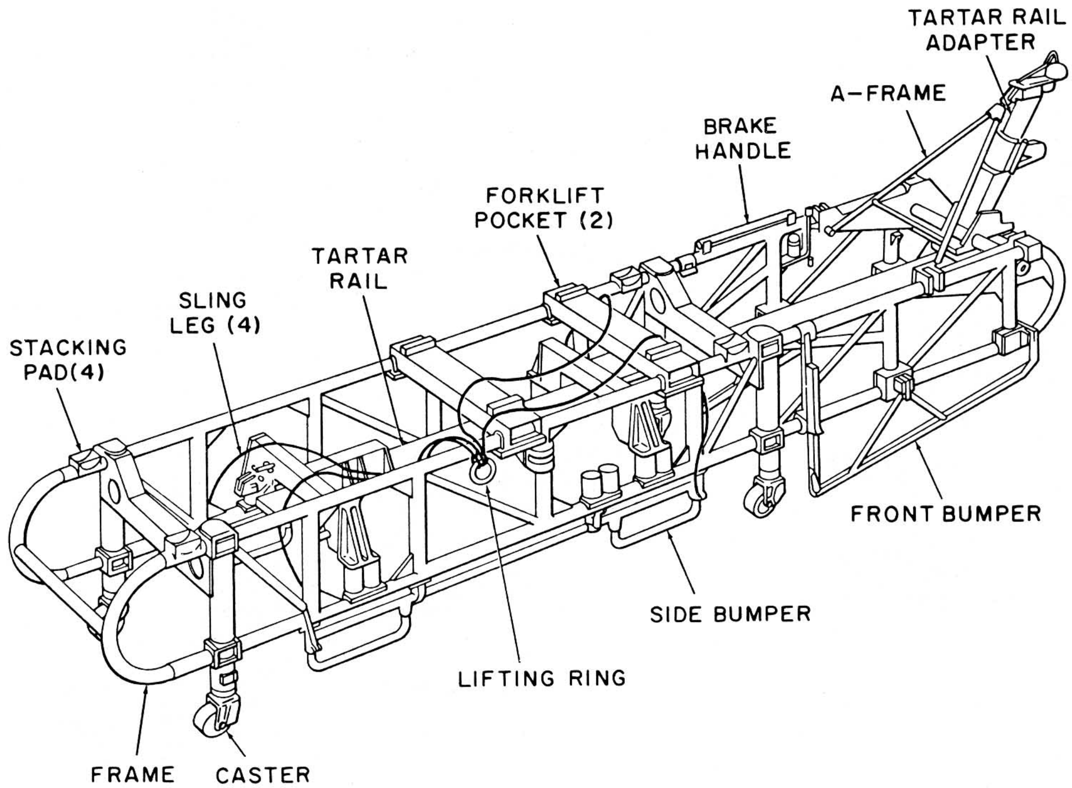
This transfer dolly (fig. 14-17), handles all types of Terrier missiles and boosters, as well as the Tartar missile types. Basically, the dolly consists of a tubular metal frame, two shock-mounted holding fixtures (for Terrier missiles and boosters), a Tartar rail adapter, a cable sling, and a "dead man" brake and caster wheels. The dolly is also equipped with channel guides for fork lift handling and a nose guard assembly for added protection of the missile forward section.

The rail adapter shown in figure 14-17 aligns the Tartar rail assembly with the launcher rail and provides a connecting surface between the Tartar rail and launcher for the missile shoes to travel on.

The adapter is coupled to and aligned with GMLS Mk 11 by means of the lower ball socket and the two lower mating guides. The upper ball socket and upper single mating guide serve the same purpose with the GMLS Mk 13. The adapter with the dolly and the GMLS is shown in figure 14-18.

The "grasshopper" is shown in use in figure 14-12, 14-14 and 14-15. Notice that it is wheeled so it can be moved easily to the strikedown elevator, or to the launcher (Tartar). Note also that it has a brake; don't forget to set it before you let go of the dolly. A sudden pitch or roll of the ship could send the dolly with its missile careening about the deck. Keep the dolly under control at all times.

OTHER TRANSFER EQUIPMENT. - The attachments shown in figure 14-16 are placed on a missile when it is to be moved by a lifting bar. Not all ships have the FAST system for at-sea transfer. Parts of missiles that are not assembled, such as wings and fins, are packed in separate containers and may be transferred



33.199
Figure 14-17.—Tartar/Terrier transfer dolly.

to shipboard by means of slings, skip box on a highline (fig. 14-12), or with other handling equipment. Whatever equipment is used, always check it first before attaching a missile or missile component. The OP for the equipment tells you the lubrication points, the type of lubricant to use, and how frequently lubrication is needed.

Most of the missile handling equipment is designed for a particular Mk Mod, so it will fit exactly and will have the necessary strength to support the missile.

STRIKEDOWN

All Talos missile launching systems, and Terrier launching systems Mks 9 and 10, use a hydraulically operated strikedown elevator to lower the boosters and missiles from the 01- or 02-level into the missile house. A hydraulically operated hatch directly over the elevator must be opened before the elevator can be raised. The elevator hatch is automatically closed as soon as the elevator is clear of the hatch during lowering.

On the Mk 9 and Mk 10 Terrier GMLSs. a checkout car is used to remove the booster from the elevator and to position it on a rail preparatory for mating. The car then removes a missile from the elevator and positions it so that the booster and missile can be mated. After mating. the assembled weapon is transferred to the magazine hoist by the rail. Later on we will talk more about the checkout car and mating process.

Talos Strikedown

As you saw in figure 14-12, there is a strikedown hatch for each of the two sides of the launching system. Each side, A and B, has a complete set of strikedown equipment. For the Talos GMLS Mk 12, strikedown equipment consists of three major assemblies: (1) ready service crane, (2) mating equipment, and (3) strikedown elevator. This equipment is used for three purposes: (1) to replenish the ready service magazine, (2) to unload the magazine, and (3) to transfer the weapons to an area where internal tests on the weapons can be made. The equipment is operated from the EP6 panel and four consoles.

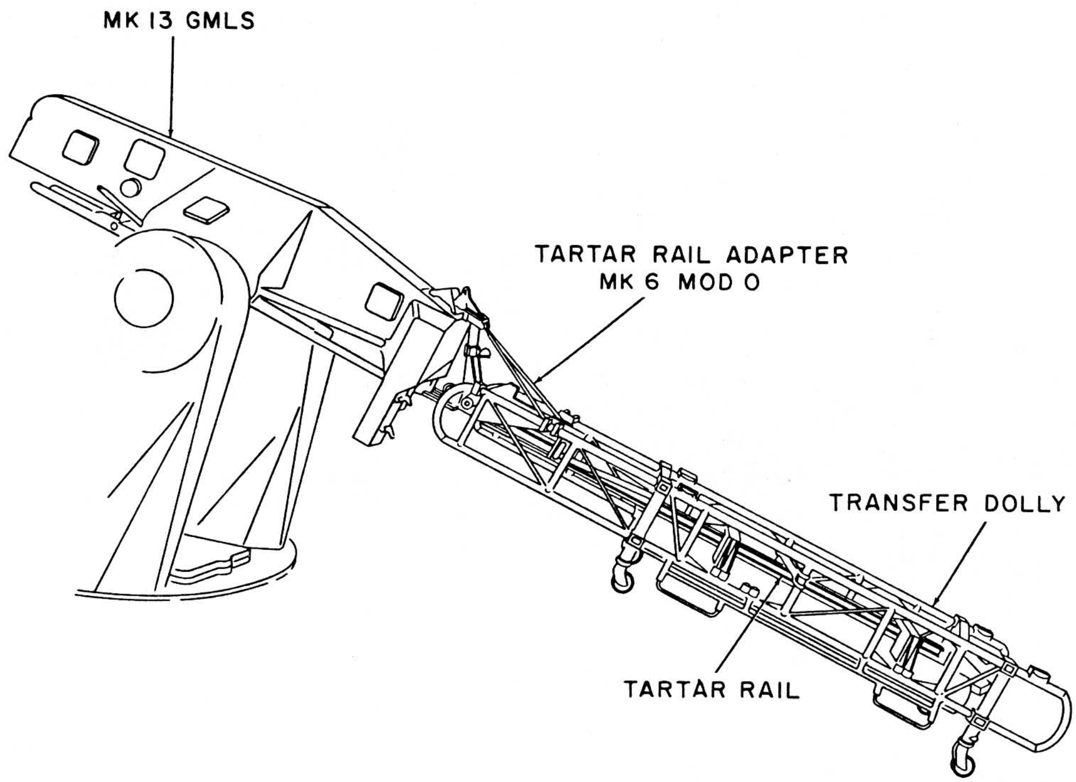


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Figure 14-18.— Tartar rail adapter alined with Mk 13 GMLS.

The missile, locked on a missile cart, is struck down first by means of the elevator, which rises beneath the hatch. Then a booster, locked on a booster cart, is struck down.

When the missile and booster are to be placed in the ready service magazine, they must be brought to the mating area and joined before being taken to the magazine. The missile and the booster, each on its cart, are moved to the mating area on a pair of rails. After mating the missile and booster, the complete round is taken to the magazine hoist by the ready service crane, which is mounted on a pair of crane rails that span the overhead between the magazine door: and the mating area. The same equipment is used to move a round from the magazine to the checkout and mating area for unmating and tests. The booster is always returned to the magazine while the tests are being made on the missile.

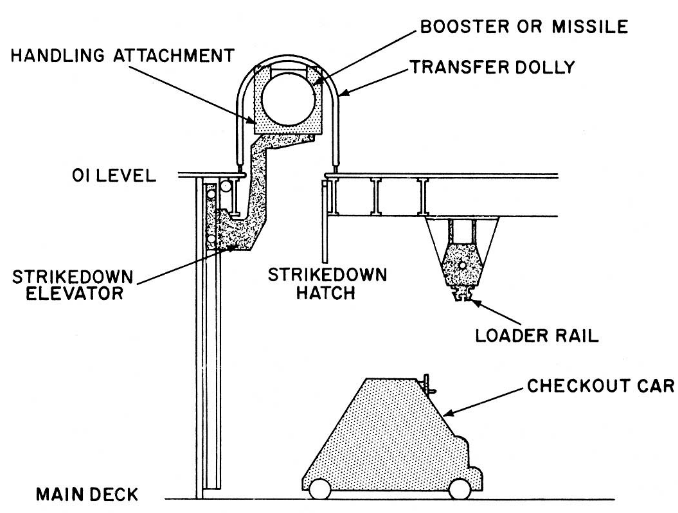

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Figure 14-19.—Terrier strikedown operation; elevator raised to receive missile.

Terrier Strikedown

To get a clearer picture of the strikedown process let's look at the step-by-step movement of a Terrier booster and then a missile as they are struck below. Refer to figures 1419, 20 and 21 as you read the description of booster and missile flow during the strikedown procedure. Keep in mind that a booster is struck below first.

1. When a booster is in the proper position above the strikedown hatch, an operator at a control station on the 01-level and an operator at the elevator control station in the checkout area simultaneously depress their control pushbuttons. The hatch opens and the strikedown elevator raises. (See fig. 14-19.)

2. When the strikedown elevator reaches its upper position, it receives a booster from the transfer dolly or from a FAST elevator.

3. The operators push their "LOWER" pushbuttons and the elevator starts going down. As the elevator passes through the strikedown hatch, the hatch door automatically closes as shown in figure 14-20.

4. The elevator with a booster on it stops in the checkout area with the booster suspended just above the checkout table. The checkout car operators move the car into position under the booster. The car table is then raised to receive the booster from the strikedown elevator.

5. The checkout car operates by means of the car controls, bringing the booster into alignment with the loader rail. See figure 14-21.

6. The loader engages the booster shoes and the loader moves the booster clear of the strikedown area.

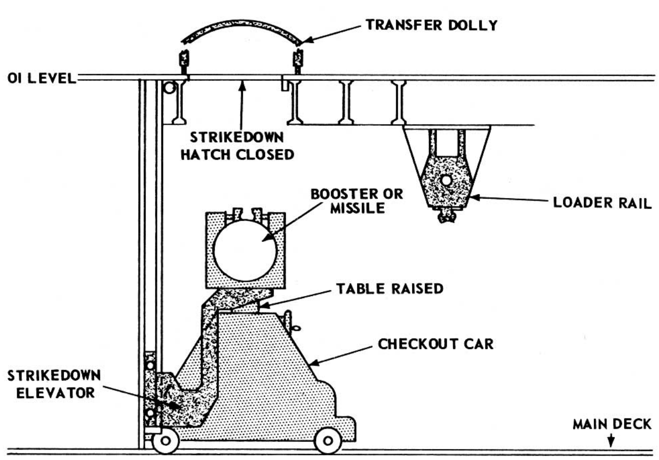

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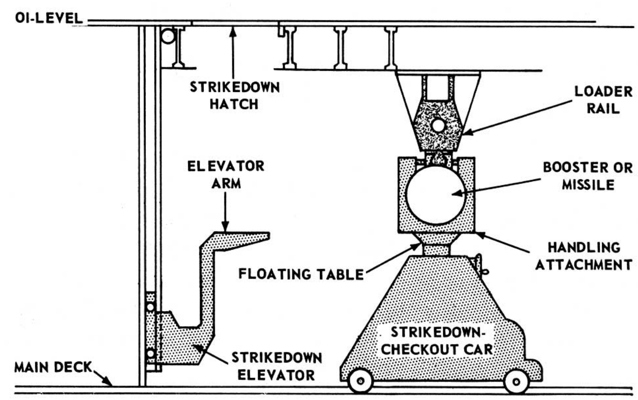
Figure 14-20. — Terrier strikedown operation; car table raised.



83.151
Figure 14-21. — Terrier strikedown operation; booster shoes engaged with loader rail.

7. To put a missile on the checkout car, steps 1, 2, 3, and 4 are repeated.

8. The loader returns the booster into the strikedown area.

9. The car is then positioned so that the missile is in the proper position for mating, and the missile and booster are mated.

10. The mated weapon is placed over the magazine hoist by the loader and then lowered into the magazine (ready service ring).

Tartar Strikedown

To strike down a Tartar missile, a missile is placed on the launcher guide arm and the launcher controls are then used to lower the missile into the magazine. Figure 8-16 shows the strikedown gear attached to the Tartar launcher. As the Tartar comes completely assembled, there is no mating or unmating to be done, and the missile is sent directly to the magazine where it is to be stowed. The dolly on which it is delivered to the ship is aligned with the strikedown gear. Latches on the strikedown chain spring-latch onto the missile forward shoe and the chain then can pull the missile on to the launcher guide arm, which then takes over the job or moving the missile down to the magazine. It is all done in step control, with the launcher captain at the electrical control box on deck (fig. 8-16), an operator at the EP2 panel, and men at the strikedown fixture to bring the missile to the fixture, align it, and see that the latches are attached to the missile shoe. When all the missiles have been struck down, the strikedown fixture is removed from the launcher and is stowed. The same fixture is used to bring missiles up from the magazine to be offloaded.

Responsibility for Missile Strikedown Equipment

The strikedown gear attached to the Tartar launcher is ordnance equipment but the rails on the deck on which you move the dolly are ship's equipment. The elevators and cranes used to move the larger missiles, the Terrier and Talos, are ship's equipment. The GMMs who use ship's equipment must exercise responsible care and give routine maintenance, but the prime responsibility for its repair and major maintenance belongs to the ship's engineering department. Always check the equipment before using it. Do not assume that it is all right. The size, weight, and dangerous characteristics of missiles and boosters make it imperative that they be moved safely.

MISSILE COMPONENT STOWAGE

A storeroom for the stowage of missile components and a magazine for the stowage of missile warheads are both located two decks below the checkout area. The magazine and the store room are connected to the checkout area by a trunk and hoist.

The location of the stowage spaces varies with the type of ship and the missiles carried. If you have missiles (Terrier and Talos) that have wings and fins to be assembled when preparing for firing, the wings, and fins are stowed in racks in the loading area of the launching system. Tartar missiles have their wings attached and folded, so there is no need for separate stowage, except for spare parts. A dumbwaiter type of elevator operated by an electric hoist is used to move those to or from the missile component storeroom.

Stowage Precautions

Classes of dangers can be grouped as general personnel, mechanical, electrical, and explosive. To these we might add: danger from liquid fuels, and danger from radioactive material. Below are a few specific precautions to review.

A. Missiles and components must be securely fastened in storage, stowage racks, and magazine ready service rings.

B. ALWAYS inspect handling equipment before using.

C. Missiles and components must NOT be placed in or removed from stowage racks and/or areas without using the proper handling equipment.

D. All arming devices must be in the SAFE position during stowage.

E. Arming tools must be kept in a designated place at all times, except when in actual use.

F. Ground wires must be attached to boosters and missiles in stowage, during check-out, and while being transported from one area to another.

G. Booster rocket components must be handled with care. A cracked propellant grain could result in an explosion when ignited.

H. Explosive and propellant components must be stowed in approved magazines in which the temperature range does not exceed the limits specified by NAVORDSYSCOM.

General Precautions

A. All missile operations must be in accordance with shipboard safety precautions.

B. The handling of sustainers, booster's warheads, and other propelling or explosive devices must conform with explosive handling practices aboard ship.

C. Only those personnel who are engaged in the operation in progress should be permitted in the immediate area of the missile.

D. Only approved nonsparking tools are to be used in the vicinity of explosives or propelling charges.

E. Only the correct handling equipment is to be used for lifting missiles and components thereof.

F. Electrical equipment must be shielded and grounded to prevent accidental ignition of propellants or explosives or injury to personnel.

G. Working areas must be clear of obstructions, loose cabling, hose, and unneeded equipment.

H. Electrical igniters or detonators (booster charges) shall not be exposed within 50 feet of, or stowed in any compartment with, any exposed electronic transmitting equipment, exposed antenna, or antenna lead, except where such apparatus or antenna is part of a missile test set, or is an integral part of the missile concerned.

I. Use extreme care in handling pressurized air hoses and couplings. Compressed air can exert sufficient force to severely injure personnel and/or equipment.

HANDLING BELOW DECKS

When you have only Tartar missiles, stowage does not require any handling below decks as the missiles are struck down to the magazine by the launcher. To offload missiles, the operation is reversed. Missile checkout is performed on the launcher guide. To replace a component in the missile, the guide arm, with the missile on it, is trained to an area where ship handling equipment is available. Again, there is no below deck handling.

Checkout Car

The checkout car is mechanically and electrically operated. The car is used for strikedown, strikeup, mating, and checkout operations.

The chassis can be moved vertically by means of the "Up-and-down" control, and can be moved forward and aft by means of the "Forward-aft" control.

The car table (fig. 14-21) can be axially adjusted by means of the "Roll" control, and can be tilted by means of the "Float" control.

Missile and Booster Carts

The missile and booster carts used to hold the missile and the booster of Talos are driven by separate chain drives. Each chain drive engages its cart when the elevator reaches the main deck with its missile or booster load, and drives it to the mating area, following the rails that lead from the elevator, through the flametight doors, to the mating area. After the missile and booster have been mated, the carts are released and returned to their positions near the elevator. There are several differences in construction of the carts; they cannot be interchanged.

Ready Service Crane

The ready service crane is used to transport the mated weapon from the mating area to an empty tray on the missile magazine hoist. When the tray receives the weapon, the hoist is at the strikedown level.

The crane is mounted on a pair of crane rails that span the overhead between the magazine door and the mating area. It is operated from a control panel on the magazine platform. The crane raises the weapon by means of its strongback, which has shoe grips that seat on the booster shoes of the missile and lock on. The strongback is raised and lowered by hydraulic actuators.

MISSILE MATING AND SERVICING

RESPONSIBILITIES OF GMM

The GMM assigned to a guided missile launching system is responsible for the handling, custody, and care of the missile used by that system. The responsibility includes the following tasks:

1. Unmating/mating.
2. Warhead and exercise head exchange.
3. Assembly and disassembly.
4. Preparation of missile for tests.
5. Missile servicing (preventive maintenance).

GMMs are not solely responsible for performing the missile system tests or for the test equipment. These responsibilities are shared by the fire control technicians. The GMMs (joins the booster and missile) all Terrier, Talos, and Standard ER missiles during strikedown and unmates these same missiles before they can be offloaded (struck up). Missiles must be mated and unmated every time they are tested (checked out) and whenever it is necessary to change warheads or install exercise heads.

The areas of responsibility for GMMs are in a changing state, tending toward more responsibility for the missile round. A review of the quals reveals a concentration on care and testing of the launching system. At the E-5 level, the GMM is responsible for positioning the missile and preparing it for testing. The deletion of the former Missile Technician rating is causing a shift in duties of the GMM with regard to the missile. As a practical matter, GMMs are already being given more responsibility for the testing of the missile round. Testing of missiles aboard ship is being reduced, however.

TESTING AND REPAIRING

As soon as practical after the missiles have been brought aboard ship, a missile system test (MST) , commonly called "missile checkout," must be performed. Thereafter, periodic checkouts will be conducted at intervals established by NAVORDSYSCOM.

For example, NAVORDSYSCOM at the time of this writing requires that BT-3 Terrier missiles be checked at 3-month intervals for the first three times and 6-month intervals subsequently. Both initial and periodic tests are conducted in areas (stations) especially provided with missile component handling equipment and test sets.

The exact locations of missile checkout stations vary in many launching systems. However, except for the Tartar missiles which are checked out in a launcher guide arm, the checkout area is normally located in the missile house, outboard of the loaders, in or near the strikedown and mating area.

Special guided missile test sets (GMTS) have been developed for each type of missile. These test sets program the missile through a simulated flight sequence, comparing missile response to known standards. The final result of the test is a GO or NO-GO indication of missile condition. A GO indication means that the missile is flight-ready, and a NO-GO indication means that the missile has failed the test. The NO-GO (fault) lights involved indicate which component or components in the missile should be repaired or replaced. (The term "component" here means a part or group of parts (package) of a missile which, by design or construction, lends itself to a unit concept of replacement or repair.)

Missile components are not normally repaired aboard ship. When the test set indicates that a missile component is defective, a new component is installed by the GMM and the missile is retested.

To replace faulty missile components, it is normally necessary to disassemble a portion of the missile. The degree of disassembly depends on the faulty components and on the missile type. Terrier and Talos missiles are disassembled and reassembled while they are on the checkout car with the aid of special tools, handling attachments, and an overhead crane. Tartar missile defective components are removed while the missile is on the launcher guide arm with the aid of special tools, handling attachments, handling king post, and a handling hoist.

Shipboard missile servicing (preventive maintenance) consists of a series of systematic inspections, checks, and servicing operations performed at regular intervals. The frequency and type of servicing performed vary on each type of missile. For example, the Talos 6Cl missile must have its battery removed and a reconditioned replacement installed every month. The Talos also must have its fuel, hydraulic, and nitrogen systems checked bimonthly. In comparison, the Terrier BT-3A missile requires no special servicing under normal conditions. However, the hydraulic system on this missile (BT-3A) requires filling after component replacement procedures which necessitate breaking into the hydraulic system. The fluid level of the hydraulic system on the BT-3A also must be checked after each checkout.

Unless otherwise noted, the remainder of this discussion will briefly describe the shipboard procedures for Terrier BT-3A missile mating, unmating, checkout, and component replacement. To simplify this discussion, only GMLS Mk 10 handling equipment will be described.

UNMATING AND MATING

In preparation for missile checkout, missile servicing, warhead exchange, or exercise head installation, the assembled missile must be unmated. Before unmating, the following step-by-step tasks must be performed.

1. Transfer of the mated weapon from the magazine to the checkout area.
2. Moving of the checkout car inboard under the missile.
3. Moving of the car table to its aft position (towards booster).
4. Positioning of standard missile handling attachments on the car.
5. Raising of the car table to the missile.
6. Fastening of the handling attachments to the missile. Bear in mind that the handling attachments should be tightened (torqued) enough to prevent the missile from moving during mating and unmating but not to exceed a value of 660 ± 30 in.-lbs.

To separate the missile from the booster, fully loosen the booster suitcase-latch torque screw, and unlock the suitcase latch by inserting a handle in the clamp actuator to lift it upwards. (The suitcase-latch assembly is shown in figure 14-22.) With the suitcase latch fully open, the booster is separated from the missile by moving the checkout car table away from the missile.

If any work is to be done on the missile, such as testing, exchange of components, or repair, the booster is returned to the ready service ring until the work on the missile is completed. Then the booster is returned to the checkout area to be remated to the missile. The movement of the missile and the booster is accomplished in Step Control by pushing the correct buttons in the correct sequence on EP4 and EP5 panels after being put in the proper mode of operation by the EP2 panel operator. Personnel must keep clear of all moving machinery, both in the assembly area and the checkout area.

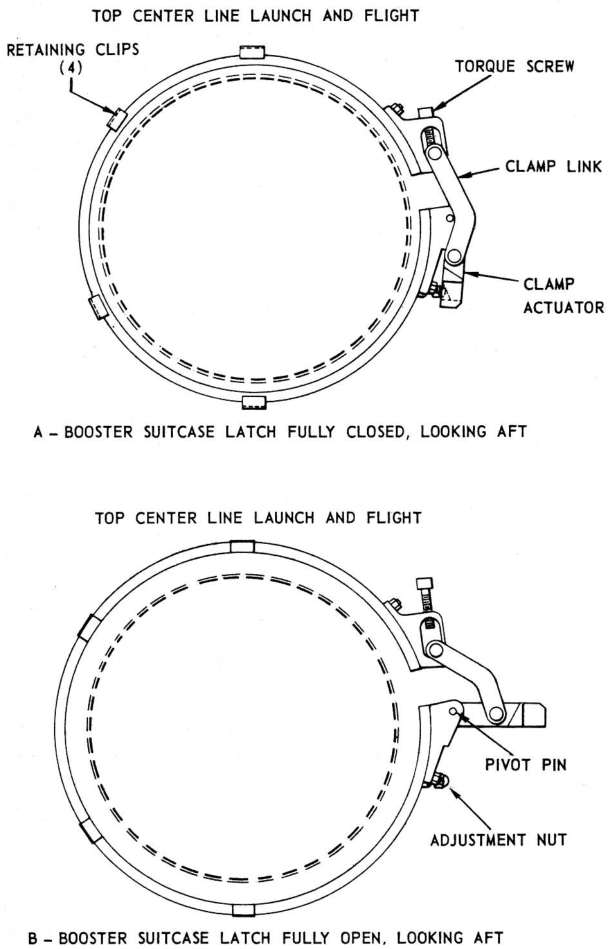


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Figure 14-22. — Terrier missile-booster suitcase latch: A. Latch fully closed, looking aft; B. Latch fully open, looking aft.

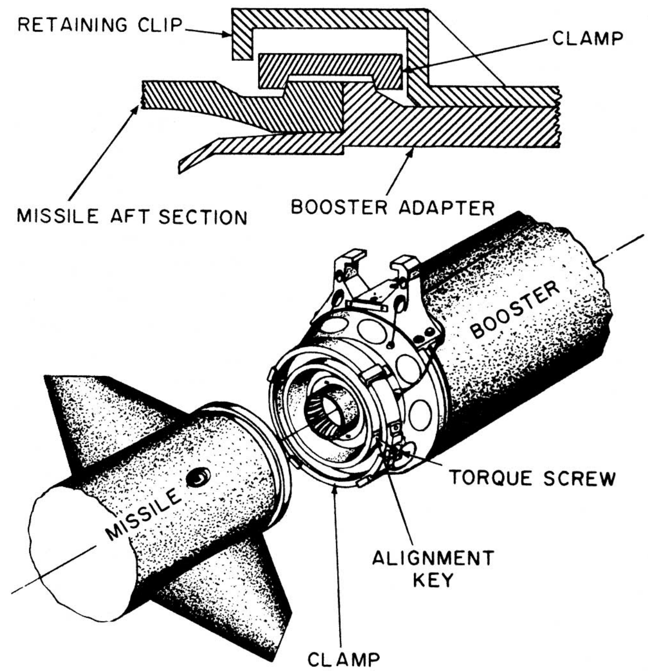

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Figure 14-23. — Terrier missile-booster connection.

To remate the booster and missile, move the booster into the checkout area. Then position the checkout car so that the missile is in the approximate mating position, and proceed with the following steps.

1. Check that the torque screw is fully loosened and that the suitcase latch is open.
2. Install the missile-booster alignment insert in the missile-booster electrical contractor.
3. Carefully align the missile, by use of the checkout car controls, until the keyways of the missile are aligned with the booster alignment lugs (keys), shown in figure 14-23. Then slowly move the missile into firm engagement with the booster.
4. After checking to ensure that the adjustment nut is fully tightened, insert the clamp-actuator handle into the hole in the clamp-actuator, and lock the missile and booster together by closing the suitcase latch.
5. Check to be sure that the clamp link is making contact with the pivot pin (refer again to part A of figure 14-22) but not contacting the adjusting nut.
6. Remove the clamp-actuator handle and tighten the torque screw to 480 ± 60 in.-lbs., using a torque wrench and special hex adapter.
7. Insert a scribe, or similar tool, into the hole in the shaft under the adjusting nut. Holding the shaft stationary, loosen the adjustment nut until it makes contact with the clamp actuator. When contact is made, back off an additional 1/4 turn, and recheck the clamp link to ensure that it is still in contact with the pivot pin.

CAUTION. - Do not use the locking ring to pull the sections together, but slowly bring the two sections together. Keep the booster grounded and the arming mechanism in SAFE position during all handling operations. Strict observance of this safety rule is mandatory.

Inspections

Inspect threads of air or hydraulic system coupling before mating. Make certain they are free from dirt, oil, and physical defects.

After completing the mating of the missile and booster, inspect to be sure the parts are strictly aligned and the locking mechanism is secure bit not overtightened. Do not apply any oil, grease, or other compound other than authorized by the OP for the system.

Missile Servicing

Missiles received aboard ship will not require special servicing under normal conditions. They will be completely assembled and operational with exception of those that require installation of a battery before firing. When preparing a missile for an exercise flight, in addition to installation of telemetering antennas and the exercise head, flash signals and a destructor may have to be installed. See the OP for step-by-step instructions for making the installations.

PREPARATION OF MISSILE FOR TESTING

If the missile is to be tested, the car with the unmated missile is lowered, moved outboard, and locked at the checkout station. The aft end of the missile is then connected to a blowout pipe with the use of an adapter, shown in figure 14- 24. The blowout pipe is built into the ship and exhausts overboard in the event of accidental sustainer ignition during tests.

To complete the preparation of the missile for a shipboard test, perform the following tasks.

1. Install a microwave adapter to the blowout pipe adapter.
2. Install telemetering antennas in dorsal fins #2 and #4 (used only during testing of missiles with exercise heads).
3. Remove the nose-probe shield.
4. Unfold the control surfaces.
5. Remove the forward end of dorsal fin #1 (to uncover the test receptacle).
6. Remove the access covers from the hydraulic pressure and return ports.
7. Ensure that all grounding leads are properly attached.
8. Attach the hoses and cabling to the missile.

The actual MST will be conducted by a fire control technician. After the test is completed. a good (GO indication) missile is mated and returned to the magazine. Should the missile be defective (NO-GO indication) however. it should be either mated and returned to the magazine as a dud or repaired (defective component replaced) immediately and retested. The decision of whether to return the NO-GO missile to the magazine or to repair it depends upon ship's doctrine and the tactical situation.

Missile code plugs MUST be installed onboard each ship after mating. The missiles are received with a shipping plug.

Warhead Exchange

When it becomes necessary to exchange warheads, the missile is removed from the magazine, unmated, and moved by the checkout car to the checkout area where interchange is performed with the use of the checkout area handling equipment. Before removing the warhead. it is necessary to install the warhead handling J- bar to the warhead hoists. This is accomplished by temporarily removing the J-bar and plate and engaging the J-bar slot with the hoist rollers. as shown in figure 14-25A.

To remove the warhead, use the following step-by-step procedure.

1. Remove the missile nose section (target detecting device or TDD), and the safe-and-arm (S&A) device. (The procedures for disassembly of these missile sections are described later. in this discussion.
2. Remove the J-bar adapter (refer to fig. 14-25A) from the J-bar and attach it to the warhead flange by rotating the adapter until the adapter pin is engaged - approximately 1/6 turn.
3. Position the warhead hoist so that the J-bar can be engaged with its adapter, and lock by inserting the chuck locking pin as shown in figure 14-25A.
4. Move the warhead hoist until the hoist rollers are at the indicated proper position for warhead removal and lock the J-bar to the hoist. Raise the hoist to remove any slack between the hoist, J-bar, and missile warhead.
5. Unlock the warhead from the electronic section by using a spanner to rotate the coupling (locking) ring.

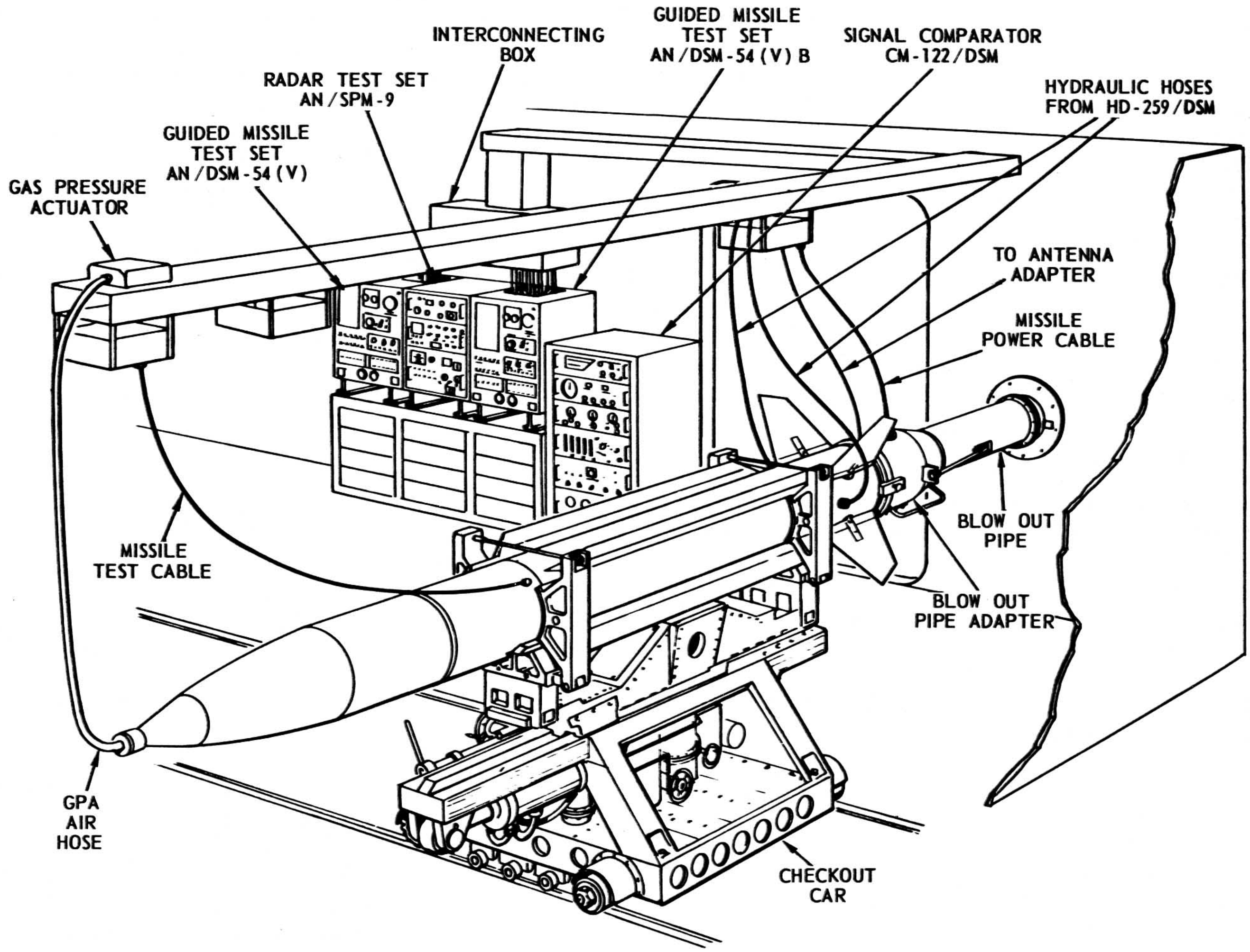

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Figure 14-24. — Typical shipboard checkout area, with missile system test (MST) equipment attached to missile on checkout car.

6. Separate the warhead and electronic section 3 to 4 inches, and disconnect the electrical connector (refer to fig. 14-25B).

7. Move the hoist to position the warhead in a clear area, to permit moving the warhead from a horizontal to a vertical position.

8. Position personnel at both sides of the warhead to restrain the warhead and prevent a sharp whip when the hoist rollers pass around the curved portion of the J-bar.

9. Unlock the J-bar and carefully roll it along the hoist rollers until the warhead is in a vertical position. See part C of figure 14-25.

10. Lock the J-bar to the hoist. and move the hoist to a point above the temporary stowage cell. See figure 14- 25D. Carefully lower the warhead into the cell, and disconnect the J-bar adapter.

Assembly of replacement warhead is essentially the reverse of disassembly. Some types of warheads, however, are connected to the electronic section with a locking ring located on the warhead rather than on the electronic section. When assembling this type of warhead, the locking ring must be removed from the electronic section before reassembly. The locking ring attached to the warhead is tightened to a torque value within a given tolerance while the locking

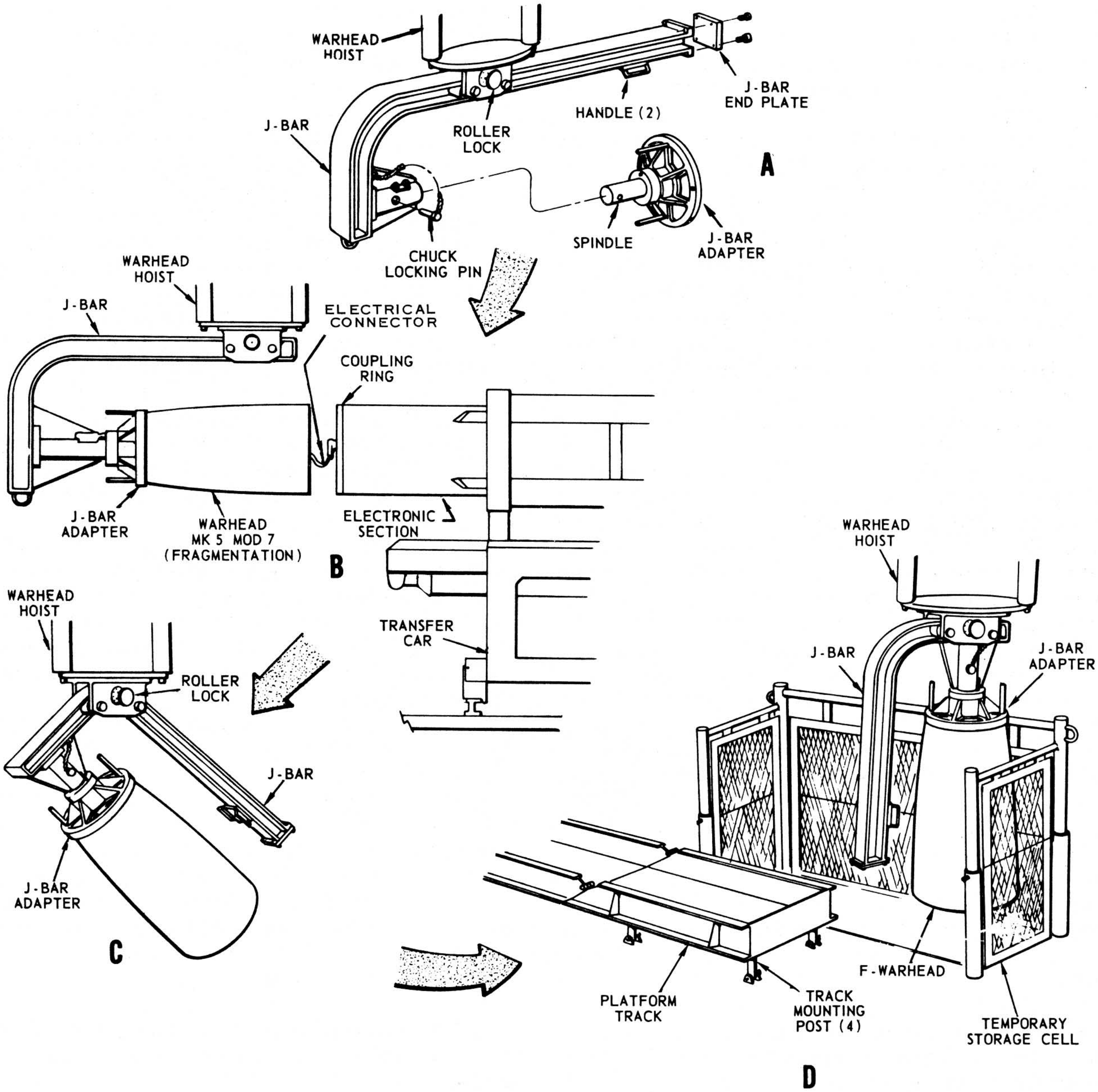

Figure 14-25.—Warhead removal, equipment and procedural steps: A. Warhead handling J-bar; B. Warhead separation from missile; C. Shifting warhead to vertical position; D. Warhead temporary storage cell. 83.155

ring attached to the electronic section is tightened to an index mark.

Exercise head installation also requires that a missile warhead be removed. Installation of the exercise head to the electronic section is accomplished in the same manner as warhead assembly, except that the electrical connections differ. The main differences between warhead exchange and exercise head installation are in connection with the preparation of the exercise head components for testing and flight. Checkout of the exercise head is to be accomplished by a missile system test within 30 days of the exercise firing. It should be noted that 30 days is the extreme limit. In actual practice, most commanding officers and weapons officers will require a MST within two or three days of the flight.

Before the exercise head is tested, both batteries must be charged and degassed. The batteries can be charged after they are removed from the exercise head or while they are still in the head, provided that the head can remain in the vertical position both during the charging procedure and during degassing. After battery charging, 12 hours of degassing are required before missile tests can be conducted.

Assuming that the system test of a missile assembled with an exercise head is conducted before an exercise firing, the exercise head is normally returned with the mated missile to the magazine. This means that if a destructor charge is used, it must be installed before the exercise head is secured to the electronic section. The exercise head is normally received with a dummy destructor charge installed, which must be removed before installation of a live destructor. An arming and firing device is installed with the destructor.

A flash signal (smokepot) may be used during training or evaluation flights to visually indicate fuze activation when the target is intercepted. Exercise warheads are normally received with two dummy flash signals installed. These signals are located 180° apart, near the forward end of the exercise head. Installation of the live flash signal requires only an exchange of one of the dummy signals the live signal and one electrical connection with the missile fuze section. It is necessary to remove the fuze section, however, or to install the flash signal before the fuze section is assembled to the warhead.

The flash signal can be assembled in the exercise head either before or after the exercise head is assembled to the missile electronic section. After installation of the flash signal, the exercise head must be kept grounded, and must also be handled and stored as a pyrotechnic item.

The charged and vented batteries must also be installed in the front end of the exercise head before installation of the fuze section. When the fuze section has been installed in the exercise head, a MST can be performed.

After the MST, the batteries are removed, topped off, recharged, degassed, and reinstalled in the exercise head. Because degassing requires 12 hours, the MST should be run at least 16 hours before firing.

Component Replacement

When a component of the BT-3A missile has been proved faulty, it should be replaced in accordance with the instructions in the applicable OP. The following discussion briefly describes component replacement, but is not intended to be used as instructions for missile assembly and disassembly. To attempt a detailed description of assembly and disassembly would require a book by itself.

A list of general component replacement instructions for all types of missiles follows.

1. When provided, special tools shall always be used to assemble and disassemble a missile.
2. Only identical or authorized replacement parts shall be used to replace defective components.
3. All areas requiring sealing compound shall be recoated when components are reassembled, to preserve watertight integrity.
4. During component replacement, a visual inspection of all preformed packings (O-rings, grommets, washers, etc.) shall be conducted to determine if replacement is needed.
5. Safety lockwire removed during component replacement shall be carefully replaced with NEW safety wire.
6. Make certain that all loosened nuts, bolts, screws, and electrical and hydraulic fittings are tightened to their specified values.
7. When hydraulic components are removed, all ports should be covered for protection from foreign matter, and only clean, lintfree rags should be used to wipe and absorb hydraulic fluid leakage.

The control surfaces of BT-3A missiles are mounted in machined sockets and retained by snap rings. Removal of the control surfaces is required only when it is necessary to replace components in the missile aft section or when a defective control surface is noted.

To remove a control surface, perform the following basic steps.

1. Unfold the control surface until latched in the flight position.
2. Loosen the wedge setscrew, shown in figure 14-26, four or five turns, using the special setscrew adapter.

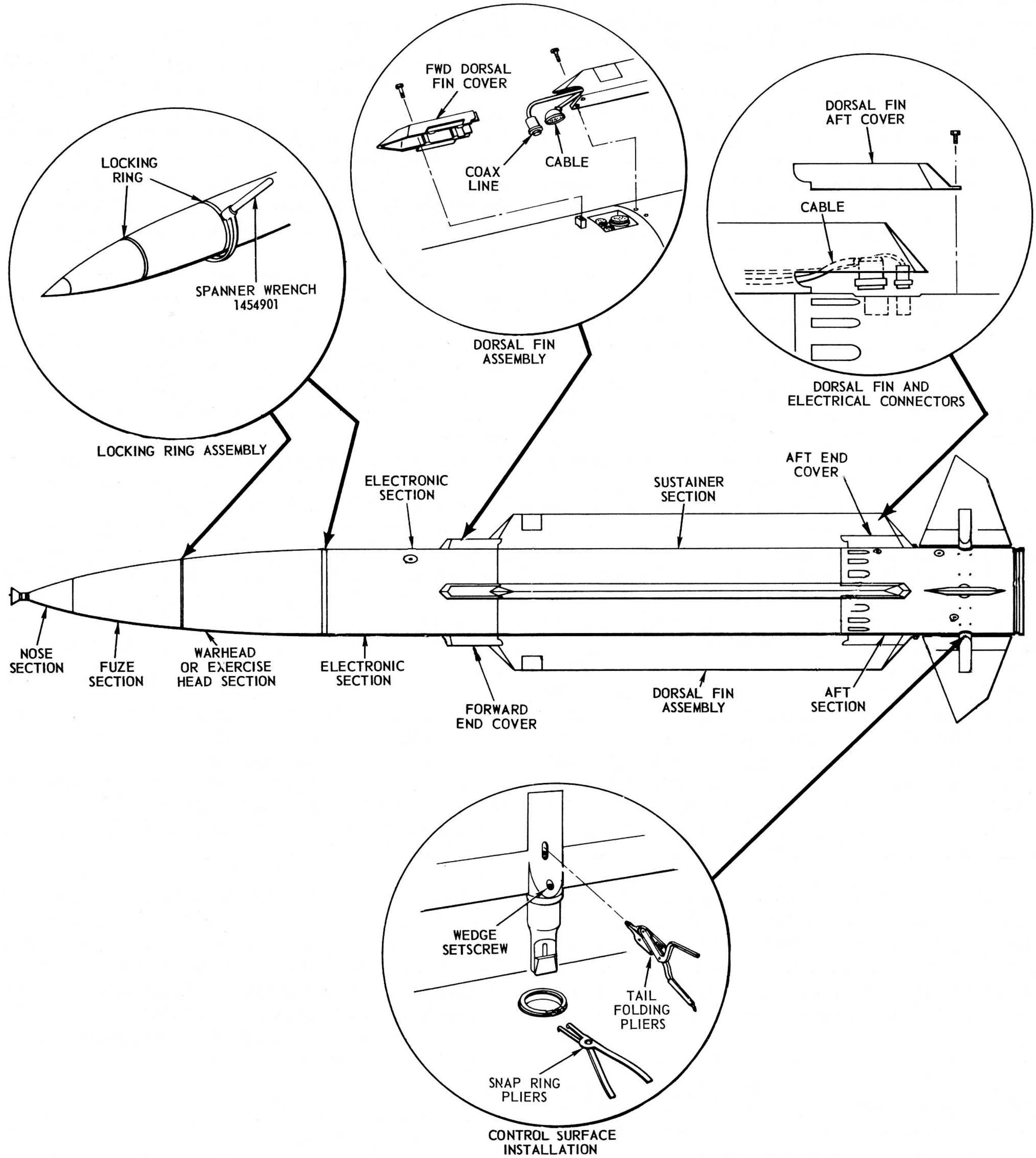

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Figure 14-26. — Component removal procedures on BT-3A missile.

3. Spread the snap ring, using the special snap-ring pliers (fig. 14-26).

4. Place the control-surface removal tool between the control surface and its retainer. Lightly strike the removal tool with a mallet until the control surface is free from its socket. Lift the control surface clear of the missile.

The control surfaces are folded by inserting the tapered tips of the special tail folding pliers (fig. 14-26) into the slot in the control surface

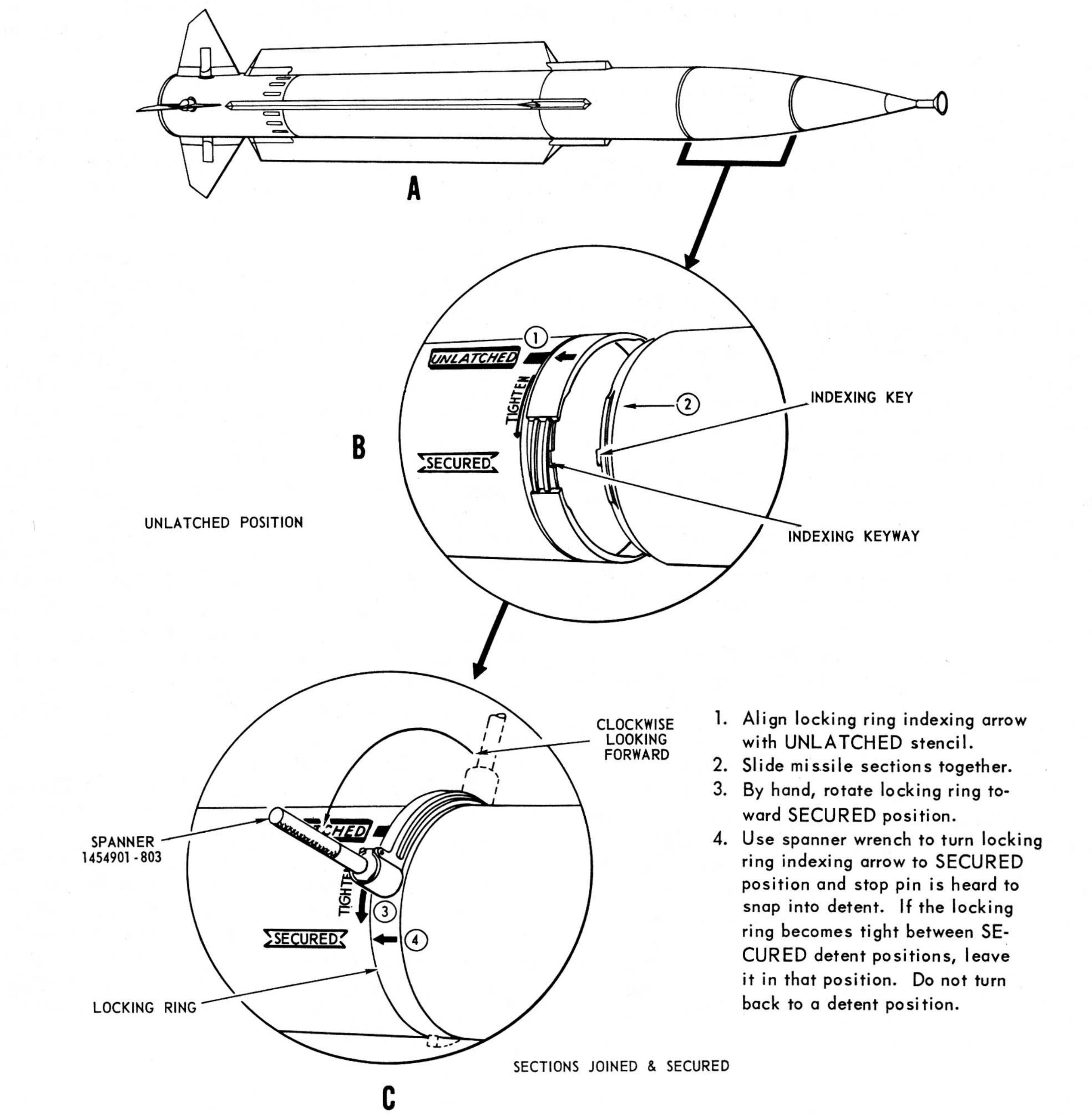

Figure 14-27. — Fuze section removal and replacement: A. Location of fuze section; B. Unlatched position; C. Sections joined and secured. 83.157

with the longitudinal axis of the pliers perpendicular to the control surface. Using a wood or rawhide mallet, strike the pliers at the joint between the two handles. Do not pry or use lever action. When the latch pin is dislodged, compress the handles of the pliers and fold the tip of the control surface to approximately the 90 position. Remove the pliers and continue folding the surface until it latches in the folded position.

The four dorsal fins are located around the center part of the missile, as shown in figure 14-26. Each fin is assembled in three sections: forward end cover, aft end cover, and main structure. After initial installation of the dorsal fins, only the end covers need to be removed for component replacement.

To remove and install the dorsal fins, proceed in the following manner.

1. Remove the screws retaining the forward end covers, and slide the covers toward the forward end of the electronic section until they disengage.
2. Remove the screws retaining the aft end cover and slide the covers rearward until they disengage from the dorsal fins.
3. Disconnect the electrical connectors and remove the retaining bolts from each end of the dorsal fin main structure. The dorsal fin main structure can then be lifted free.
4. Replace the main structure and tighten the retaining bolts to a torque value of 90 ± 10 in.-lbs.
5. Replace the forward and aft end covers and tighten the screws to a torque value of 27.5 ± 2.5 in.-lbs.

The nose section is removed or replaced as a unit, because removal of the transducer (probe) voids the factory air-leakage test. To remove the nose section, use a special wrench adapter and socket to loosen the eight setscrews at the aft end of the nose section. Unmate the nose section from the fuze section and disconnect the electrical connections between the nose and fuze sections.

To reassemble the nose section follow in reverse the disassembly procedures, except that the setscrews should be tightened to a torque value of 13.5 ± 1.5 in.-lbs.

The fuze section is removed after the nose section, without the use of special handling equipment. With the fuze section supported by two persons and using the special spanner wrench shown in figure 14-27 turn the locking ring counterclockwise (when viewed from the rear) until the alignment arrows indicate the unlatched position. Separate the fuze and warhead sections far enough to disconnect the electrical connections between fuze and warhead. The fuze section can now be replaced or repaired.

To replace the fuze section, fasten the electrical connectors and position the indexing key on the fuze section in the indexing keyway in the warhead. Using the special spanner wrench, move the locking ring index mark to the secured position.

The circuits of the electronic section are packaged according to their functions and mounted on a T-beam in five separate plug-in packages. Each package is held to the T-beam by captive screws or bolts. The T-beam is attached to sliding rails which allow the complete electronic unit to be pulled out of the missile airframe for servicing.

The major components of the aft missile section are the auxiliary power supply (APS) and steering control unit which are combined to form the steering-power assembly. The assembly is retained within the airframe by 16 screws. When a component of this assembly is defective, it is necessary to remove the complete assembly from the airframe by sliding it rearward. The step-by-step procedures for removal of the steering-power assembly will not be described here. However, these procedures include removal of the control surfaces and dorsal fin aft end covers.

Many of your sessions will be with training missiles. You will transfer missiles from ship to magazine, and the reverse, bringing them up from the stowage to the launcher. You will conduct tests on them. In other words, you will put the launching system through its paces as if you were using a real missile. To do this you need the instructions. The instructions for Tartar Training Missile (TSAM) Mk 16 Mod 1 are contained in OP 2831. It simulates the Mk 15 Tartar missile.