CONFIDENTIAL

ORDNANCE PAMPHLET No. 1002

FIRST REVISION

7".2 ROCKET LAUNCHERS, MARK 20, MARK 22 AND AMMUNITION

DESCRIPTION AND OPERATION

30 NOVEMBER 1943

NAVY DEPARTMENT
BUREAU OF ORDNANCE
WASHINGTON, D. C.

CONFIDENTIAL 30 November 1943

ORDNANCE PAMPHLET NO. 1002, FIRST REVISION

7".2 ROCKET LAUNCHERS, MARK 20, MARK 22, AND AMMUNITION

1. Ordnance Pamphlet No. 1002, First Revision, describes the operation and use of the 7".2 Rocket Launchers, Mark 20 and Mark 22, the control panels, the equipment, and the ammunition used with these launchers. This pamphlet is made in loose leaf form with the intention that when new Marks and Mods. of 7".2 Launchers and Ammunition therefor are approved, the data thereon can be readily added as additional chapters.

2. This pamphlet is intended for use by officers for the instruction of men who may be assigned to operate and maintain the equipment.

3. This pamphlet supersedes O. P. 1002 dated August 1942, Ordnance Circular Letters A69–43, G4–42, and G13–43, which should be destroyed by burning in the presence of a commissioned officer. Other publications on these and related equipments are listed on page 4 of this Ordnance Pamphlet.

4. This publication is CONFIDENTIAL and should be handled in accordance with the current edition of the Registered Publication Manual and Article 76, U. S. Navy Regulations, 1920.

W. H. P. BLANDY,
Rear Admiral, U. S. Navy,
Chief of the Bureau of Ordnance.

REFERENCES TO EXISTING PUBLICATIONS

The following publications, pertaining to Launchers, Mark 20 and Mark 22, and accessories, may be of interest to personnel responsible for launcher installations.

O. P. No. 1017	Projector Charge Fuzes (Restricted) August 1943.
O. S. No. 2759	Specifications for the Installation and Test of Projector, Mark 20. (Restricted.)
O. S. No. 2963	Specifications for the Installation and Test of Projector, Mark 22. (Restricted.)
Ordalt No. 1383	Projector, Mark 20, Installation of Watertight Safety Plug and Rewiring of Control Panel. (Restricted.)
Ordalt No. 1435	Projector, Mark 20, Instructions for Stiffening the Projector Ways. (Restricted.)
Ordalt No. 1803	Control Panel, Mark 2, for Launchers, Mark 20 and 22—Replacement with Control Panel, Mark 3, Mods. 2 or 3.
Ordalt No. 1836	7".2 Launchers, Mark 20 and Mark 22, Installation of New Type Knife Edges.
Ordalt No. 1952	7".2 Rocket Launchers, Mark 20 and Mark 22, Installation of Watertight Electrical Wiring.

BuOrd. Conf. Circular Letter No. A4–43, dated Jan. 1943.

BuOrd. Circular Letter No. A31–43, dated 1 May 1943.

BuOrd. Conf. Circular Letter No. A50–43, dated 25 June 1943.

BuOrd. Order No. 47–43, dated 8 July 1943.

Cominch "Tentative Instructions, Projector Charge, Mark 20 and Mark 22 (Mouse-trap)" (confidential).

OP 1347

Range Table for 7.2 Inch Shipboard Rockets

CONTENTS

Page

CONTENTS

Page

Chapter 7

Chapter 8

COGNIZANCE

Chapter 9

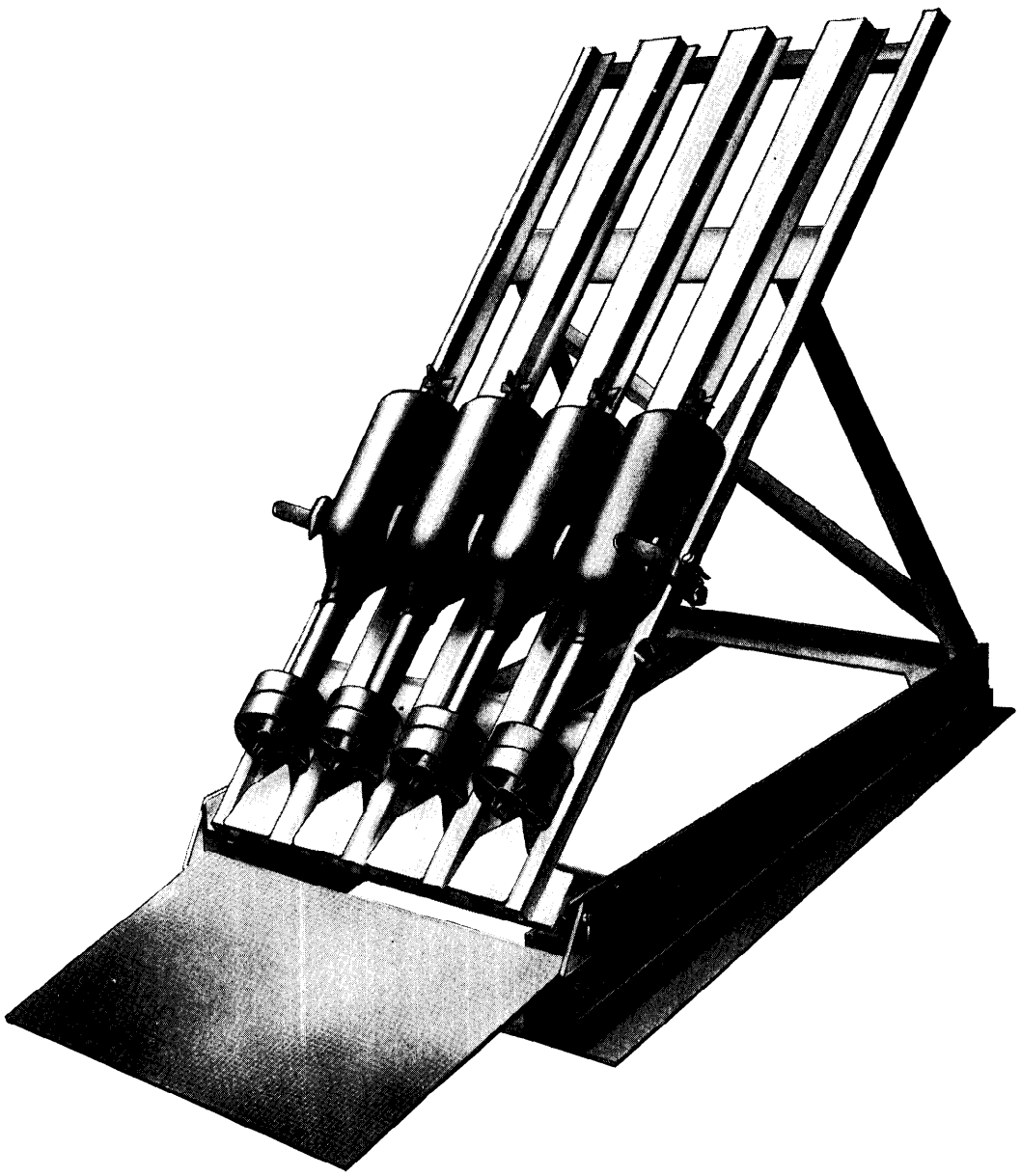


FIG. 1. 7".2 ROCKET LAUNCHER, MARK 20, LOADED, READY FOR FIRING

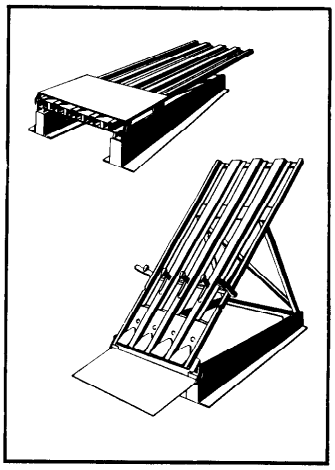
Chapter 1

7".2 ROCKET LAUNCHER, MARK 20

DEFINITION

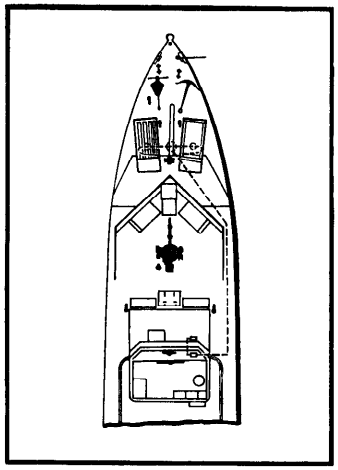
The 7".2 Rocket Launcher, Mark 20 (formerly known as the "Mousetrap") is a set of steel ways for supporting and firing 7".2 Rockets. This launcher was also formerly known as the Projector Mark 20, and many name plates are so marked.

The designation Control Panel was changed to Firing Panel subsequent to the preparation of this Ordnance Pamphlet.



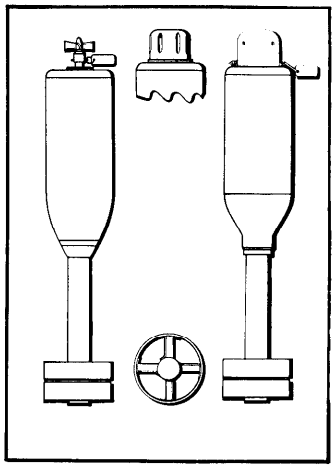
LAUNCHER IN FOLDED AND RAISED POSITIONS

The launchers can be folded, lashed down and locked to the deck when not in use. When raised for firing, they are fixed in elevation and azimuth, the salvo being fired with the ship heading on the "gun train order bearing" and at the proper value of range.



LOCATION OF LAUNCHERS ON FOREDECK

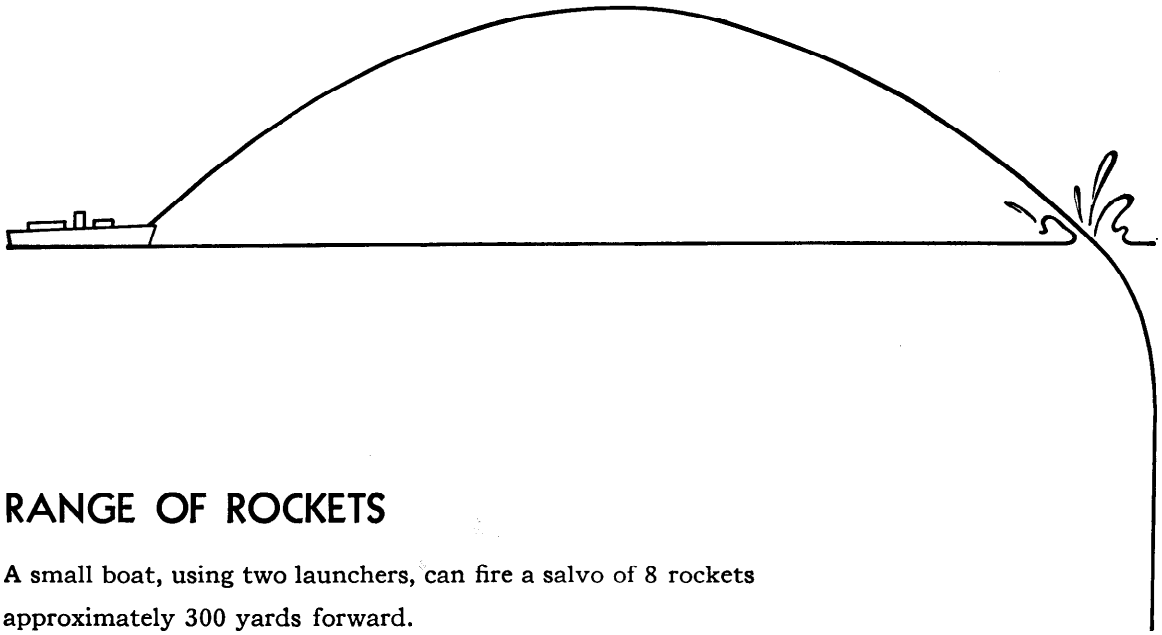
Ordinarily two launchers are mounted on the foredeck, one port and one starboard, arranged symmetrically about the center line of the boat and facing forward. Each launcher fires 4 rockets in a salvo. Firing is electrical and is controlled from the bridge.



7".2 ROCKETS

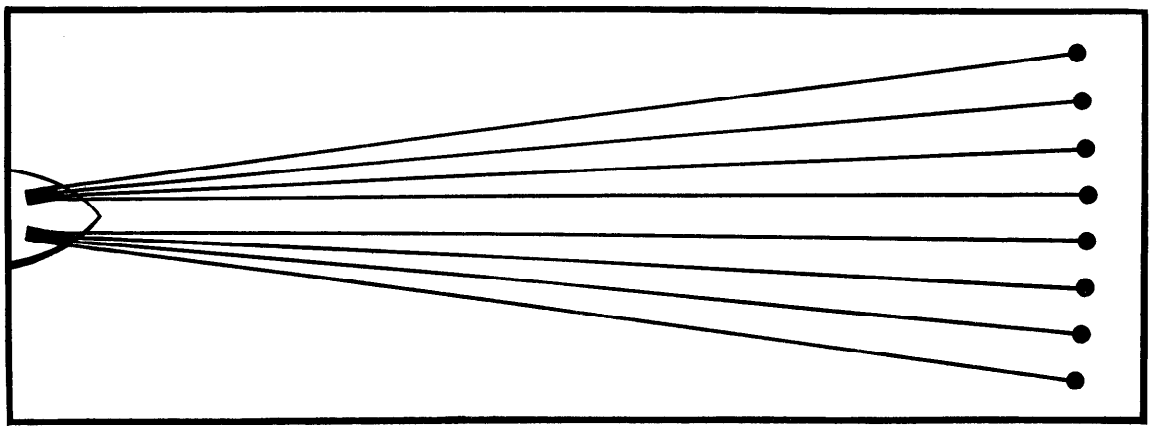
The rockets fired from the Launcher, Mark 20, are 7".2 in diameter and 35".0 long. The body is filled with about 30 pounds of explosive. The rocket is equipped with an impact-firing fuze and is propelled through the air by the burning of the powder in the motor.

INTRODUCTION



RANGE OF ROCKETS

A small boat, using two launchers, can fire a salvo of 8 rockets approximately 300 yards forward.



PATTERN OF FIRE

The ways of the launcher are spread apart at the ends, fanwise, so that the 8 rockets strike the water in a straight line about 83 yards long at right angles to the center line of the boat.

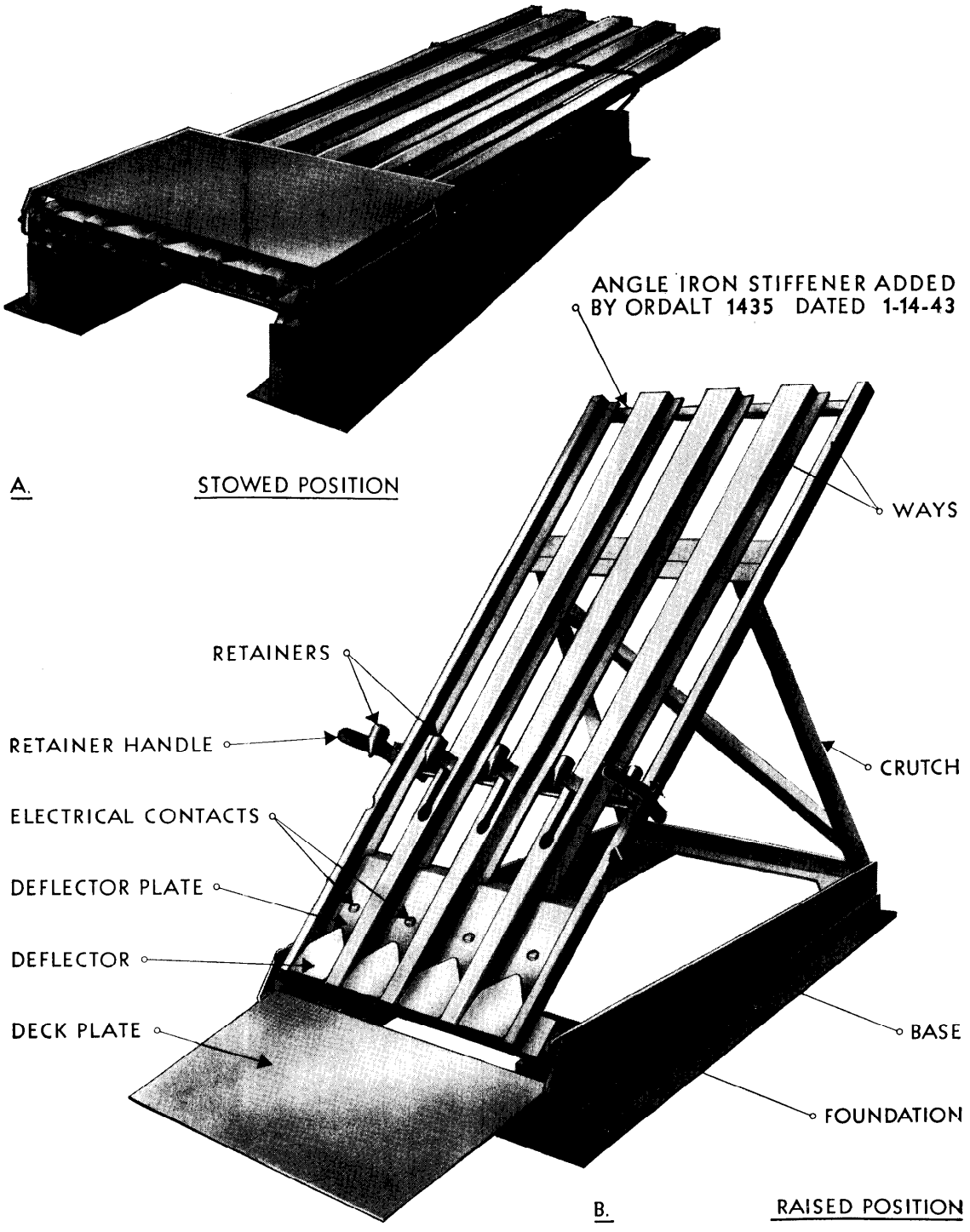


FIG. 2. 7".2 ROCKET LAUNCHER, MARK 20

7".2 ROCKET LAUNCHER, MARK 20

The launcher consists of ways welded together to make a rigid unit which is hinged to the base which in turn is fastened to the deck structure. When erected, the ways are supported by a crutch which also is hinged to the base and locks in place with two levers. The ways themselves consist of sections of steel plate bent up to make rails in which the rockets ride. The three inside sections are made broad and wedge-shaped, one piece thus serving as common rail for two adjacent rockets. A spread of one part in 40 is made between ways to give the required spacing of shots. A set of retractable retainers is provided to keep the rockets from being washed out of place in a heavy sea. These retainers are raised manually and pinned in place after the ways are loaded. They do not interfere with the firing. In firing, an intense blast of hot gases is ejected from the nozzles of the rocket motors for several feet. Unless the deck and nearby structures are protected, they are likely to be scorched considerably. To divert the direct blast at the base of the projector, heavy steel deflectors are provided and a $\frac{3}{16}$-inch steel plate 24".0 long laid on the deck immediately behind. For places not directly struck by the blast, a light steel sheet is sufficient.

The launcher is designed to fold down and be lashed to the deck when not in use, as shown in figure 2. When conditions require it, weather permitting, the launcher may be maintained elevated and loaded. Whenever weather conditions are such that the launchers or the ammunition exposed on the rails would be subject to damage or deterioration, the ammunition should be unloaded and stowed and the rails lowered and lashed down.

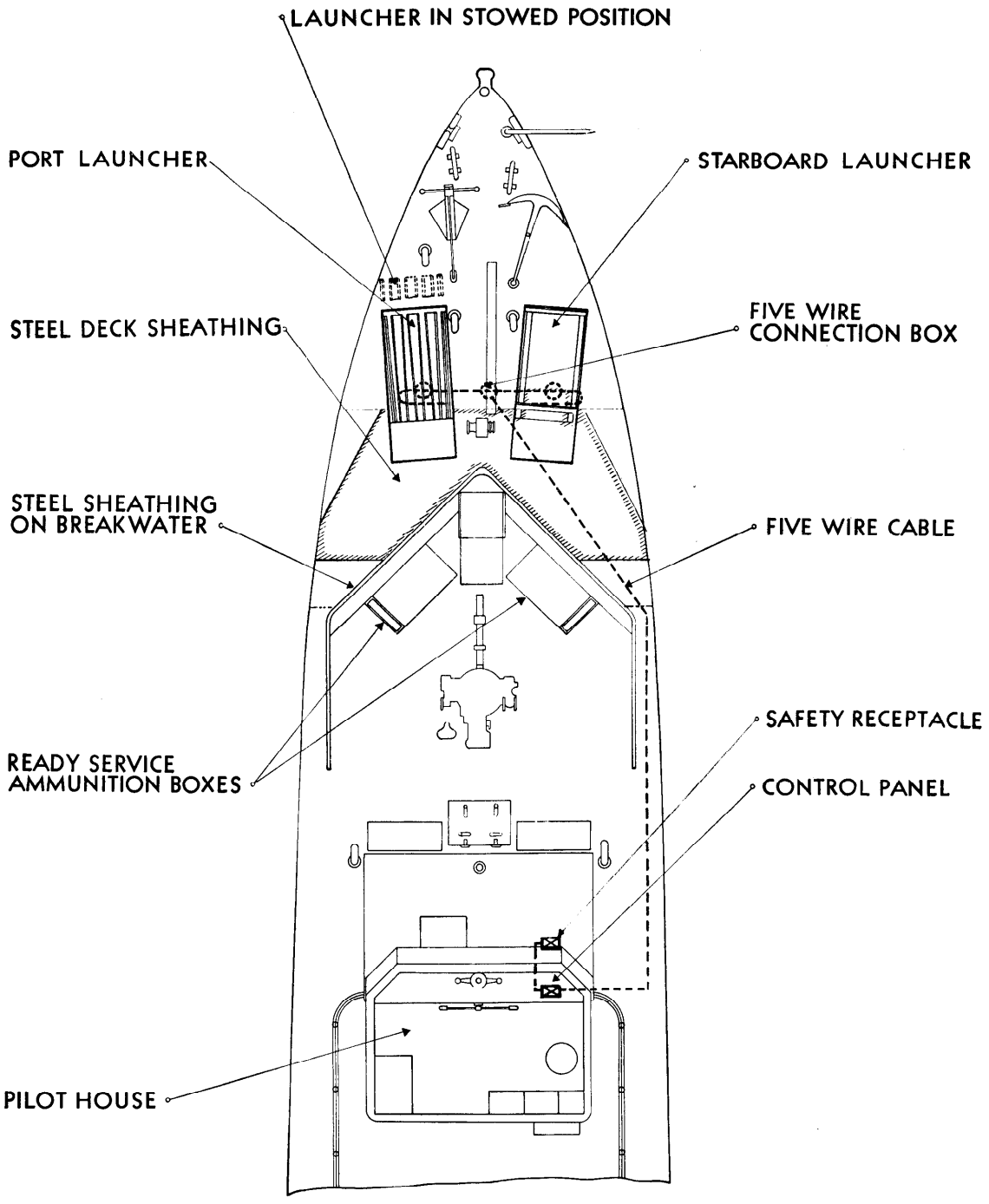


FIG. 3. FOREDECK INSTALLATION OF 7".2 ROCKET LAUNCHER, MARK 20

INSTALLATION

The launchers are mounted on the foredeck (see fig. 3) requiring two clear spaces about 38″.0 by 84″.0. All wooden structures directly aft are sheathed with 1/16-inch steel sheet as protection against blast. Extending from the launcher, in the direct line of the blast, a 3/16-inch steel floor plate about 2 feet long is provided. The flame is of sufficient intensity to remove paint from surfaces directly in line for the first 2 or 3 feet, so frequent repainting of the sheathing may be necessary.

The launchers are mounted on wood or metal foundations so that they are level athwartships and have a 3°–5° slope fore and aft with the high point forward. The two launchers are placed, in the folded position, on the foredeck symmetrically about the centerline of the ship. The extreme forward point of the inboard edge of the base of each launcher deviates 4 to 5 inches further from the centerline than the aft end of the base. This deviation is inversely proportional to the distance between launchers. This placement of the launchers gives an approximately equal spacing to all 8 rockets.

Ready-service boxes are provided on the foredeck, convenient to the launchers, for ready ammunition. Each box is waterproof and holds 8 rounds in easily accessible racks. Additional ammunition is stowed below decks in magazine stowage.

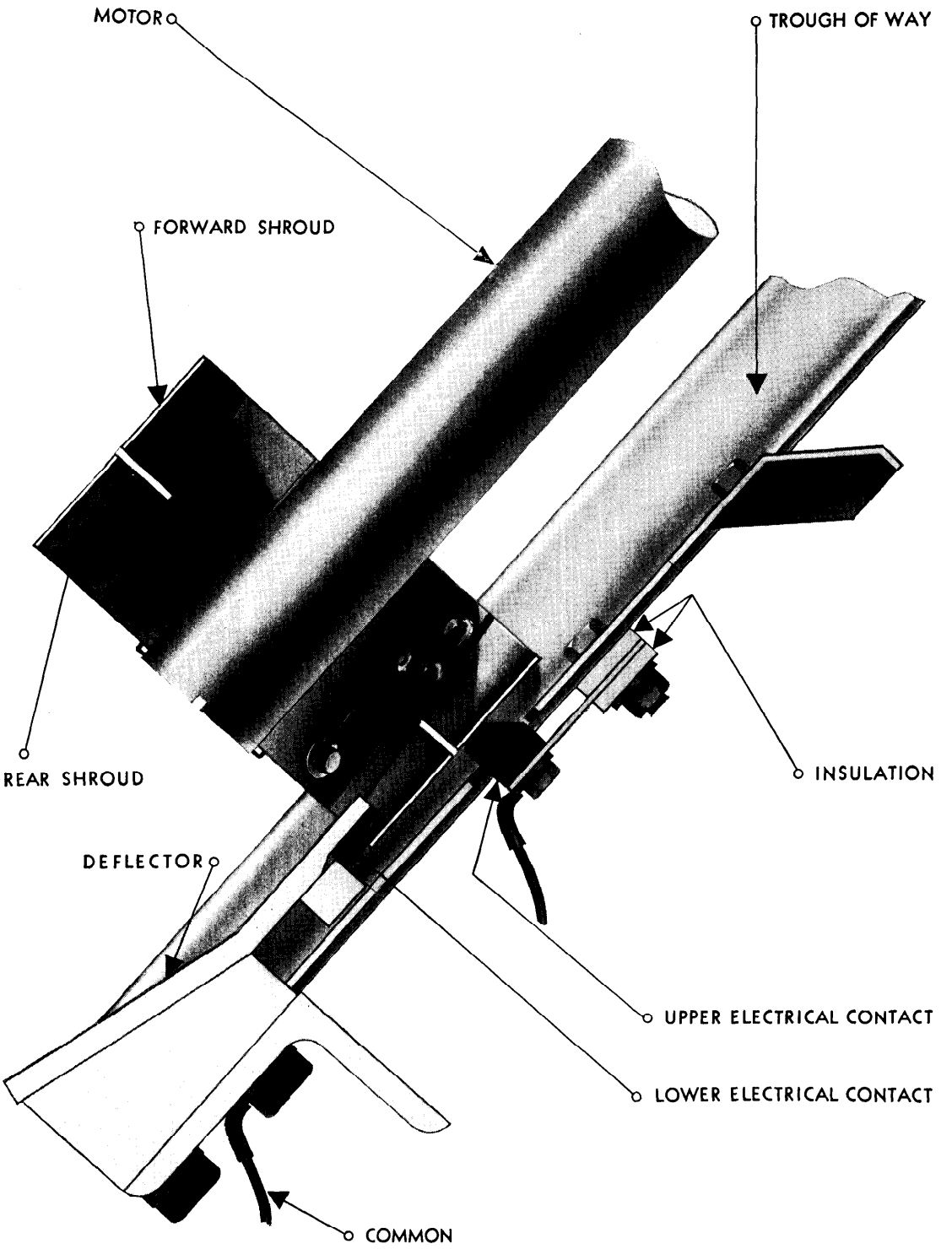


FIG. 4. ELECTRICAL CONTACTS FOR 7".2 ROCKET LAUNCHER, MARK 20

ELECTRICAL CONTROLS

Electrical contact for firing is made to the two shrouds of the rocket motor by means of knife edges (see fig. 4). The lower contact mounted in the deflector plate grips the inside of the grounded rear motor shroud, which is electrically connected to one side of the igniter, and serves as a stop. The upper insulated contact is mounted on a phosphor bronze spring and bears on the outside of the insulated forward shroud. Both contacts are made of hardened stainless steel.

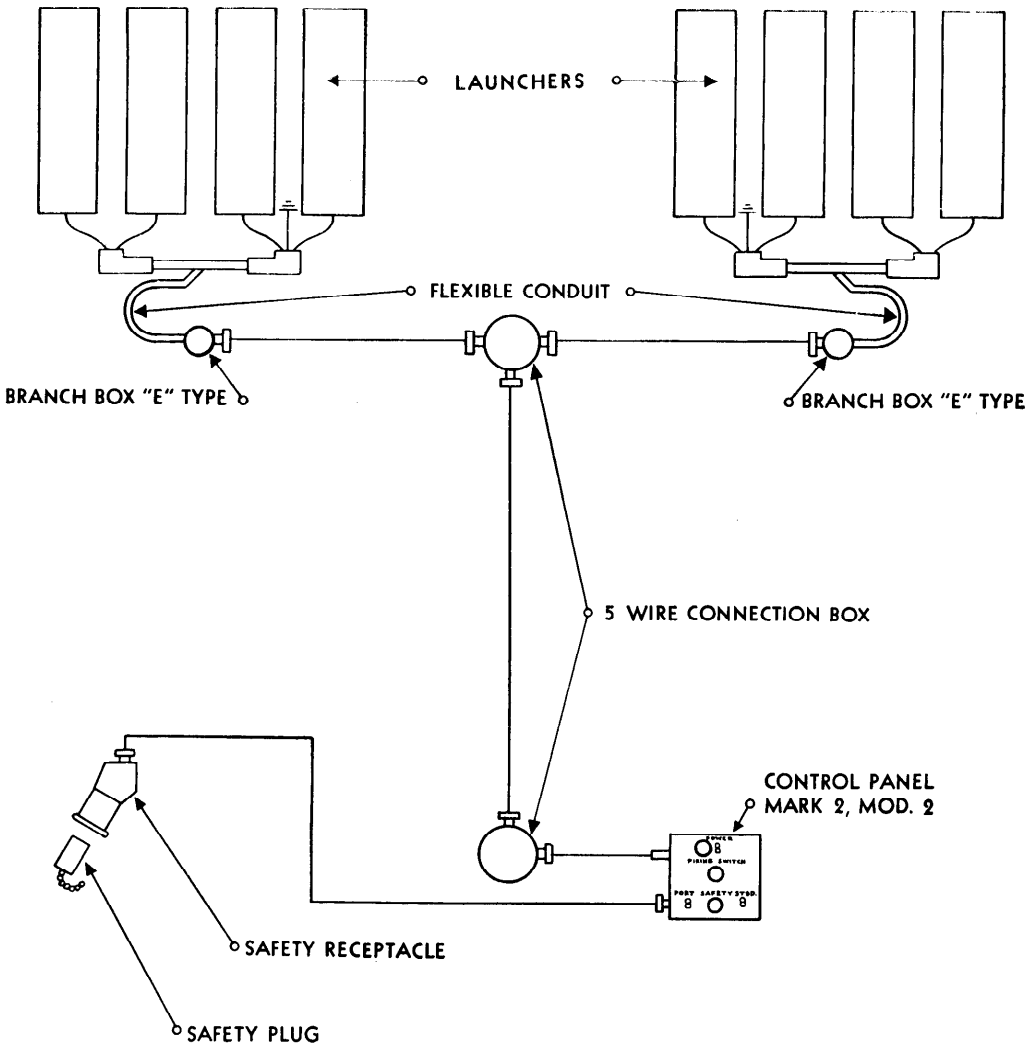


FIG. 5. CIRCUIT SCHEMATIC FOR 7."2 ROCKET LAUNCHER, MARK 20
(USING CONTROL PANEL, MARK 2, MOD. 2)

A cable with 5 active conductors runs from the control panel to a 5-wire connection box. From this box, a cable runs to a branch box Type E at each launcher, and thence to the launcher. In certain installations, the cable from the control panel passes through the deck through a watertight bushing to a 5-wire connection box. For schematic diagrams of the circuits, see figures 5 and 6.

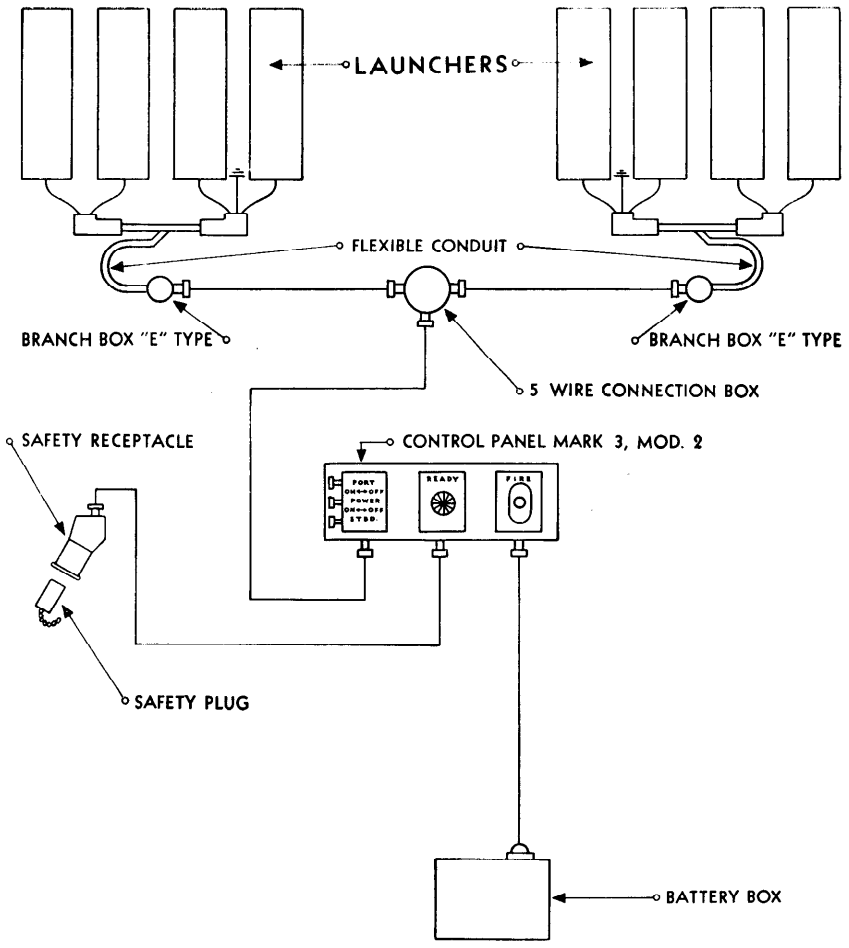
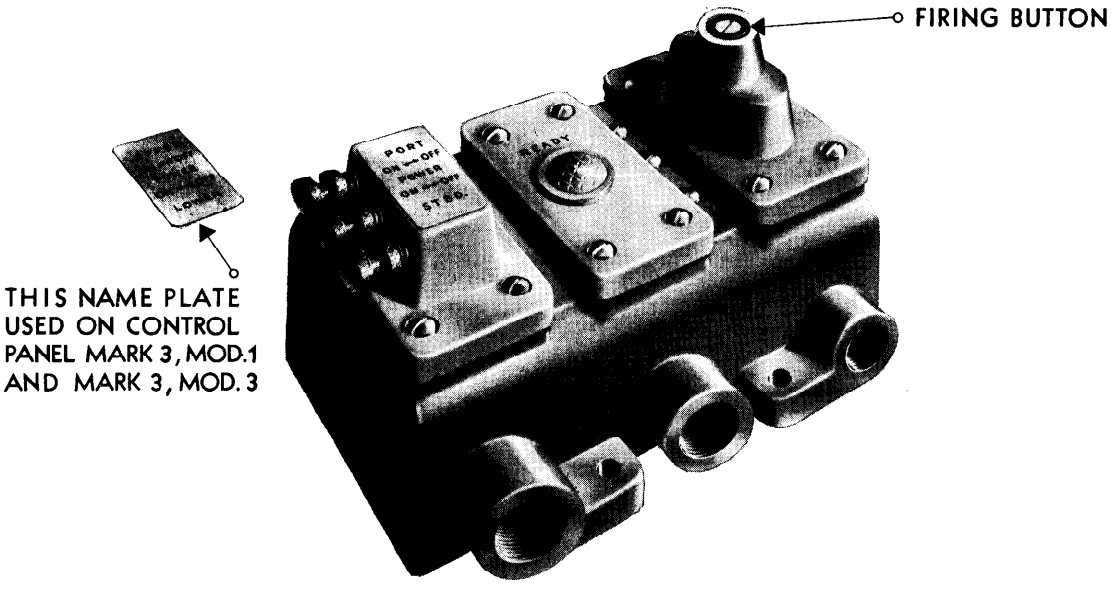


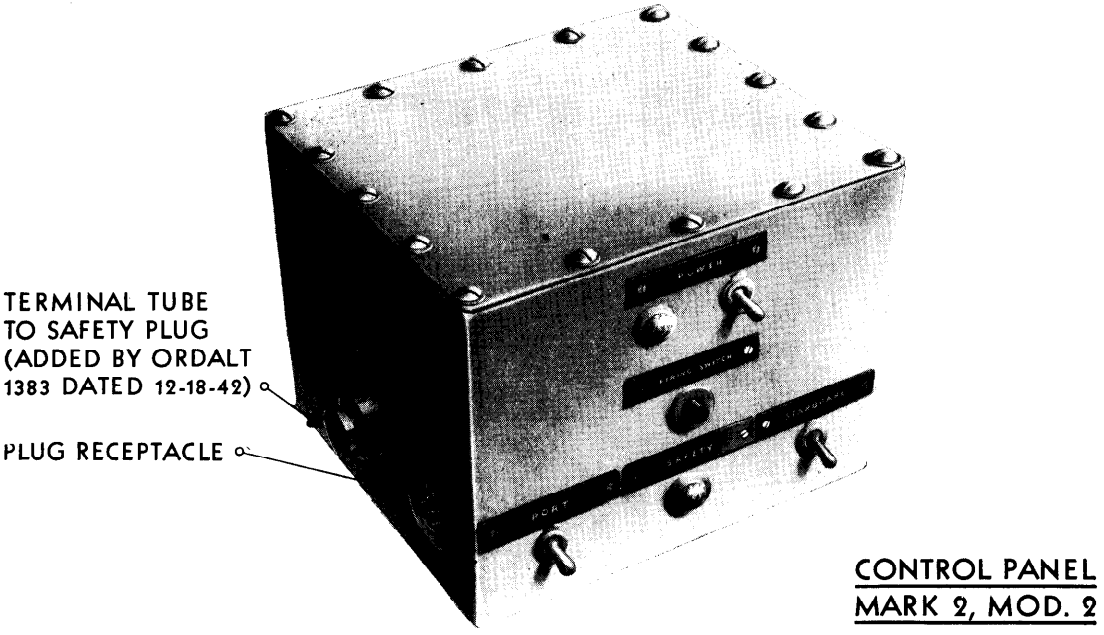
FIG. 6. CIRCUIT SCHEMATIC FOR 7".2 ROCKET LAUNCHER, MARK 20

(USING CONTROL PANEL, MARK 3, MOD. 2)

The control panel is located on the bridge. From the control panel, a 4-conductor cable runs to a safety plug receptacle. All connections are broken in this receptacle unless the safety plug is in place. The safety receptacle is usually mounted on the side of the bridge structure in a position protected from blast and at a safe distance from the launchers.



CONTROL PANEL MARK 3 AND MARK 3, MOD. 2



CONTROL PANEL MARK 2, MOD. 2

FIG. 7. CONTROL PANELS FOR 7".2 ROCKET LAUNCHERS, MARK 20 AND MARK 22

CONTROL PANELS

The types of control panels in use are Mark 2, Mod. 2, the Mark 3, and Mark 3, Mod. 2. (See fig. 7.) The latter two are identical in external appearance. The differences lie in the batteries used as sources of power and in the internal wiring. The Control Panel Mark 2, Mod. 2, contains batteries whereas the Control Panel Mark 3, and Mark 3, Mod. 2, have power supplied from batteries in a separate box located either above or below decks. One 45-volt and one 6-volt dry battery serve as power for the Control Panel Mark 2, Mod. 2, as is shown in the wiring diagram, Figure 8. The Control Panel Mark 3 operates with either one 45-volt and one 6-volt dry battery or one 45-volt and two 6-volt batteries as is shown in Figure 9 (A). The wiring to the panel is unchanged whether one or two 6-volt dry batteries are supplied. Two 7½-volt dry batteries are supplied with the Control Panel Mark 3, Mod. 2. The wiring of this panel is shown in Figure 9 (B). The battery box supplied with the Control Panels Mark 3 and Mark 3, Mod. 2, should be discarded as a unit when the batteries are exhausted and replaced by a new box. Prior to discarding, the receptacle should be removed from the old box and installed on the new one. In case no battery box is available, a portable storage battery may be used for operating the launchers. This battery should be 6-volt and preferably not less than 50 ampere-hour capacity. The Control Panel Mark 2, Mod. 2, should be operated only with 45-volt and 6-volt batteries, as described above.

Service experience and laboratory tests have demonstrated that the 45-volt battery originally supplied with control panel Mark 2 and with about 200 control panels Mark 3 as unsuitable due to high internal resistance. Ordalt No. 1803 has been issued which provides for the replacement of the firing panel Mark 2, Mod. 2 by the firing panel Mark 3, Mod. 2.

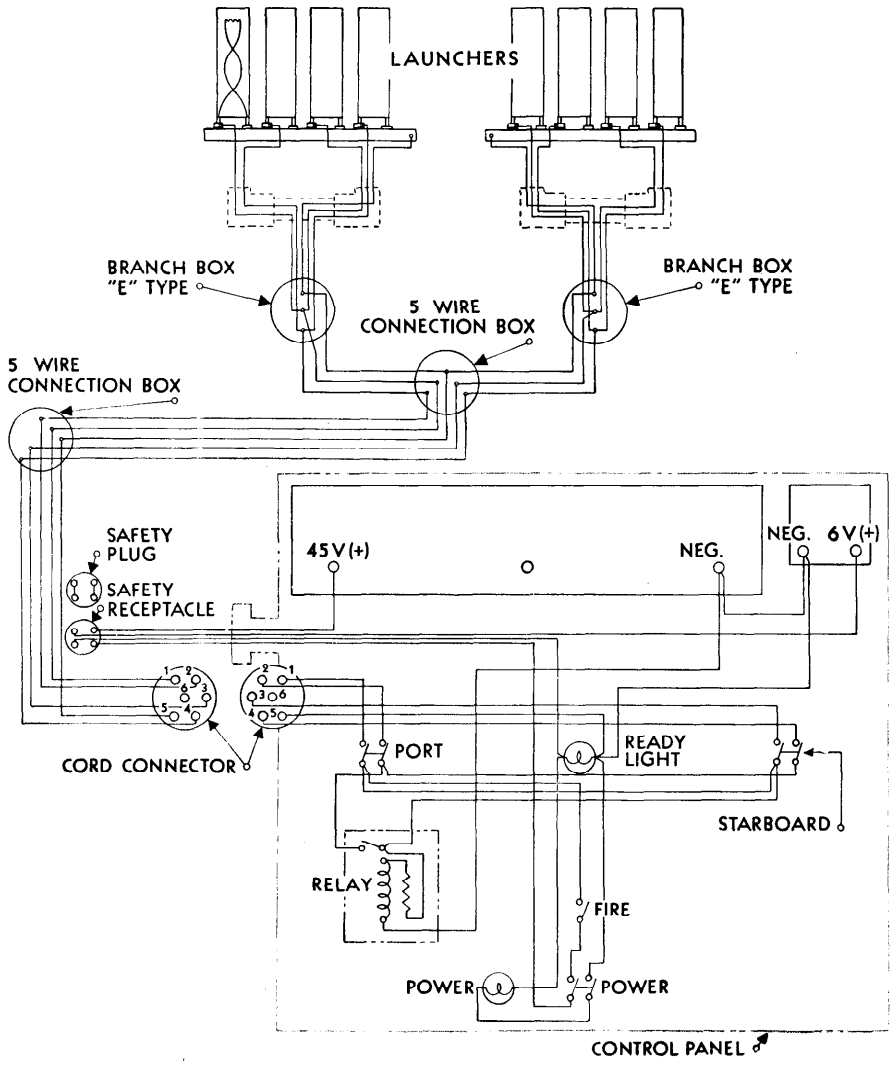


FIG. 8. WIRING DIAGRAM FOR 7".2 ROCKET LAUNCHER, MARK 20

(USING CONTROL PANEL, MARK 2, MOD. 2)

The operation of any of the above control panels is the same. A push button marked "FIRE" fires the odd-numbered ways and actuates a time-delay relay which fires the even-numbered ways 1/8-second later. Switches permit selection of port or starboard launchers or both and a master switch cuts off all power. A green pilot light indicates when the power switch is on and a red light indicates when the Safety Plug is in place in the case of the Control Panel, Mark 2, Mod. 2.

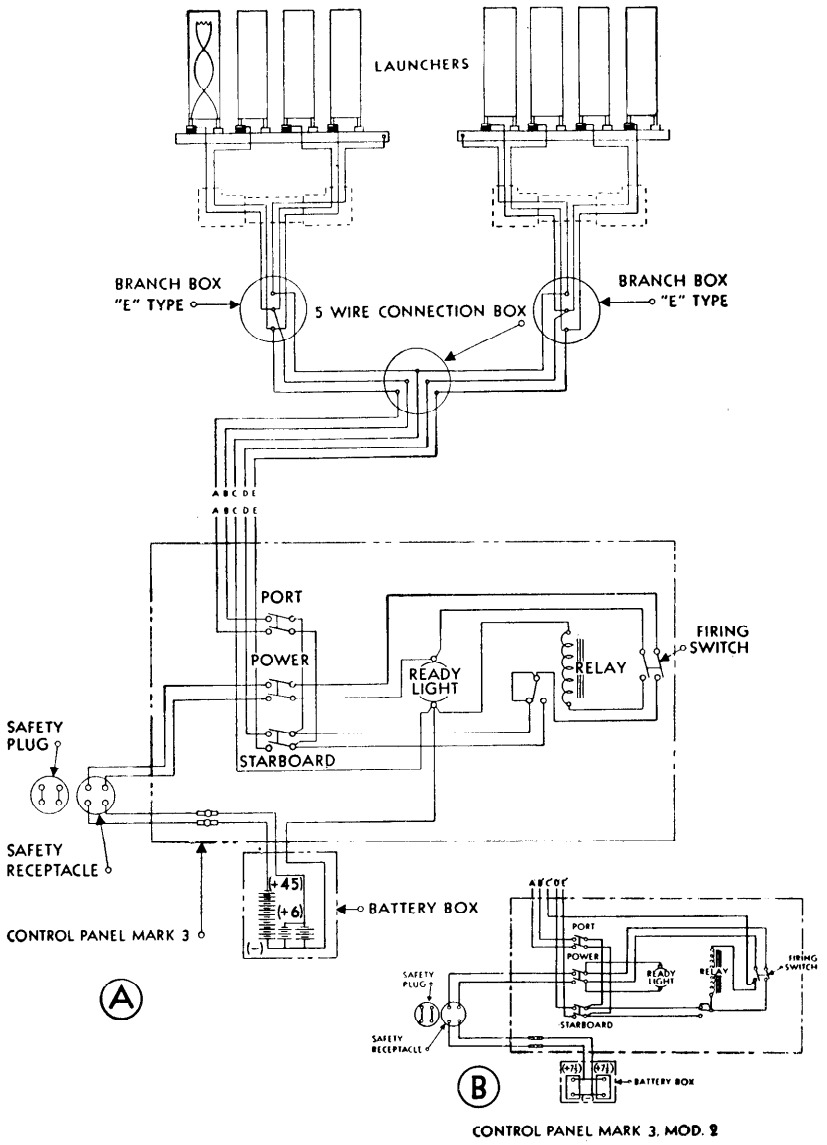


FIG. 9. WIRING DIAGRAM FOR 7".2 ROCKET LAUNCHER, MARK 20

(USING FIRING PANEL MARK 3 OR MARK 3, MOD. 2)

On the Firing Panels, Mark 3 and Mark 3, Mod. 2, a single light is illuminated when the Safety Plug is in place and the power switch is "ON." The power switch on the panel should be turned to "ON" only to ascertain if the launchers are in a ready condition, and just prior to firing. Leaving the switch at "ON" unnecessarily will result in a run-down battery and misfires. The indicator lights furnished with the panels are Navy type TS–20 (Mazda No. 64) 6–8 volt 3 c-p, bayonet candelabra double contact bases. If these lamps are too bright, Navy type TS–43 (Mazda No. 90) 12–16 Volt 6 c-p may be used instead.

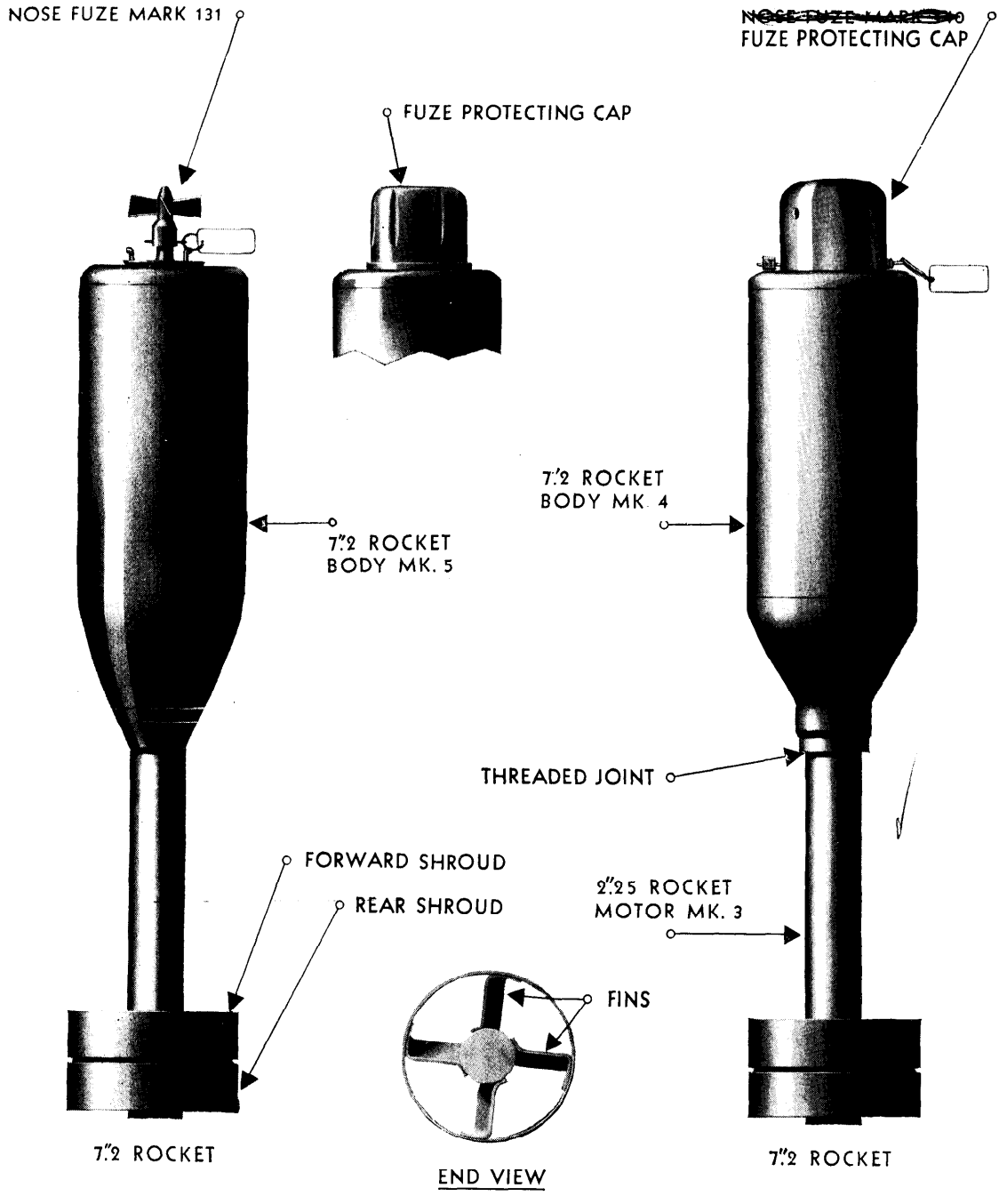


FIG. 10. 7".2 ROCKET

Chapter 2

7".2 ROCKET AMMUNITION AND FUZES

7".2 ROCKET AMMUNITION

Two general views of the 7".2 Rocket ammunition for use with Launchers, Mark 20 and 22, are shown in figure 10. The units consist of the body, the motor, and the fuze. The body is 7.2 inches in maximum diameter and the assembled projectile weighs about 63 pounds. The entire unit is streamlined and provided with fins to give stable flight and a high sinking rate in water.

The body of the projectile is filled with approximately 30 pounds of TNT or 34 pounds of TPX. An auxiliary booster consisting of granular TNT is employed to detonate this charge.

BODY

The body for 7".2 Rocket ammunition is a welded steel cylindrical case, with a relatively flat nose section and a conical tail fairing. It is provided with an opening in the nose section to receive the fuze seat liner and the fuze. Originally the body was designed for nose filling and the fuze seat liner was screwed into the nose. Later designs provide for filling through the rear and the fuze seat liner in these bodies is integral with the body.

The body, Mark 4, and motor, Mark 3, are assembled by screwing the motor into the threaded cone bushing of the body. The newer body (Mark 5) with integral fuze seat liner uses a connector closure into which an adapter is screwed which, in turn, accommodates the motor. The design of this body not only permits of pouring of the high explosive through the rear opening but also permits the use of a larger motor when the adapter is omitted, thus allowing other applications of this body.

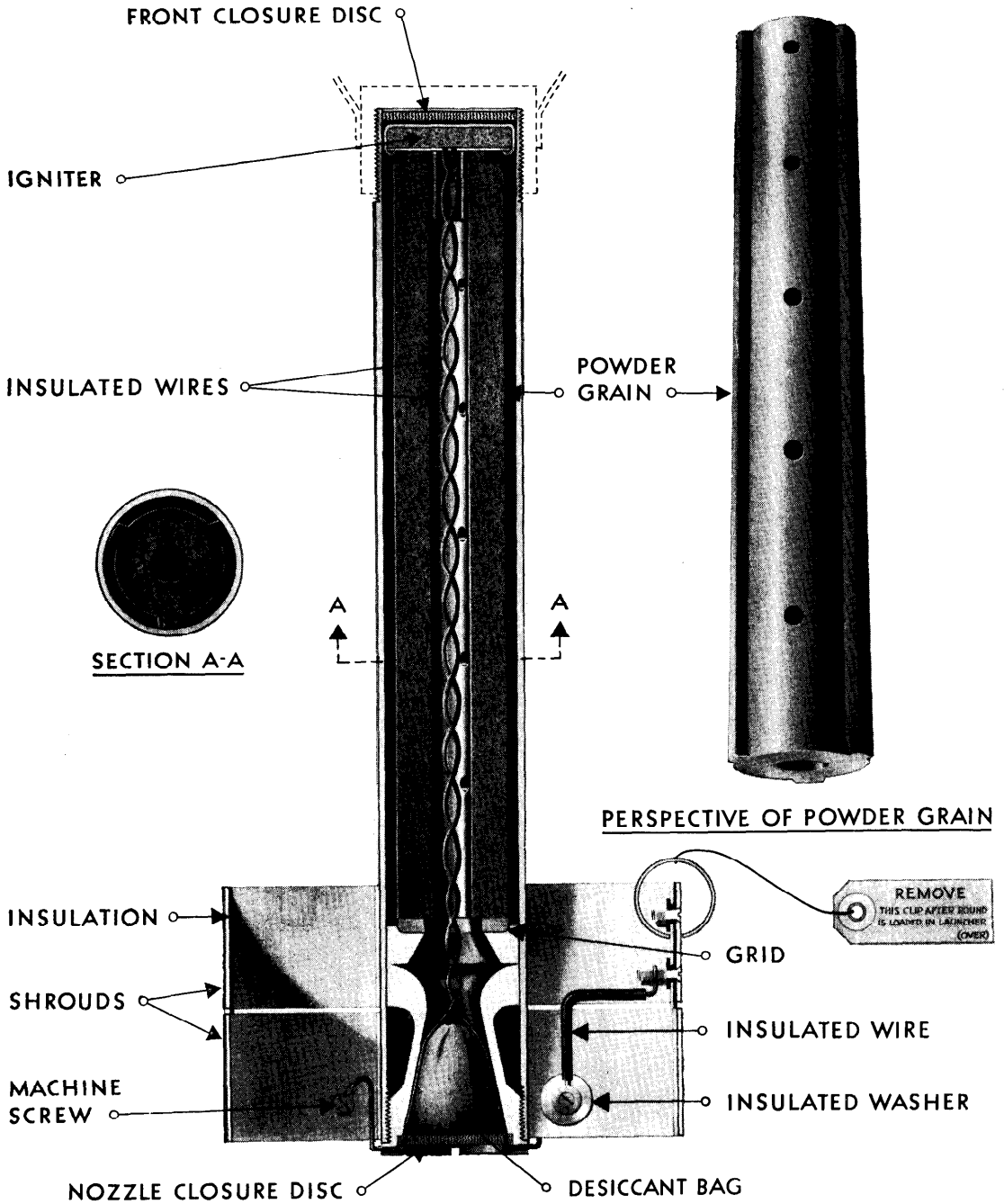


FIG. 11. DIAGRAMMATIC SKETCH OF ROCKET MOTOR
(SHOWING DETAILS OF TYPICAL PROPELLANT ASSEMBLAGE)

MOTOR

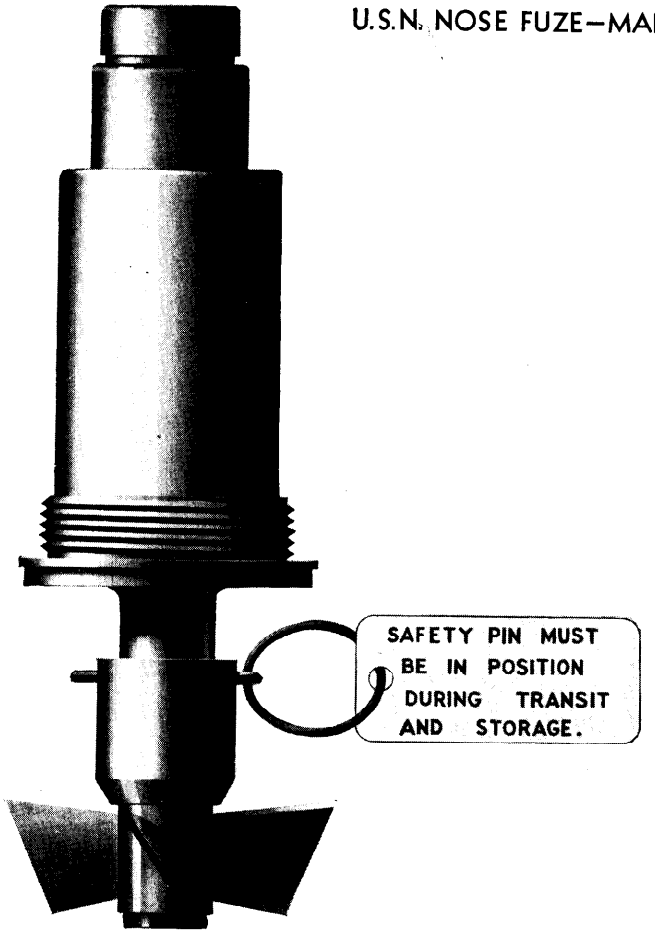
The motor consists of a steel tube having an outside diameter of 2.25 inches, 4 radial fins and a cylindrical shroud surrounding the fins (see fig. 11). The forward end of the motor tube is externally threaded for assembly with the body. The fins are inclined 10° relative to the tube axis. This design is intended to impart rotation to the rocket and to cancel "ruddering" effects which would disturb the underwater trajectory.

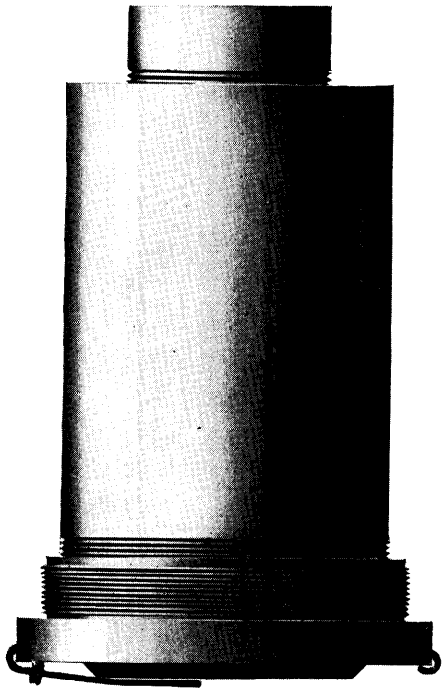
PROPELLANT COMPONENTS

The propellant components are contained in the motor. A typical assembly of the components is shown in figure 11. The main component is a single grain of solventless extruded ballistite powder. At the forward end of this powder grain is located an igniter which consists of an electrical squib leading into a charge of black powder. Two electrical wires are run from the motor shrouds through a central perforation in the powder grain to the igniter. When the electrical circuit is closed, the igniter burns, igniting the propellant grain which burns uniformly on all surfaces at a pressure of 800 to 2,300 pounds per square inch, depending upon temperature. The gases evolved are forced out through the nozzle at high velocity and, by their reaction on the motor, propel the unit forward. The propulsion does not depend on any interaction with the air or upon the shields struck by the blast, so no recoil problem exists. It is this feature which makes the use of such equipment possible on relatively light boats. The burning continues for about 0.4 second at normal temperature, while the rocket travels about 33 feet. After this period, no further propulsion occurs and the rocket is in free flight.

U. S. N. NOSE FUZE, MARK 131

U.S.N. NOSE FUZE—MARK 131





U. S. NOSE FUZE, MARK 135

FIG. 13

FUZE SEAT LINERS

(See fig. 12). A threaded opening is provided in the 7".2 Rocket body, Mark 4, into which the fuze seat liner is screwed. The fuze seat liner is threaded externally to fit this threaded opening in the body head and is threaded internally to fit the fuze threads. A formed, light metal extension or liner permanently fixed to the fuze seat liner head forms the cavity for the fuze and auxiliary booster. The fuze seat liner flange is provided with hooks for engaging the fuze cap when the Mark 131 fuze is used. This fuze cap is intended to protect the propeller vanes of the Mark 131 fuze and should remain in place until the rocket is loaded on the launcher way.

The fuze seat liner is an integral part of the 7".2 Rocket body, Mark 5.

THE FUZES

One of the three fuzes is used with 7".2 Rockets as follows:

1. U. S. N. Nose Fuze, Mark 131 and Mods. (Uses one Mark 1 (3-inch) booster.)

2. U. S. N. Nose Fuze, Mark 135 and Mods. (Used only in bodies provided with a special fuze seat liner. Uses one Mark 1 booster.)

3. U. S. N. Nose Fuze, Mark 140 and Mods. (Uses two Mark 2 (2-inch) boosters.)

These fuzes are armed after entering the water and all fire upon impact with the steel surface or the wood deck gratings of a submarine or other submerged object.

The fuze is screwed into the fuze seat liner of the Mark 4 body or directly into the Mark 5 body. Before the fuze is screwed into the body, inspection should be made to ascertain that the auxiliary booster is present in the fuze liner and that the cardboard shipping cylinder is removed.

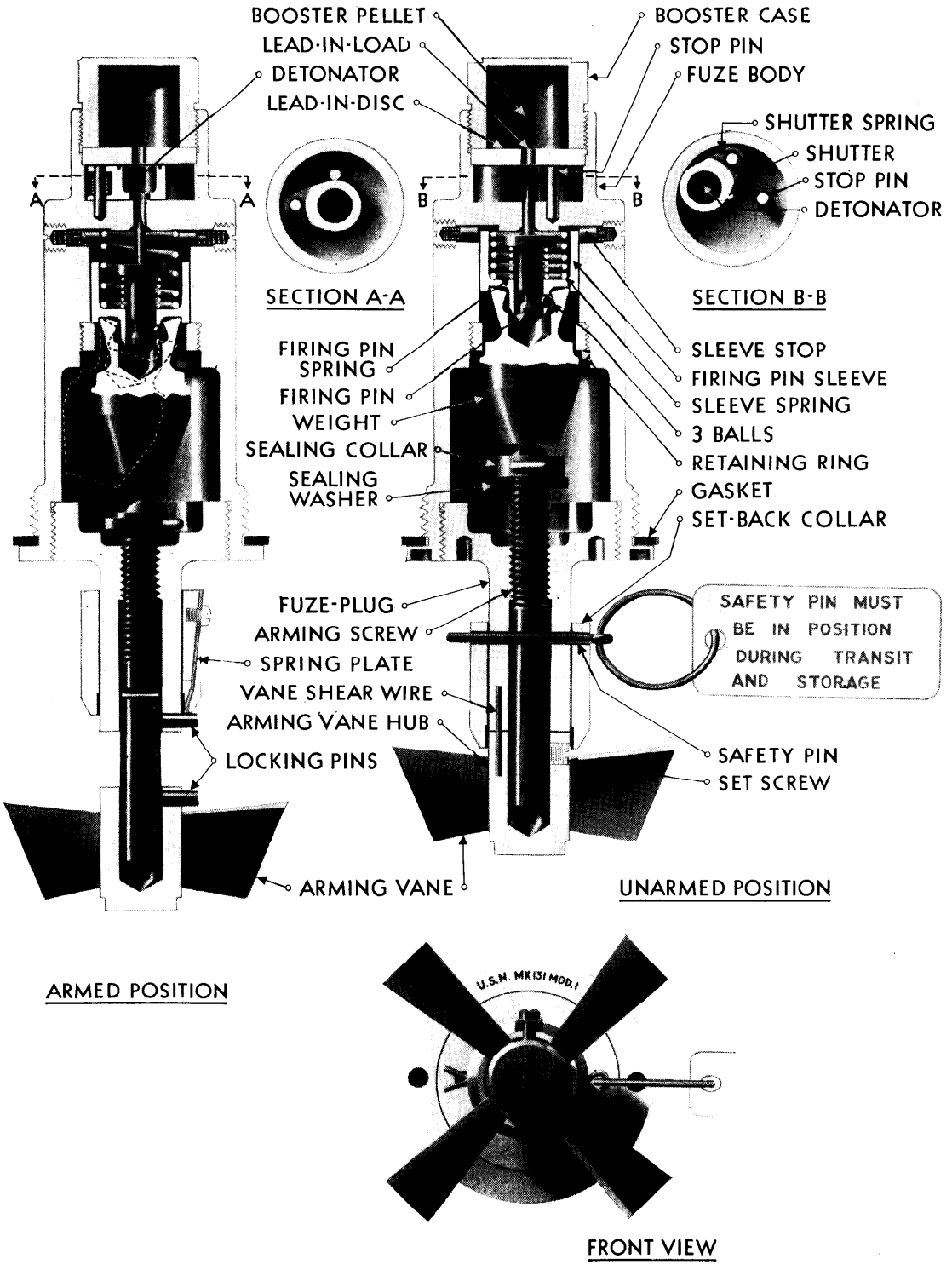


FIG. 14. U. S. N. NOSE FUZE, MARK 131

U. S. N. NOSE FUZE, MARK 131 (AND MODS.)

GENERAL

The Nose Fuze, Mark 131, in general a counterpart of the British Fuze No. 420, except that the collar shear wire is omitted, is illustrated in Figure 14.

NOTE. The Nose Fuze, Mark 131, is identical in appearance to the Fuze, Mark 136, which is used in the projectile charge, except that the nose of Nose Fuze, Mark 131, is painted red. The Nose Fuze, Mark 136, has a collar shear wire and since the set back in rockets is not sufficient to shear this wire, it should never be used in rockets.

Arming the fuze is accomplished after the fuze strikes the water and has sunk to between 10 and 15 feet below the surface. Seven complete revolutions of the arming vanes are required for complete arming, although it will probably be sufficiently armed to fire on side impact after only 4 complete revolutions of the vane.

Detonation of the fuze is accomplished by impact, either direct, oblique, or glancing, on an immersed object after the rocket has sunk beyond the arming distance of between 10 and 15 feet.

Generally, the fuze will not operate on striking and sinking into soft sea bottoms.

OPERATION

The fuzes are issued with the tagged safety pin in place. This pin passes through the arming screw, fuze plug, and set-back collar and should remain in place until after the fuzed rockets have been positioned on the launcher ways, at which time it should be removed. The fuze caps should remain in place on fuzed rockets at all times—until just before firing—to avoid damage to fuzes by handling or by exposure to weather.

Prior to firing from the launcher, the arming vane is prevented from rotating by the set-back collar which engages locking pins in the arming vane hub and the plug. These pins fit in a slot in the set-back collar and positively lock the arming vane until set-back force causes the set-back collar to move backward on the plug. The vane is further secured against rotation by a vane shear wire which fixes the arming vane hub directly to the fuze plug.

When the rocket is fired from the launcher, the set-back collar moves rearward due to its inertia and is retained in this rearward position by a small spring plate which drops behind the fuze plug pin.

NOTE. When operating in temperatures below 50° F., the set-back collar on the *Mark 131, and mods. only* (except Mark 131-1 fuzes from lots 1M, 6M, 7M, 8M, and 9M) may be retracted by hand after the rocket is in place on the launcher, in order to insure arming after water impact. This precaution is necessary, since at low temperatures the set-back is less than at normal or high temperatures. Retraction of the collar by hand under other conditions is not desirable, because this removes one safety feature. The vane shear wire

remains, it is true, but this could be severed by heavy impact of sea water coming over the bow, and the fuze armed by subsequent spray. Under such sea conditions, the set-back collar should not be retracted until just before firing, in cold weather or with sticky collars. If the fuze is not fired, the collar should be replaced.

After the set-back collar has moved rearward, the arming vane is restricted against rotation, during air flight, by the vane shear wire. Upon striking the water, the torque imposed on the vane by the water action shears the vane shear wire, allowing the vane to rotate as the charge sinks. As the vane rotates, the arming screw moves forward, allowing the weight, together with the associated firing pin, firing pin locking balls, firing pin spring and firing pin sleeve, to also move forward under the influence of the compressed sleeve spring. This action places the weight in its armed position, free to oscillate about its base, and allows the detonator shutter to spring into an armed position in alignment with the firing pin. As the firing pin sleeve moves forward, the 4 stops are released and moved inward by their springs. These detents prevent the firing pin from being forced against the detonator by rotation of the arming vane and screw in the reverse direction when unarming an inadvertently armed fuze by hand in an effort to render it safe to handle.

With the fuze in the armed condition described above, any blow which will cause the weight to oscillate about its base will permit the release of the firing pin from the locking balls and sleeve. The firing pin spring then forces the firing pin into the detonator. The detonator initiates the lead-in which fires the tetryl booster pellet in the base of the fuze, which in turn detonates the auxiliary booster and the main filler. The detonation of one rocket will probably cause adjacent "armed" rockets to fire due to the countermining action accelerating the rockets laterally sufficiently to cause oscillation of their weights.

SAFETY FEATURES

The safety features of the fuze, when in the unarmed condition, may be summarized as follows:

(a) The detonator is held out of alignment with the firing pin point and in alignment with a vent hole leading to the interior of the fuze body. Firing of the detonator while in this position by any means, accidentally or otherwise, will permit the explosive force to be transmitted into the interior of the fuze body rather than to the lead-in and subsequently to the booster pellet.

(b) The arming screw holds the weight within a retaining ring of the fuze body in such manner as to prevent oscillation of the weight.

(c) The arming vane is held against rotation by the set-back collar, by the vane shear wire, and by the tagged safety pin—all of which must be displaced or ruptured before the arming vane can turn.

Remember that the fuze is in a very dangerous condition after the arming vane has been unscrewed 2 or 3 revolutions, for any reason.

HANDLING

The fuze is very dangerous to handle if it is armed, because of its extreme sensitivity. To make armed or partially armed fuzes safe for handling, carefully screw the arming vane backward counter clockwise looking at the nose of the fuze into the fuze as far as it will go without forcing. This will leave a space of about 1/8 inch between the plug and the arming vane hub. The vane should then be secured to the hub with adhesive tape to prevent further turning. **It should not be forced at any time.** Mechanical stops prevent pushing the firing pin into the detonator during this operation which accounts for the 1/8 inch space referred to above. **Fuzes so treated are safe, but should be handled carefully.**

SPECIAL PRECAUTIONS

No attempt should be made to remove armed or partially armed fuzes from rockets under any circumstances. The rocket and the fuze should be disposed of together.

In installing or removing this fuze in or from a rocket, do not grasp the fuze by the arming vane or use a pipe wrench or any other tool on the plug, set-back collar, or arming vane. If this precaution is not followed, the plug may be unscrewed or the arming vane turned, thereby arming the fuze. Only the special spanner wrench which has been placed on the ship's launcher allowance list (spare parts) should be used for installing or removing the fuze. This wrench fits the outer pair of holes in the fuze body, and not the holes in the fuze plug. There is on record a serious accident caused by the use of improper tools.

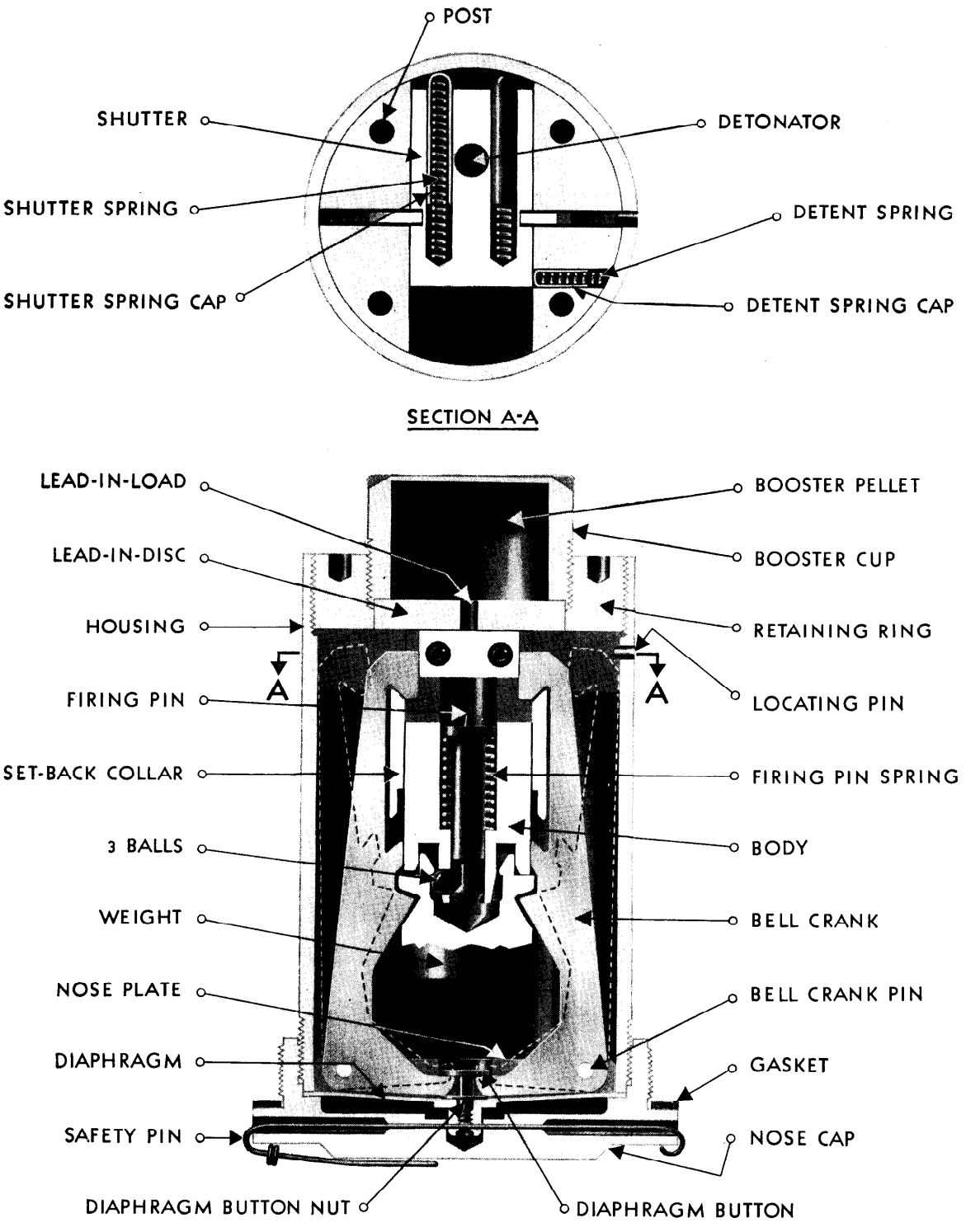


FIG. 15. U. S. N. NOSE FUZE, MARK 135 AND MARK 135, MOD. 1
(H. I. R. FUZE)

U. S. N. NOSE FUZE, MARK 135 (AND MODS.)

GENERAL

The Nose Fuze, Mark 135, is illustrated in figure 15. This fuze was formerly designated "H. I. R." fuze. The fuze is of the hydrostatic arming, impact firing, rocket type.

OPERATION

Arming the fuze is accomplished by pressure of water entering the cavity in the nose of the fuze through two $\frac{1}{16}$-inch holes from which a safety pin has been previously withdrawn. The water pressure builds up against a prestressed phosphor bronze diaphragm. At a certain value of pressure, the diaphragm "pops," behaving like the bottom of an oil can and operates two bell cranks, releasing the detonator shutter and freeing the weight, thus arming the fuze. Upon impact or jarring, the weight is displaced, freeing the firing pin locking balls. The firing pin spring then forces the firing pin point into the lead azide detonator. The detonator initiates the lead-in which fires the tetryl booster pellet which in turn detonates the auxiliary booster and the main filler.

The fuze normally arms under a static pressure equal to approximately 30 feet of water. At the high velocity with which the rocket strikes the water when actually fired, a dynamic pressure is built up on the head immediately after the impact, causing the fuze to arm at a depth of 15 to 20 feet. This effect would not occur on a rocket merely dropped overboard or on one which fell considerably short of the normal operating range. In these cases, the velocity in the water would not be sufficient to cause arming before a 30-ft. depth had been reached.

After the fuze is armed, it will fire if the weight is jarred off, releasing 3 steel balls which hold the firing pin. A sudden deceleration, for example when the rocket strikes head-on, pulls the weight forward, first forcing the balls inward against the force of the firing pin spring and then releasing them. A glancing hit causes the weight to roll about a point on the edge where it is supported against the body and releases the balls. The sensitivity to forward and sidewise impacts is about equal, corresponding to about a 2-inch drop in air on the end of a wood post. The fuze will fire on an under-water surface inclined at as much as 75° from normal (head-on). Thus a hit within less than a foot of the extreme outline of a submarine hull is sufficient to actuate the armed fuze.

SAFETY FEATURES

Safety against dropping or jolts is guaranteed by the fact that the bell cranks hold the weight positively in place until they have been forced out by the diaphragm. Their symmetry is such that sidewise blows tend to move one bell crank out and move the other in. The interlocking button on the diaphragm prevents their moving independently. Similarly, effects of shaking are cancelled out by the opposing action of the bell cranks. In shipping and handling, positive safety is provided by a safety pin which passes through a hole in the nose cap and locks the diaphragm in the safe position. If this wire is pulled out just before the rocket is fired, it serves also to clean out the ports through which water enters the nose cap.

Since the diaphragm is fairly heavy and completely supported in the collapsed position, the fuze will remain operative at depths in excess of 600 feet. The unit is sealed against penetration of water by the gasket action of the edge of the diaphragm clamped between the nose cap and the body, supplemented by a coat of "crater compound". This seal also prevents penetration of moisture to the moving parts in storage.

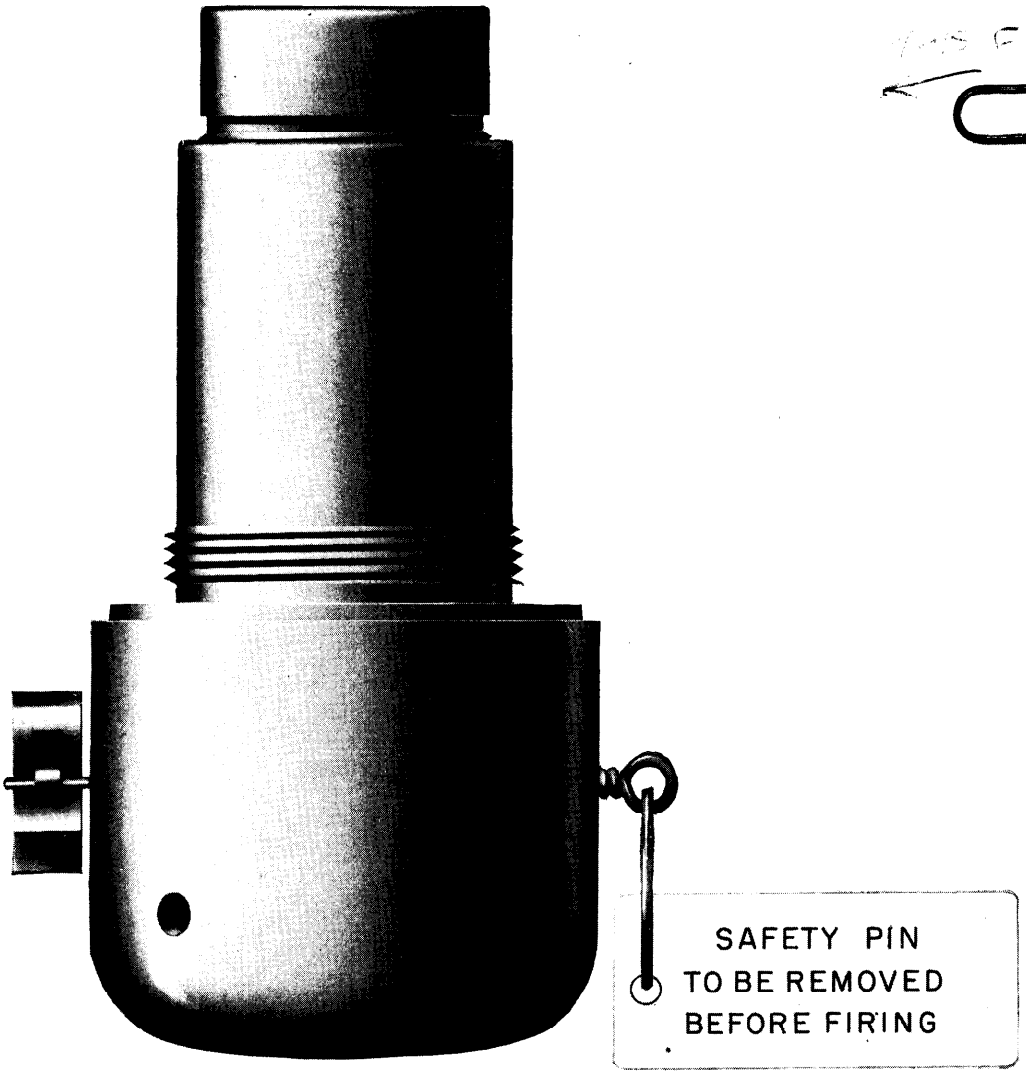


FIG. 16. U. S. N. NOSE FUZE, MARK 140

GENERAL

The Nose Fuze, Mark 140, is a hydrostatic arming, impact-firing fuze.

Arming occurs under a static pressure of approximately 30 feet of water; however, at the high velocity with which the rocket strikes the water, dynamic pressure is built up on the head so that the fuze arms at depths of from 8 to 15 feet.

The fuze will function on impact with a solid object such as a submarine deck or a wooden deck grating.

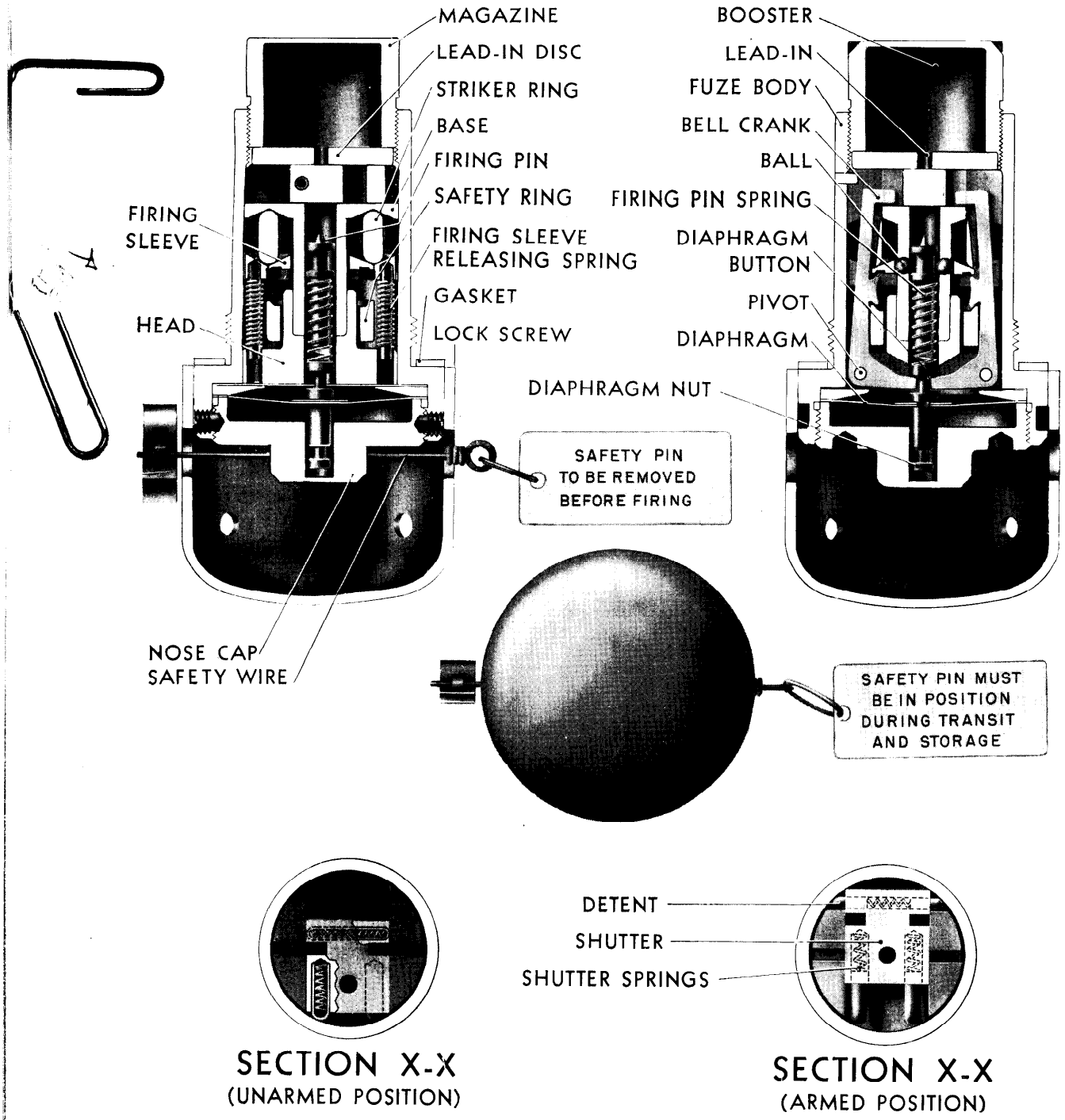


FIG. 17. U. S. N. NOSE FUZE, MARK 140

U. S. N. NOSE FUZE, MARK 140

THE MECHANISM

The mechanism is contained in the fuze body. A nose cap with two water intake ports is screwed in the upper end of the body and covered with a fuze protective cup. A phosphor-bronze diaphragm is set in the upper end of the body against a diaphragm seat. This diaphragm is prestressed and so clamped at the rim that a static pressure of from 12 to 15 pounds per square inch is required to push it inward. A button, in which two bell cranks are engaged, is secured by a nut in the diaphragm, so that inverting the diaphragm will work against the bell cranks. The nut to which the button is secured is so shaped that it will anchor the diaphragm to the nose cap when a safety wire is inserted through the water intake ports of the nose cap. The bell cranks are affixed by pins to slots in the head in which they can be pivoted. On each bell crank there is a projection from which hooks extend upward and downward. A safety ring is loosely fitted on the hub of the head. The head fits tightly on the fuze base and is secured by a press fit.

The fuze base houses the firing pin, firing pin spring, and locking balls. The striker ring and the firing sleeve which maintains the locking balls in place are set around the base. The detonator shutter under spring pressure is fitted in a groove in the fuze base. A lead-in disc is housed between the shutter and the booster. A booster magazine encloses the fuze cavity.

EXPLOSIVE COMPONENTS

The explosive components consist of:

(1) Detonator—Housed in shutter.
(2) Booster lead-in—Housed in disc.
(3) Booster—Approximately 30 grams (1.1) ounce tetryl—Housed in booster cap.

OPERATION

ARMING. After the fuze has been assembled in the nose of the rocket, the safety wire is removed. When the rocket enters the water, the pressure of the water which enters the intake ports of the nose cap and the dynamic pressure built up by the motion of the rocket through the water act on the diaphragm tending to push it inward. When the rocket has reached a depth of from 8 to 15 feet the diaphragm "pops" or is inverted, behaving like the bottom of an oil can. This diaphragm action moves the two bell cranks out of engagement with the shutter and the firing sleeve, thereby arming the fuze. The shutter operating under spring pressure slides to a position where the detonator is aligned with the firing pin and booster lead-in where it is locked by spring detents. The firing sleeve is also free and can now be dislodged by impact with a solid object.

At the time the rocket is fired, the set-back force and air pressure acting on the diaphragm tend to arm the fuze prematurely. However, the freely moving safety ring is held in engagement with the hooks on the bell cranks by the set-back force to prevent such premature arming.

When water impact occurs, premature arming is also prevented by the momentary engagement of grooves in the firing sleeve with the hooks on the bell cranks.

FIRING: The fuze functions upon impact with a solid object. It is designed so that it is not likely to function on impact with soft objects such as muddy bottoms. It will function however on impact with wood gratings on the decks of submarines. When the impact occurs, inertia forces the firing sleeve forward, thereby releasing the locking balls. The balls are ejected by the force of the firing pin which is under pressure of its compressed spring. The firing pin, now free, is moved forward under the force of its compressed spring, strikes the detonator and sets off the explosive train.

A glancing blow causes the loosely fitting striker ring to move sidewise camming the firing sleeve forward, releasing the locking balls and thus permitting the fuze to function.

The sideways sensitivity is approximately one-fourth of the nose sensitivity.

SAFETY FEATURES

DETONATOR SAFETY: This fuze is detonator safe. In the unarmed position, the detonator is out of alignment with the booster charges. Should the detonator function prematurely, the force of the detonation would be dissipated through an opening in the body away from the explosive components.

INSTALLED IN ROCKET: When the fuze is installed in the rocket, the fuze is in the unarmed position. Arming will not occur until pressure "pops" the diaphragm. Pressure of 12 to 15 pounds per square inch is required to operate the diaphragm. After the fuze has been armed, it will not function until the locking balls are freed by impact of the fuze with some solid object.

DURING SHIPPING AND STOWAGE: Additional safety is provided during shipping and stowage by a safety wire inserted through the water intake ports. The safety wire positively locks the diaphragm button to the nose cap, thereby preventing the diaphragm from moving inward and accidentally arming the fuze. The removal of the wire serves to clean the water intake ports.

DROP SAFETY: The fuze has a large dome-shaped steel cup fitted over the exposed end with water entry and spanner wrench holes around its sides. The sole purpose of this fuze protective cup is to prevent functioning of the fuze if a round is accidentally dropped on its nose.

ARMED FUZES

From an examination of the exterior of the fuze, it is impossible to tell whether or not the fuze is armed. However, when this fuze is armed, it is impossible to reinsert the safety wire through the water intake ports in the nose cap. If the fuze is unarmed, the safety wire can be reinserted all the way through the nose cap.

INSTALLING IN ROCKET

INSTRUCTIONS:

(1) Remove the shipping plug from the rocket and inspect the fuze seat liner. Clean if necessary.

(2) Remove the fuze from its container and examine it for defects, particularly as to the gasket. Check the freedom of movement of the safety ring. This is accomplished by turning the fuze alternately nose-down and nose up. The ring should be heard to "click" with each movement. The last click should be heard when the fuze is turned to the nose-up position. In this position the ring engages the hooks on the bell cranks.

(3) Screw the fuze securely in the nose of the rocket using a spanner wrench in the openings provided. The spanner wrench fits the holes in the side of the fuze protective cup. Insure that the gasket is properly in position so that the connection of the fuze with the rocket will be watertight. Seepage of water past the gasket may result in the malfunctioning of the fuze. Before inserting the fuze the threads should be given a light coat of petrolatum or any available mineral grease. Also, the safety wire should be coated with a light coat of grease in order to keep moisture from entering into the fuze.

(4) Remove the safety wire from the water intake ports in the nose of the fuze prior to firing the charge.

(5) Do not remove the fuze protective cup from the fuze. This cup is a part of the Mark 140 fuze and should not be confused with the fuze cap used to protect fuzes and which is a part of the projectile body.

POINTS TO CHECK:

The following points should be checked during the installation of the fuze in the rocket:

(1) That the fuze seat liner into which the fuze is to be screwed is clean and free of foreign substances.

(2) That the two 2".0 length auxiliary boosters are in place in the rocket.

(3) That the safety ring moves freely.

(4) That the fuze gasket is properly in position.

(5) That the fuze is securely seated in the rocket.

(6) That the safety wire has been removed.

ASSEMBLY SHEET
7".2 AND 2".5 ROCKET AMMUNITION
FOR SHIPBOARD USE

COMPLETE ROUND MARK No.	USE OF ROUND	NOMINAL ROUND WT. (LBS.)	ROCKET BODY COMPONENTS					
			ROCKET BODY				LINER	FILLER
			Size	Mark	Mod.	Dwg. No.	Dwg. No.	Type
1	Service	60	7".2	1		Lane Wells	SK99440	TNT
101	Target	60	7".2	1		Lane Wells	SK99440	Plaster
201	Drill	60	7".2	1		Lane Wells	SK99440	Plaster
2	Service	60	7".2	3		330904	SK99440	TNT
102	Target	60	7".2	3		330904	SK99440	Plaster
202	Drill	60	7".2	3		330904	SK99440	Plaster
4	Service	65	7".2	4	All (Note 1)	329138	SK99440	TNT
6	Service	62. 5	7".2	4	All (Note 1)	329138	328708 329292	TNT
106	Target	62. 5	7".2	4	All (Note 1)	329138	(Note 3)	Plaster
206	Drill	62. 5	7".2	4	All (Note 1)	329138	(Note 3)	Plaster
7	Service	61. 4	7".2	5		330906	Integral	TPX
8	Service	62. 4	7".2	5		330906	Integral	TPX
9	Service	57. 5	7".2	5		330906	Integral	TNT
109	Target	57. 5	7".2	5		330906	Integral	Plaster
209	Drill	57. 5	7".2	5		330906	Integral	Plaster
10	Service	58. 5	7".2	5		330906	Integral	TNT
15	Service	63. 5	7".2	4	All	329138	328708 329292	TNT
	Target	8. 8	2".5	1	All	329402	None	Solid

NOTE. (1) Mark 4 all mod. bodies do not include Mark 4a bodies.
(2) Mark 3 all mod. motors do not include Mark 3 mod. 1 motors.
(3) Mark 4 plaster loaded bodies may or may not include fuze seat liner.

BOOSTER		ROCKET MOTOR COMPONENTS						BALLISTIC DATA	
		ROCKET MOTOR				GRAIN	FUZE	Curve No.	Column No.
Mark	Needed	Size	Mark	Mod.	Dwg. No.	Mark	Mark	Page 54	Page 58
1	1	2".25	1		330905	1	135	1	1
	None	2".25	1		330905	1	None	1	1
	None	2".25	1		330905	None	None		
1	1	2".25	3	1	329932	1	135	1	1
	None	2".25	3	1	329932	1	None	1	1
	None	2".25	3	1	329932	None	None		
1	1	2".25	3	All (Note 2)	329932	2	135	2	2
1	1	2".25	3	All (Note 2)	329932	3	131	3	3
	None	2".25	3	All (Note 2)	329932	3	None	3	3
	None	2".25	3	All (Note 2)	329932	None	None		
1	1	2".25	3	All (Note 2)	329932	3	131	4	4
2	2	2".25	3	All (Note 2)	329932	3	140	3	3
1	1	2".25	3	All (Note 2)	329932	10	131	5	5
	None	2".25	3	All (Note 2)	329932	10	None	5	5
	None	2".25	3	All (Note 2)	329932	None	None		
2	2	2".25	3	All (Note 2)	329932	10	140	6	6
2	2	2".25	3	All (Note 2)	329932	3	140	7	7
	None	1".25	1		329403	4	None	8	8

SERVICING

USE OF LUBRICANTS: Fuze surfaces that might become rusted or corroded should be given a light coat of petrolatum or mineral grease. Before installing in the projectile fuze threads should be given a light coat of grease.

DISASSEMBLY: No disassembly of this fuze is authorized.

REPORTS OF MALFUNCTIONINGS: Reports of malfunctionings or any difficulties encountered with this fuze should be reported to the Bureau of Ordnance. The report should contain the lot number, a complete detailed history and all pertinent information concerning the fuze.

PACKING AND MARKING

PACKING: One fuze is packed in a sealed cylindrical metal container. Twenty-four fuzes in containers are packed in a wooden shipping box.

MARKING: The fuze is marked with mark, mod., and lot number, the date of manufacture and the loading activity. The container and shipping box are marked with mark number, lot number, number of fuzes contained within, name of manufacturer, year of manufacture, order number, and the inspector's initials.

Chapter 3

OPERATION AND MAINTENANCE 7".2 ROCKET LAUNCHER, MARK 20

STOWAGE AND ASSEMBLY

The 7".2 Rockets are issued to ships in three units: Bodies (with auxiliary boosters installed), rocket motors, and fuzes. They are to be stowed in magazines with bodies and motors assembled, uncrated and unfuzed, and may be stacked on top of each other not to exceed ten high. Separators should be used between the motors to keep the shrouds slightly apart. The above is in conformity with existing stowage facilities.

Fuzes are issued in boxes of 24 each. Except in ready service stowage, fuzes are not to be assembled in the ammunition or stowed in magazines with the ammunition. In ships where it is impracticable to provide separate magazine stowage for the fuzes, it is acceptable to provide stowage in watertight lockers, topside.

In assembling the motor to the body care must be exercised to avoid cross threading. It will be necessary to employ strap wrenches in order to drive the motor threads fully home into the body threads. The auxiliary booster, tubular cardboard spacer, shipping plug, and fuze cap are installed in the body when shipped. Prior to inserting the nose fuze, remove the fuze cap, shipping plug, and tubular cardboard spacer from the nose of the body and make certain that the correct number and correct mark of auxiliary boosters are in place (see page 31), and that the fuze hole threads are undamaged. Before inserting the fuze the threads should be given a light coat of grease petrolatum or any available mineral grease, such as water pump grease, bearing grease, or cup grease. After the fuze has been inserted in the nose of the body and screwed down it should be set up sufficiently tight on its gasket to insure a watertight seal The special wrench provided must be used for this purpose. Attention is invited to O. P. 1017

and BuOrd Circular Letter *No. A50–43* covering this subject. When the Mark 131 fuze is used the fuze cap should be put on again after the fuze has been installed, and should be kept in place until just before firing. Nose plugs and fuze caps should be turned in to the next issuing depot.

Rockets should not be fuzed until just before they are put into the ready-service boxes. Excessive ready box temperatures should be avoided by any means at hand. Fuze caps on rockets in ready service boxes should be removed at frequent intervals for inspection of the fuze and to remove any moisture which may have accumulated under the cover. Fuzes should be covered with a light coat of petrolatum or mineral grease on the exposed surfaces to avoid rust or corrosion. Before screwing the fuze in the body the threads should be covered with a light coat of grease.

LOADING AND FIRING

Exact loading and firing procedure is covered in publications under the cognizance of Headquarters, Commander in Chief, United States Fleet.

In general, 4 to 6 loaders plus a gun captain will be used. To prepare a launcher for firing, two loaders lift the rails or ways and swing the crutch up in place, locking it with the latches provided. **Before loading, the gun captain of the launcher crew must have the safety plug in his possession.** Two loaders are stationed at the ready boxes. They remove the rockets from the ready boxes and pass them to 2 other loaders who are stationed at the launchers. The two loaders, last mentioned, load the rockets in the ways of the launchers. In loading the rockets, one hand is placed between the fins of the tail ring and the other hand grasps the nose of the rocket. The rocket is then laid in the way about 6 inches above its normal position and pushed down into the contacts. Care must be taken that the motor shrouds seat properly and that the vanes do not interfere with the rear contact. If the rocket should accidentally be dropped the two motor shrouds may short together and make a misfire possible.

When all the ways are loaded, the retainers are swung up and pinned in place, and the crew takes firing stations. These positions are chosen in such a way that all entrances to the foredeck are guarded and the guards protected out of line of blast of the launchers. The gun captain takes station at the safety receptacle and inserts the safety plug at a command from the bridge. To prepare for firing, the conning officer throws the switch marked "POWER" on the Control Panel, Mark 2, Mod. 2, the red safety indicator lights up when the safety plug is inserted in the receptacle, and the green indicator when the power switch is turned "ON." On the Control Panel, Mark 3, Mod. 2, the red indicator lights when the safety plug is in place *and* the power switched "ON." The power switch should be kept at "OFF" except to

check for readiness or to fire. To fire both launchers, the switches marked "port" and "starboard" are thrown to the "ON" position. When the proper range is reached, the conning officer presses the firing button at the next instant that the ship is on even keel. The firing button should be kept depressed until all the rockets have gone; unless the battery is in good condition, there may be a relatively large interval between the firing of the halves of a salvo. **As soon as the salvo is gone, the safety plug must be removed and the power switch opened.** The launchers can then be reloaded.

The ready boxes are replenished from storage as soon as possible, in any time available between salvos. It should be noted that certain rockets have safety shorting wires shorting the connection in the motor. These wires are to be clipped off close to the terminals before the rockets are placed in the ready boxes. With ammunition of present and future issue, a safety clip will be used instead of wires. This clip must be removed after the ammunition has been loaded on the ways.

SAFETY PRECAUTIONS

It should be emphasized that all rocket ammunition must be treated with care. Rocket motors should not be needlessly exposed to the direct rays of the sun or to any temperature in excess of that printed on the motor tube, as such exposure may result in the rocket motor blowing up on the launcher when the rocket is fired. Under no circumstances are rockets to be fired when they have been subjected to a temperature in excess of the safe firing limitations until they have been allowed to return to a temperature within the safe limits. Ammunition which has been exposed to excessive temperatures (temperatures in excess of the upper limit or less than the lower limit printed on the tube) should be maintained within the safe firing limits for at least 6 hours before use. Every effort should be made to maintain ammunition in ready service within the safe temperature firing limits at all times.

Since, at present, the propellant is sealed into the motor tube by means of closure discs and asphalt paint, it is not possible to conduct visual or surveillance tests of any kind. The development of surveillance tests for ballistite is at present being undertaken and when a proper procedure has been worked out it will be made the subject of a publication. Under no circumstance is the propellant to be removed from the motor of any rocket. Any rocket motors on hand in which the closure disc or discs have become loosened must not be fired. They must be disposed of either by turning in to an ammunition depot or, if this is not practicable, by dumping into deep water.

It is obvious that it is dangerous to stay directly in front of a launcher while it is loaded or being loaded. **It is more dangerous, however, to stay directly behind the launcher under the same**

circumstances. The blast that is emitted from the nozzle (rear) end is intensely hot and the gases travel at a rate of between six and seven thousand feet per second. Small slivers of burning powder may be blown out of the nozzle, and these are very difficult to extinguish. **Extreme caution must be taken to make sure that no one is directly in front of or directly to the rear of a loaded launcher or one that is being loaded.** Loading should always be done in such a manner that the loader and any member of the crew are well to one side of the path that the projectile or the blast would take in case a rocket should be fired either accidentally or intentionally. Carelessness in this respect has resulted in fatal casualties.

All rocket launchers are equipped with safety plugs and receptacles. These receptacles are installed on an external bulkhead, in sight of the launcher and at a safe distance therefrom, and are part of the electrical firing circuit. The safety plug is at all times to be in the possession or under the control of a particular person, whose responsibility it shall be to see that the safety plug is not installed in the receptacle until the launcher is in all other respects ready to be fired, and is removed immediately after firing. The safety plug shall be removed by the person charged with its care before a loaded or partially loaded launcher with the plug in place is approached by any other person. All personnel must be instructed not to load any launcher or to approach any loaded launcher until it has been made absolutely certain that the safety plug is in the possession of the crew member charged with its care. Fatal casualties have resulted from failure to observe the necessary precautions.

Tests of firing circuits of launchers, Marks 20 and 22, when they involve personnel being in the immediate vicinity of the launchers shall not be conducted until all rockets have been removed from the launchers and the immediate vicinity of the launchers or stored in the ready-service box. Subsequent to the completion of such tests, the rockets may be reloaded on the launchers only at the order of an individual at the launchers who has been made responsible for the loading operation and is in actual physical possession of the safety plug.

The safety precaution in the preceding paragraph shall be posted conspicuously and personnel concerned frequently and thoroughly instructed and drilled in it.

The projectiles should be kept free from rust, and the unpainted surfaces protected with grease. The condition of the insulation should be periodically inspected, but no electrical tests should be made because of the danger of setting off the electric primer. It is important that it be stored and handled in such a way as to avoid bending of the tail rings, since distortion of these rings may cause misfires due to lack of contact in the launcher, and will also have a serious effect on the underwater trajectory.

It may sometimes happen that a misfire occurs and one or more rockets in a salvo will remain on the ways. No one is to be allowed on the forecastle for at least 10 minutes after such a misfire. **Before approaching the launcher, which should be done from one side if possible, make sure that the safety plug has been removed from the safety receptacle.** If inspection then reveals that the closure disc in the nozzle has not been blown out, it is probable that the igniter

did not fire because of electrical difficulties. The contacts should be checked and connections inspected. If the rockets have been subjected to sea spray while in the launcher, it may be that shorting has been caused by salt bridges which have formed on the contacts. These can easily be removed by washing down with water. The stream of water must not be directed at the nozzle closure disc, as it may loosen the disc.

Note that if a misfire is due to a short circuit, two rockets may remain on the ways, since the contacts are connected in parallel pairs. For example, if all the even- or odd-numbered rockets are misfired, examine the delay-relay in the control panel. If any obvious defects are found, they are to be repaired and the firing repeated. In case the same rocket again fails to fire, and inspection reveals no obvious defects, remove the round from the launcher, replace the safety wire in the fuze, and remove the fuze from the projectile. After replacing the shorting wire or shorting clip, unscrew the motor from the rocket body, properly tag it so as to show the character of malfunctioning, the number of days the round had been on the ways, the number of immediately previous successful firings from the same ways, or any other remarks which may aid in determining the cause of misfire. Then turn in the motor to the nearest ammunition depot for trans-shipment to the Naval Mine Depot, Yorktown, Va., for inspection. All the foregoing rules apply to target practice or test firings. In actual combat against the enemy, the time interval may be shortened at the discretion of the commanding officer, **but in such case every precaution shall be taken that personnel remain clear of the area which experience has shown to be dangerous because of burning powder gases.** The misfired rounds shall be dropped overboard, after the fuze safety wire has been replaced. It is not intended to prevent efforts to fire the rocket by repeating the normal firing procedure as the time taken to repeat the firing cycle and possibly clear the launcher of misfire, is small.

Because of the fact that the fuze remains armed once it has been armed, unfired rockets are not to be fished up out of the water. They do not necessarily fire on sand bottom.

Since small pieces of solid propellant may be ejected during firing and remain on the deck precautions should be taken to avoid fire hazards. After firing the launcher, the decks should be thoroughly hosed down and all such powder fragments washed overboard, as they are highly inflammable.

It is of the utmost importance that naked lights, matches, or other flame producing apparatus shall never be allowed in the vicinity where this ammunition is present. The presence of black powder in the igniter makes this ammunition highly susceptible to ignition. Before performing any work which may cause either an abnormally high temperature or an intense local heat in a magazine or storage place where rocket ammunition is kept or in an adjacent compartment, the ammunition must be removed to safe storage. Because of the presence of black powder in the igniters of rocket type ammunition separate storage should be provided where practicable. Storage in magazines should not be made except in accordance with approved plans.

MAINTENANCE

The launcher units should be kept painted and free from rust, dirt and accumulations of salt. The electrical system should be examined at frequent intervals to insure that the batteries, firing panel, contacts, safety plug and receptacle and wiring are in satisfactory condition. **Under no condition should the electrical system be checked when rockets are on the launcher rails or when in an exposed condition in the immediate vicinity of the launcher.** A simple test of the electrical system is outlined below:

(a) With all switches in the **OFF** position measure the voltage at the battery.

(b) With the launcher unloaded place the power switch at **ON** and the **starboard** (or **upper**) switch at **ON**. Insert the safety plug into its receptacle. Measure the voltage between the hot knife edge contact and ground. A reading appreciably less than that obtained under (a) indicates a short circuit or low resistance parts, which should be found and corrected. If both voltage readings (a) and (b) are substantially the same, connect a suitable resistance between the knife edge contact and ground; a convenient resistance consists of a 6-volt 21 cp or 32 cp automobile type lamp, passing about 4 and 6 amperes, respectively. Such a lamp should light up fairly brightly; a quick check with a voltmeter should show at least 3 volts across the lamp. To avoid running the battery down these tests should be of as short duration as possible.

(c) Repeat (b) with power switch at **ON**; and the **port** (or **lower**) switch at **ON**.

(d) All terminal tubes, glands, boxes, fittings, etc., exposed to salt spray should be kept tight, gaskets and packing being used as necessary. Unless this is done water may enter into one of the electric cables, which will act as a hose, providing a channel whereby water may pass into connection boxes, etc., both above and below decks.

(e) Remove the covers of all boxes at frequent intervals. If moisture is present ascertain and remove means of entry. Wash out the box with fresh water and dry.

(f) Do not use ordinary paint on the knife edge contact assembly, particularly on the insulation. If necessary use an approved insulating varnish; in general the application of varnish will not materially improve performance.

(g) Salt bridges may form on exposed parts causing short circuits and misfires. In general, a thorough hosing with fresh, or even sea water, should remove them.

Each ship may carry a spare safety plug and one spare battery. Additional batteries may be obtained from tenders or Navy Yards.

If ice forms on the launchers, including the contacts, it must be completely removed before firing. If loaded, care must be taken to insure that the rockets are not frozen to the ways. Extreme care must be taken that the fuzes are not armed during the de-icing process, particularly when using a hose.

TACTICAL OPERATION

Tactical employment of the launcher, Mark 20, including the several corrections which must be determined and included in the proper firing range, will be found in a publication issued by Headquarters, Commander in Chief, United States Fleet.

Chapter 4

PERFORMANCE DATA OF 7".2 ROCKET LAUNCHER, MARK 20

As has been previously mentioned, the propellant grain burns with an almost constant pressure for several tenths of a second. The value of the pressure depends on temperature, varying from about 800 pounds per square inch at 10° F., and 1,500 pounds per square inch at 70° F., to 2,300 pounds per square inch at 120° F. Since the motor tube is tested to 5,000 pounds per square inch, ample safety factor is provided. The time of burning depends inversely on the temperature, varying from 0.7 seconds to 0.2 seconds.

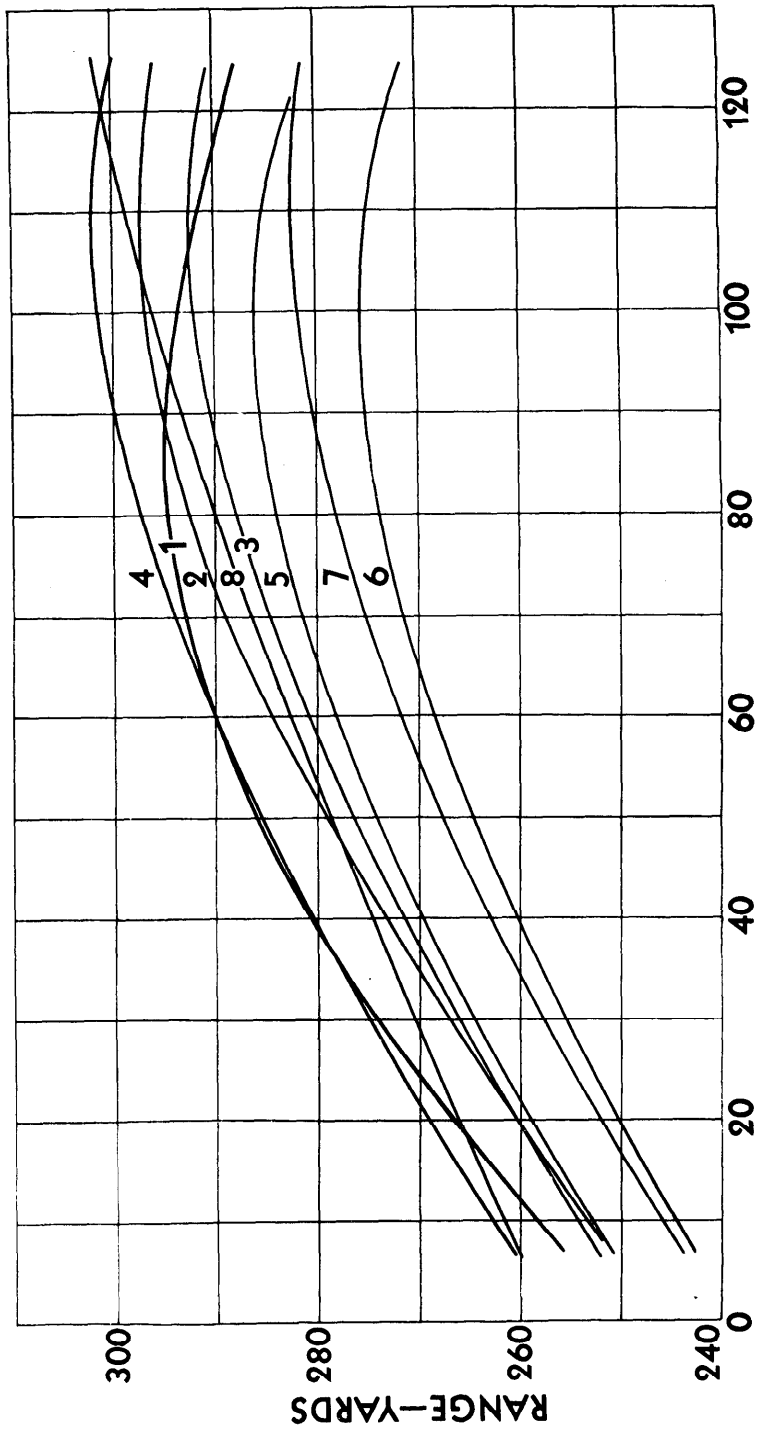


FIG. 18. CURVE OF RANGE VERSUS PROPELLANT TEMPERATURE FOR 7".2 AND 2".5 ROCKETS

A graph, figure 18, shows the relationship between range and propellant temperature. The variation of velocity and range with temperature depends on a number of factors. At low temperature, the effective velocity of the gas escaping from the nozzle is lowered because of the lower burning pressure. Also, more energy must be used to heat the powder mass to the burning temperature, leaving less for propulsion. Further,the acceleration distance is greater at low temperature, resulting in more curvature in this part of the trajectory and hence in shorter range. The combination of these effects results in a decrease in velocity of about 10 percent, in range of about 20 percent, in going from 70° F. to 10° F. At elevated temperatures, decrease in mechanical strength of the powder results in an increased loss of powder in unburned form, practically compensating for effects tending to increase the range. Thus the range is sensibly constant from 70° F. to 120° F. Because of the relatively low velocities, the ranges will only be about 3 percent shorter than those calculated for vacuum.

A range correction for complete round assemblies which differ in weight from the nominal round weight of page 44, may be made by the following rule: The percentage change in range is twice the percentage change in weight, and in the opposite direction, i. e., an increase in weight causes a decrease in range and vice versa.

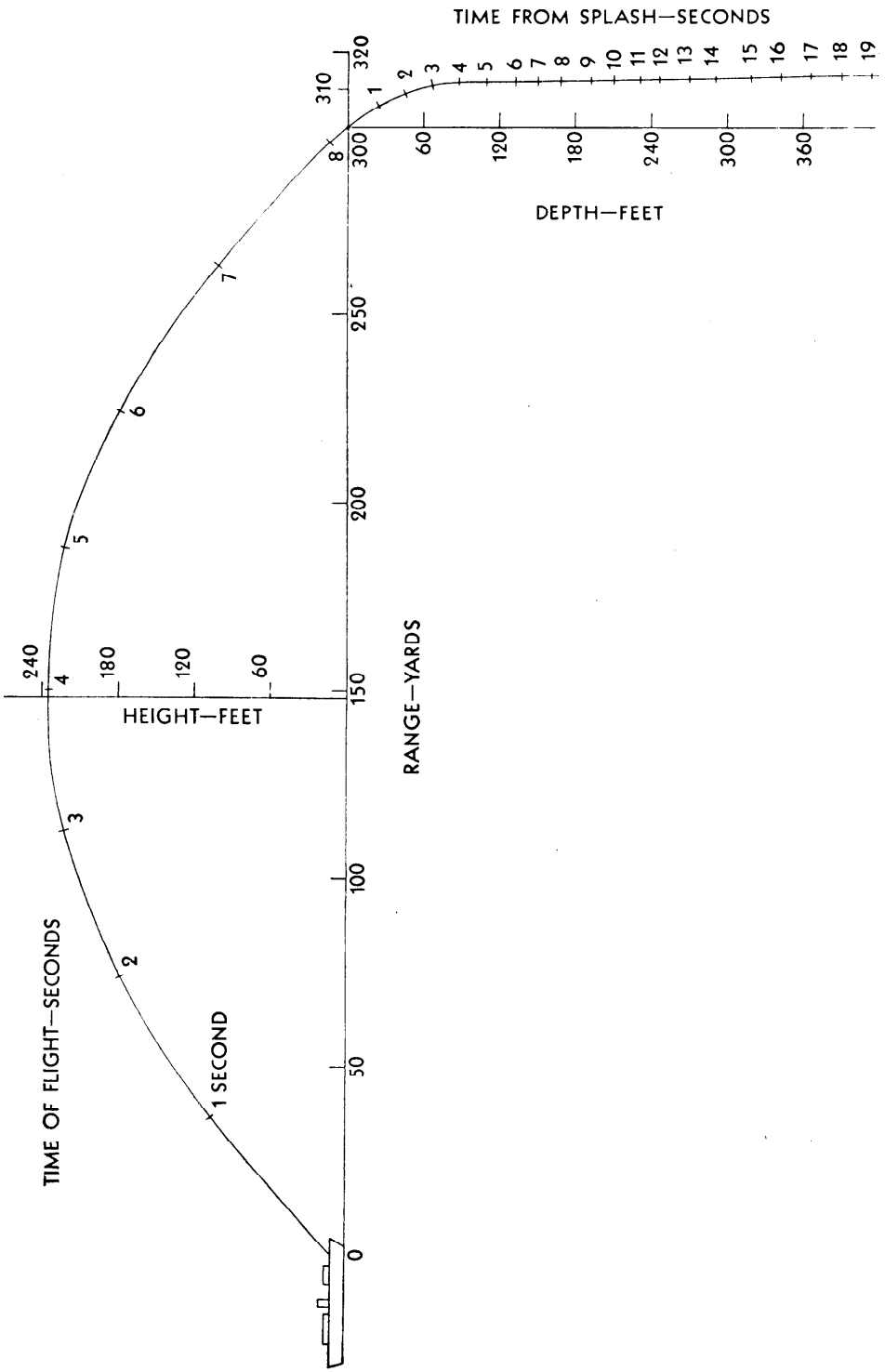


FIG. 19. NOMINAL TRAJECTORY OF 7".2 ROCKET FIRED FROM LAUNCHER, MARK 20 OR MARK 22

Since the point of application of thrust of the rocket motor is behind the center of gravity of the charge, there may be some tendency to veer off course when the acceleration continues beyond the launcher. For this reason, the lateral dispersion of shots from a given way may depend quite markedly on the burning time, and hence on the temperature. For example, at 120° F., about one-fifth of the burning occurs on the ways and the lateral dispersion is approximately 2 yards in 300. At normal temperatures, one-tenth of the burning is on the ways and the dispersion is approximately 4 yards. At 10° F., the fraction is one-thirteenth and the dispersion approximately 12 yards. The dispersion in range, on the other hand, is nearly constant, about 6 yards in 300, since at 49° quadrant angle, the range is not sensitive to the angle of the trajectory at the end of burning.

In cold weather, due to slower burning time of propellant grain, a strong cross wind causes notable deflection errors. For example, at 25° F., a 20 mile per hour cross wind produces a 25 yard deflection into the wind. At 70° F. or higher, the corresponding error is 5 yards or less. The error into the wind is proportional to the cross range component of wind velocity.

It is recognized that pitch affects the range since the ways are in a displaced position and the charges have an upward or downward component depending on the direction of the pitch. However, the amount of this variation in range is not sufficient to make corrections worthwhile. Also the roll of the ship results in an error in train. Thus firing should be done when the ship is on an even keel. Another quantity which has a bearing on the trajectory of the rocket is the forward speed of the boat.

In the first 2 or 3 feet after striking the water, the rocket continues on its former path, but with a large deceleration of the order of 50 to 100 times gravity. In about 30 feet of travel, the rocket is brought to a vertical course and proceeds downward with its terminal velocity of 22 to 25 ft./sec. To reach 100 foot depth takes 12.5 seconds, including 8 seconds flight in air. (See fig. 19.) In order to keep the rocket on course under water, it is given a spin by the vanes on the motor. Near the end of the air trajectory, the rockets make about four revolutions per second and one revolution in 40 feet. Just under the surface, the rate of spin is approximately one turn in 6 feet, probably decreasing to about one in 12 at greater depths.

Until further notice is given, this ammunition must not be used if the propellant temperature is higher than 120° F., or lower than 10° F. At temperatures higher than 120° F., burning of the propellant grain is greatly accelerated with a dangerous increase in pressure. At temperatures lower than 10° F., burning may be incomplete and large unburned pieces of powder may be ejected from the nozzle. Also misfires may result.

	7".2 ASSEMBLIES																					2".5 ASSEMBLIES		
Column Number: (For applicable assemblies see pages 44 and 45)	1			2			3			4			5			6			7			8		
Propellant Temperature (°F.)	10	70	120	10	70	120	10	70	120	10	70	120	10	70	120	10	70	120	10	70	120	10	70	120
Time of burning (sec.)	0.70	0.34	0.24	-----	0.44	0.29	0.59	0.40	0.26	0.59	0.40	0.26	-----	-----	-----	-----	-----	-----	0.59	0.40	0.26	0.29	0.16	0.11
Velocity at end of burning (f. s.)	154	169	168	143	164	167	153	166	170	155	168	173	-----	-----	-----	-----	-----	-----	150	163	167	162	172	178
Range at 49° elevation (yd.)	258	293	289	253	289	296	254	285	291	263	294	301	253	281	283	245	271	273	246	275	282	262	286	301
Time of flight (sec.)	7.5	8.0	7.9	6.6	7.5	7.5	6.8	7.4	7.8	6.9	7.5	7.9	-----	-----	-----	-----	-----	-----	6.7	7.3	7.7	7.3	7.6	7.8
Mean lateral deviation (yd.)	11	4	2	11	6	2	9	6	3	9	6	3	7	3	2	7	3	2	9	6	3	7	3	1
Mean range deviation (yd.)	6	5	2	5	4	3	5	5	7	5	5	7	-----	-----	-----	-----	-----	-----	5	5	7	8	7	6
Vertical component of underwater velocity (f. s.)																								
From 0 to 25 ft. depth	30.6			32.7			32.2			39.3			37.1			37.7			32.7			35.5		
From 25 to 50 ft. depth	15.3			16.3			16.1			15.7			14.9			15.1			16.3			18.7		
From 50 to 100 ft. depth	21.9			23.5			23.1			21.5			20.3			20.6			23.4			27.4		
Below 100 ft. depth	23.1			24.7			24.3			22.4			21.1			21.5			24.7			28.4		
Time from splash (sec.)																								
To 25 ft. depth	0.8			0.8			0.8			0.6			0.7			0.7			0.8			0.7		
To 50 ft. depth	2.5			2.3			2.3			2.2			2.4			2.3			2.3			2.0		
To 100 ft. depth	4.7			4.4			4.5			4.6			4.8			4.7			4.4			3.9		
To 200 ft. depth	9.1			8.5			8.6			9.0			9.5			9.4			8.5			7.4		
To 300 ft. depth	13.4			12.5			12.7			13.5			14.3			14.0			12.5			10.9		
To 400 ft. depth	17.7			16.6			16.8			17.9			19.0			18.7			16.6			14.4		
Forward travel beyond splash (ft.)																								
At 25 ft. depth	20			20			14			14			14			14			14			15		
At 50 ft. depth	24			24			17			17			17			17			17			22		
At 100 ft. depth	26			26			19			19			19			19			19			27		
Below 100 ft. depth	26			26			22			22			22			22			22			27		

note: Range table data for 7".2 assemblies given in OP 1437 supersede the corresponding data given in this table.

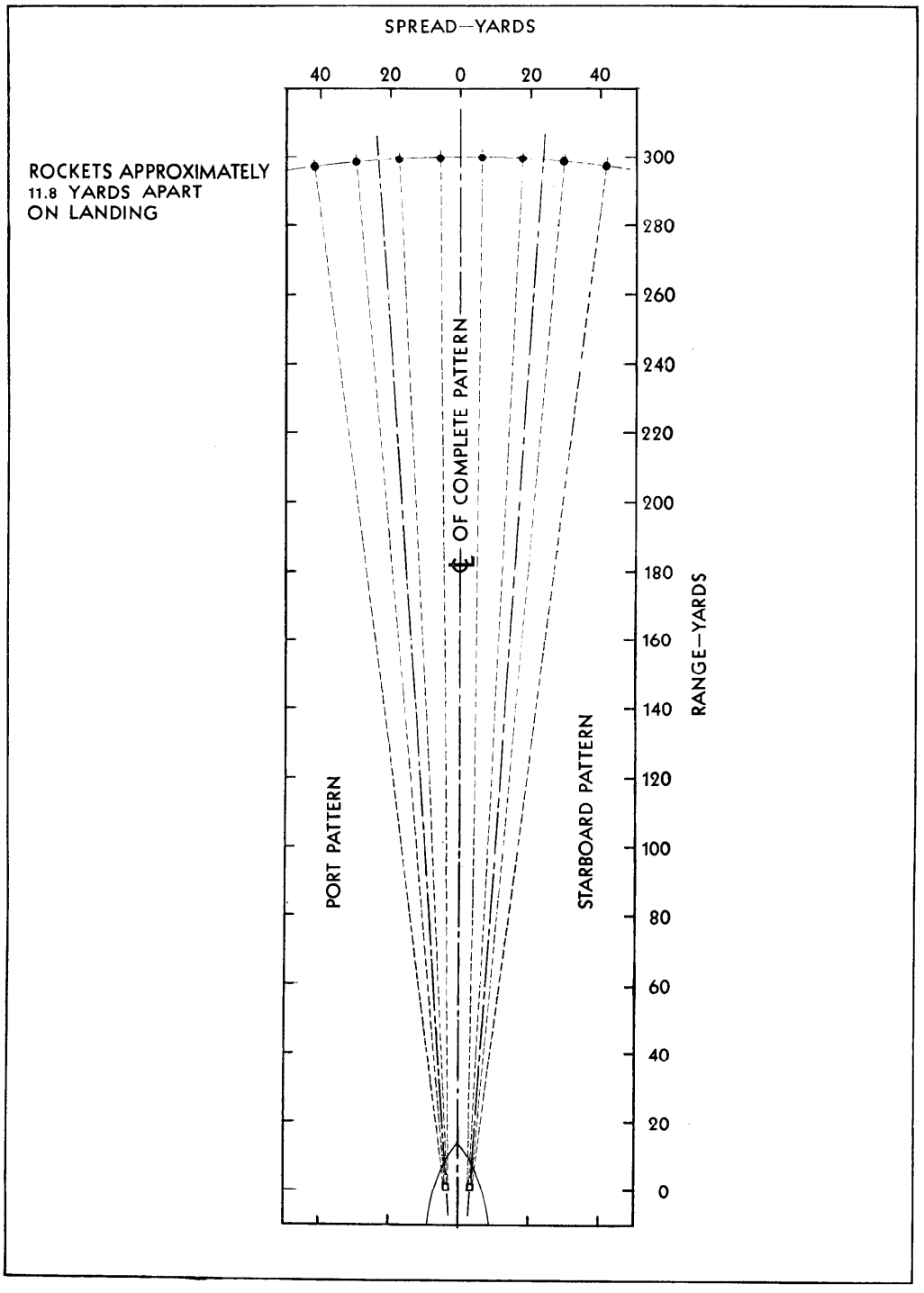


FIG. 20. PATTERN OF FIRE

Chapter 5

COGNIZANCE

The Bureau of Ordnance will supply and retain cognizance over the following items of equipment:

A 7".2 Rocket Launcher, Mark 20.

B Control panel, Mark 2, Mod. 2, or Mark 3 or Mark 3, Mod. 2, or control panel, Mark 7, when furnished.

C Safety plug and receptacle.

D Wiring from launcher to branch box "E" type.

E Ammunition and fuzes.

F Fuze wrenches.

G Batteries.

The Bureau of Ships will supply and retain cognizance over the following items of equipment:

A Foundations for the launchers, including means for securing the launchers thereto.

B All steel sheathing or other material used for deck protection.

C Watertight metallic stowage lockers for ready-service ammunition.

D Magazine stowage for fuze containers.

E Magazine stowage for assembled rockets (unfuzed).

F All wiring and electrical appurtenances (except safety plug and receptacle) for connecting the launchers to the control panel.

G Such communication or signal facilities as may be authorized in order that the firing station may maintain proper contact with personnel at the launchers.

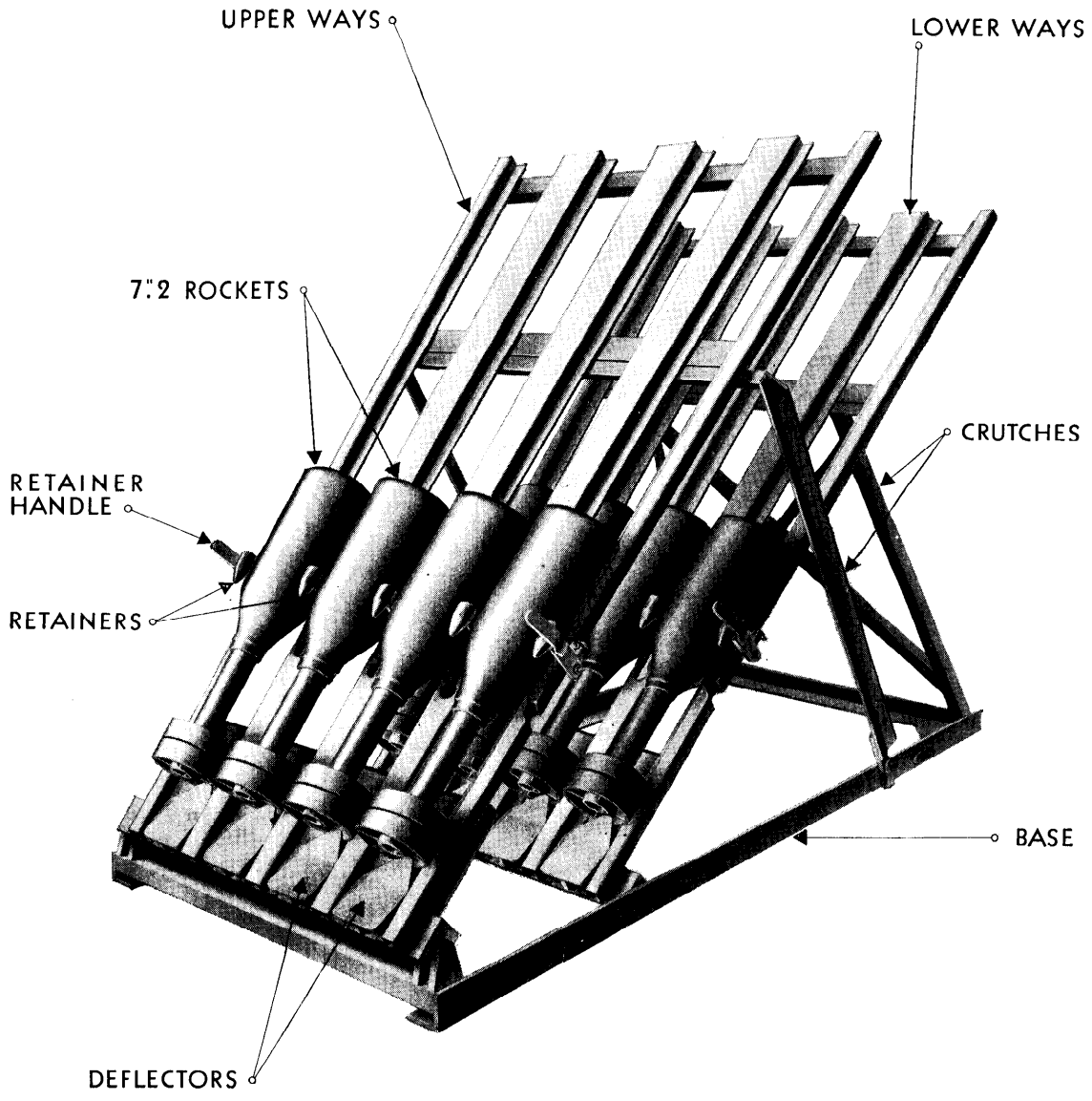


FIG. 21. 7".2 ROCKET LAUNCHER, MARK 22, LOADED, READY FOR FIRING

Chapter 6

7".2 ROCKET LAUNCHER, MARK 22

DEFINITION

The 7".2 Rocket Launcher, Mark 22, is a rocket-launching device similar to the launcher, Mark 20, but consisting of two hinged sets of steel ways instead of one set, as is the case with the Mark 20.

This launcher was formerly known as the Projector, Mark 22, and many name plates are so marked.

The designation Control Panel was changed to Firing Panel subsequent to the preparation of this ordnance pamphlet.

USE

The launcher, Mark 22, is used exactly the same as the Mark 20. Each launcher, Mark 22, fires 8 rockets in a salvo.

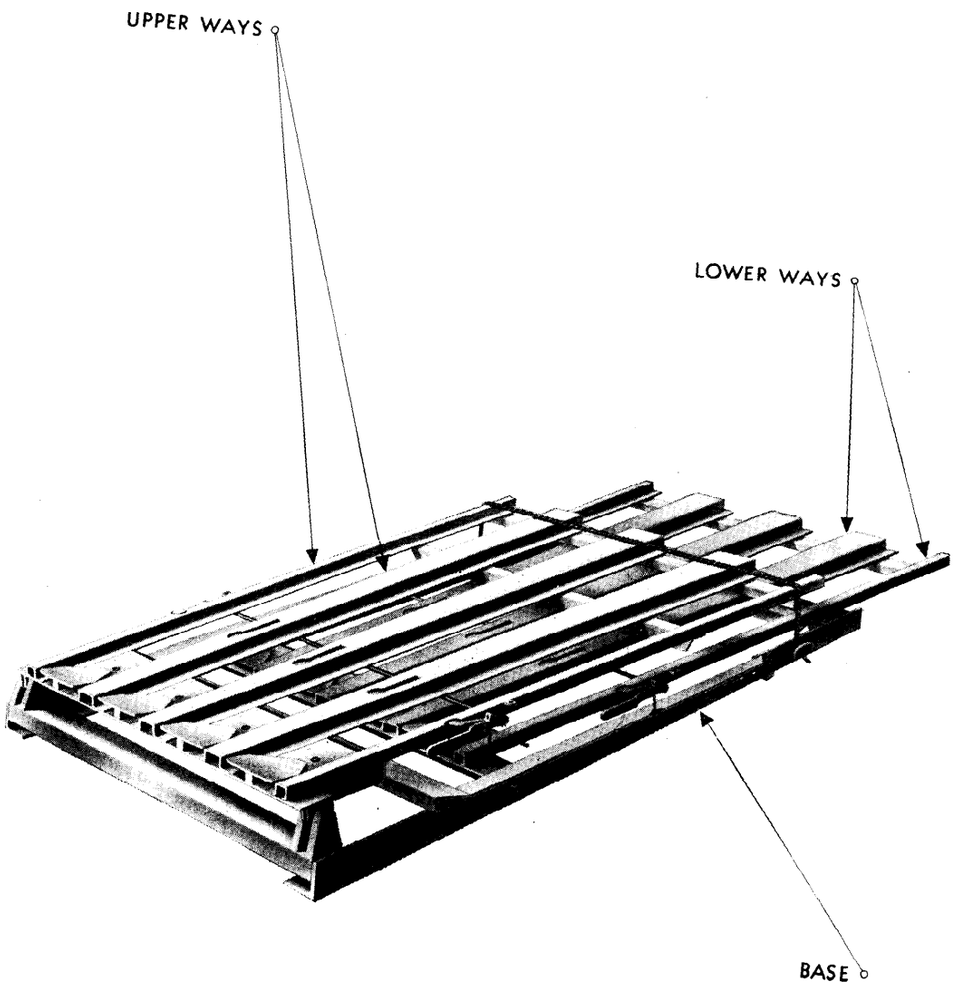


FIG. 22. 7".2 ROCKET LAUNCHER, MARK 22, IN STOWED POSITION

7".2 ROCKET LAUNCHER, MARK 22

The launcher consists of 2 sets of steel ways. Each set of ways is hinged to the base frame and is independently supported in the raised position by its own crutch. The ways themselves consist of sections of steel plate bent up to make rails in which the rockets ride. The three inside sections are made broad and wedge-shaped, one piece thus serving as common way for two adjacent rockets. A spread of one part in 40 is made between ways to give the required spacing of shots. A set of retractible retainers is provided for each set of 4 ways to keep the rockets from being washed out of place. In general, the same protection against blast must be provided as is provided for the Launcher, Mark 20. It should be noted that the deck plate is not a part of the launcher, Mark 22 as it is with the Launcher, Mark 20.

The launcher is designed to fold down and be lashed to the deck when not in use, as shown in figure 22. When conditions require it, weather permitting, the launcher may be maintained elevated and loaded. Whenever weather conditions are such that the launchers or the ammunition exposed on the rails would be subject to damage or deterioration, the ammunition should be unloaded and stowed and the rails lowered and lashed down.

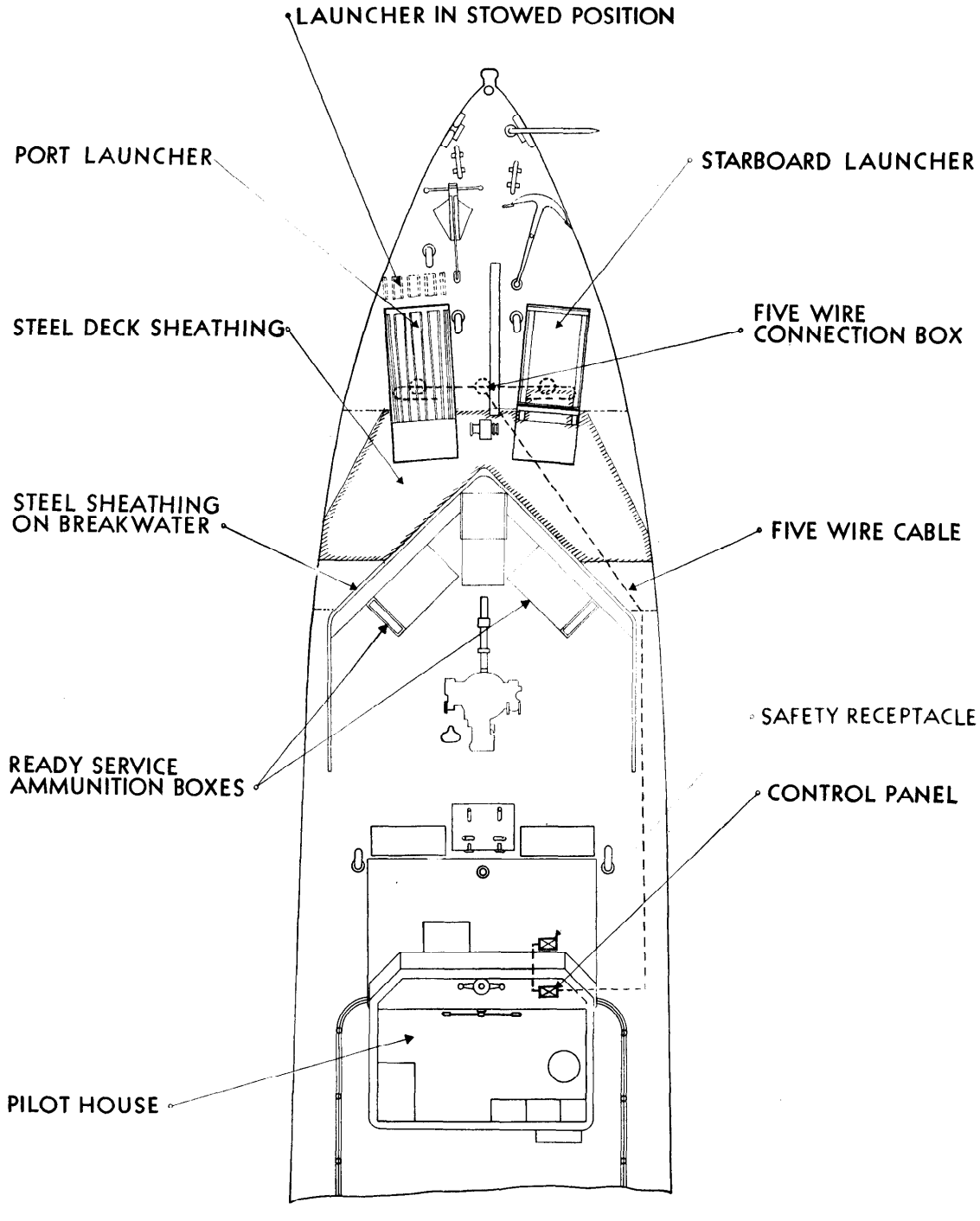


FIG. 23. FOREDECK INSTALLATION OF 7".2 ROCKET LAUNCHER, MARK 22

INSTALLATION

For mounting the launchers, two clear spaces about 42 inches by 108 inches are required on the foredeck. A 16-inch or less portion of the forward end of the lower launcher ways may be cut off only if installation requires it. The same type of blast deflector plates are used for the Launcher, Mark 22, as have been described on Page 15. In addition, the portion of the deck between the upper and lower set of ways and immediately behind the upper set of ways is sheathed against blasts.

The launchers are mounted on wood or metal foundations so that they are level athwartships and have a 3°–5° slope fore and aft with the high point forward. The two launchers are placed, in the folded position, on the foredeck symmetrically about the centerline of the ship. The extreme forward point of the inboard edge of the base of each launcher deviates 5½ to 6¾ inches further from the centerline than the aft end of the base. This deviation is inversely proportional to the distance between launchers. This placement of the launchers gives an approximately equal spacing to all eight rockets.

Ready-service boxes are provided on the foredeck, convenient to the launchers, for ready ammunition. Each box holds the rounds in easily accessible racks and is watertight. Additional ammunition may be stowed below decks in magazine stowage.

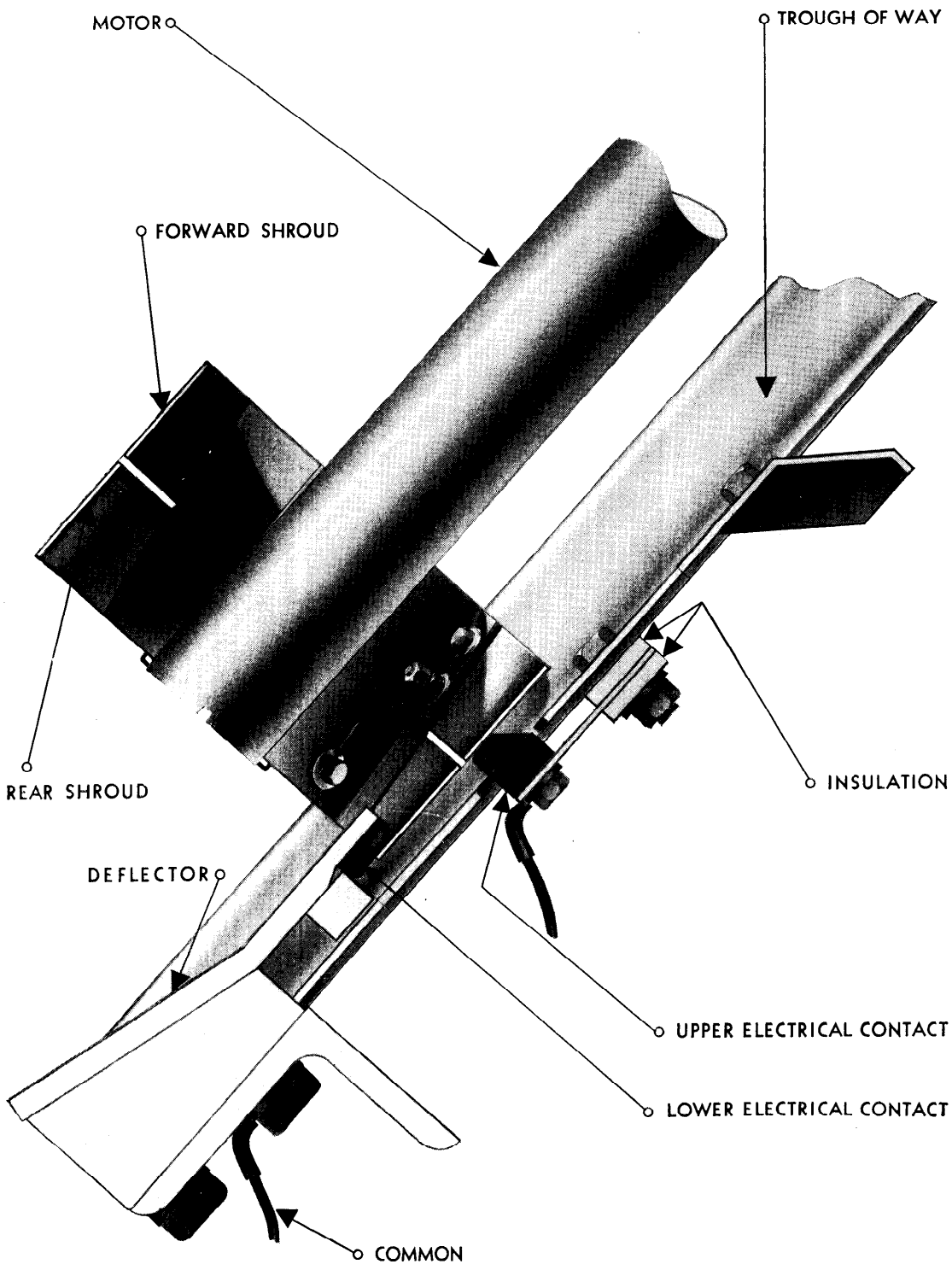


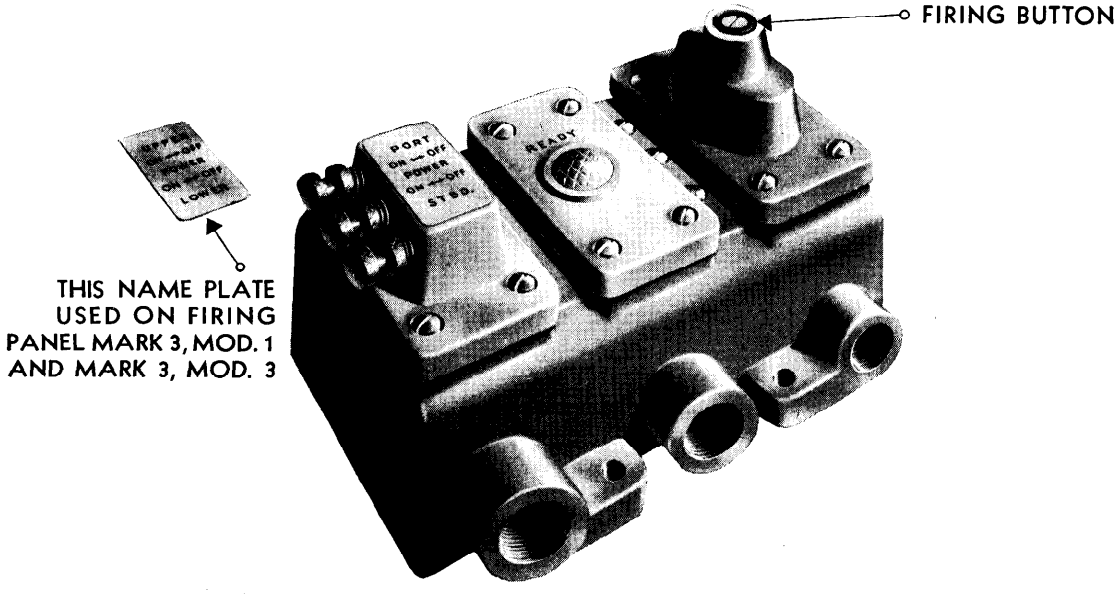
FIG. 24. ELECTRICAL CONTACTS FOR 7".2 ROCKET LAUNCHER, MARK 22

ELECTRICAL CONTROLS

Firing is electrical and is controlled from the bridge.

Electrical contact for firing is made to the motor shrouds of the rocket by means of knife edges as in Launcher, Mark 20. The lower contact mounted in the deflector plate grips the inside of the grounded rear motor shroud which is electrically connected to one side of the igniter and serves as a stop. The upper insulated contact is mounted on a phosphor-bronze spring and bears on the outside of the forward shroud. Both contacts are made of hardened stainless steel.

The wiring to the safety plug is the same as described for the Launcher, Mark 20. **The safety plug is carried by the gun captain and it is his responsibility to see that the plug is not inserted in the safety receptacle until all personnel is off the foredeck, after the launchers have been loaded.**



CONTROL PANEL MARK 3 AND MARK 3, MOD. 2

FIG. 25. CONTROL PANEL FOR 7".2 ROCKET LAUNCHER, MARK 22

FIRING PANELS

The Control Panels, Mark 3, Mod. 1, or Mark 3, Mod. 3, are used with the Launcher, Mark 22. The Control Panel, Mark 3, Mod. 1 utilizes one 45-volt and two 6-volt dry batteries. (The 45-volt battery is now known to be unsuitable). The Control Panel, Mark 3, Mod. 3 utilizes two 7½-volt dry batteries. Control Panels, Mark 3, Mod. 1 and Mark 3, Mod. 3 are identical to the Control Panels, Mark 3 and Mark 3, Mod. 2, respectively, except that the name-plate is changed. In the Control Panels, Mark 3 and Mark 3, Mod. 2, the plate reads "Port-Power-Starboard." In the Control Panels, Mark 3, Mod. 1 and Mark 3, Mod. 3, the plate reads "Upper-Power-Lower." (See fig. 25.)

When the switch marked "UPPER" is operated and the projectors are fired, the odd-numbered upper ways of both port and starboard launchers fire together. When the switch marked "LOWER" is operated and the launchers are fired, the same sequence as described above is repeated for the lower ways, both port and starboard.

A detailed description of the rocket is given in chapter 2 of this pamphlet. Views of the rocket and fuzes are shown in the illustrations mentioned in this chapter.

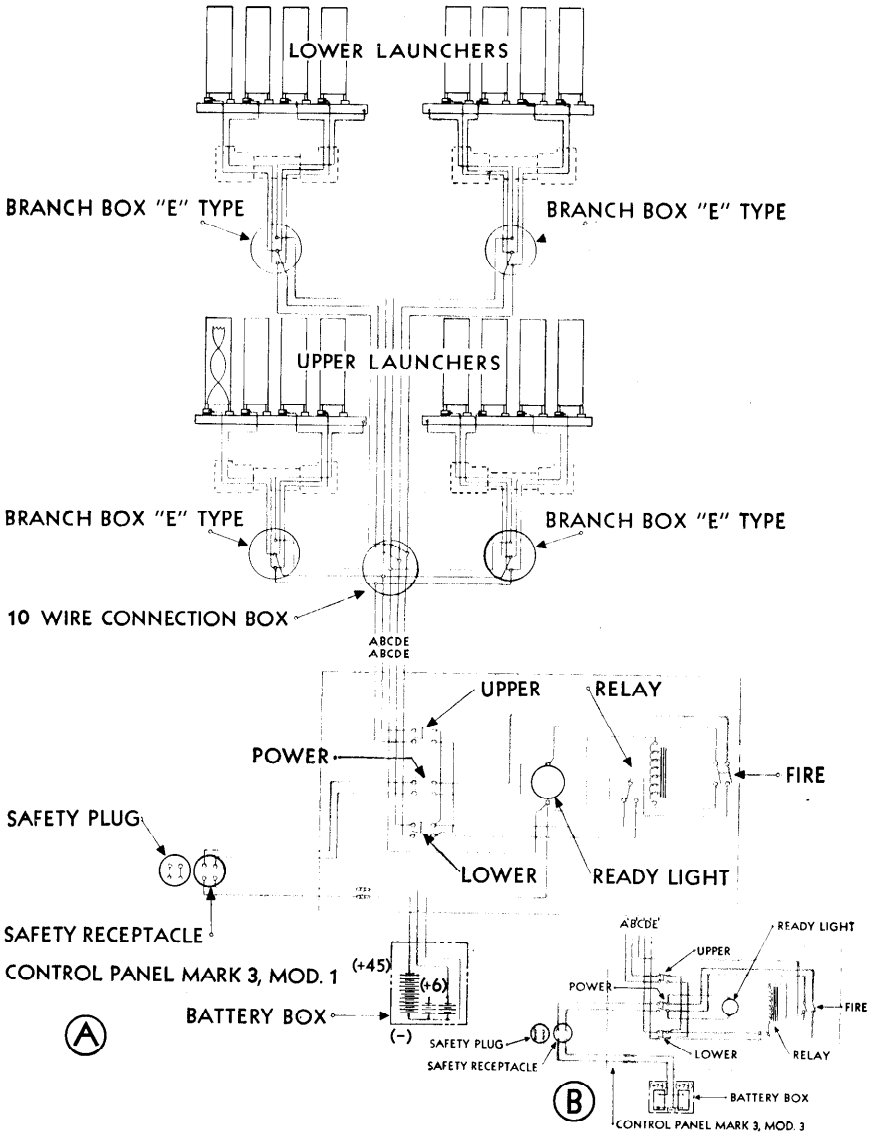


FIG. 26. WIRING DIAGRAM FOR 7".2 ROCKET LAUNCHER, MARK 22

(USING CONTROL PANEL, MARK 3, MOD. 1 OR MARK 3, MOD. 3)

WIRING DIAGRAMS

Wiring diagrams for the launcher, Mark 22, are shown in figures 26 A and B. Figure 26A shows the wiring of Control Panel, Mark 3, Mod. 1 and figure 26B shows the wiring of Control Panel, Mark 3, Mod. 3.

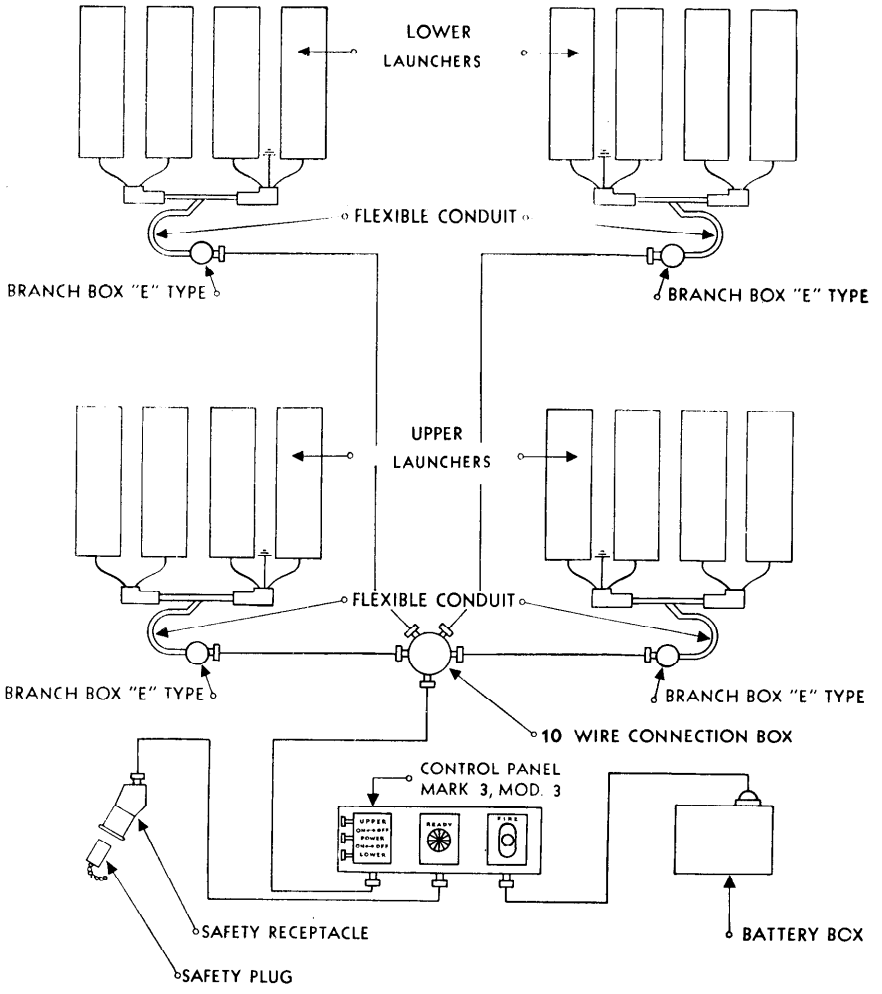


FIG. 27. CIRCUIT SCHEMATIC FOR 7".2 ROCKET LAUNCHER, MARK 22
(USING CONTROL PANEL, MARK 3, MOD. 3)

CIRCUIT SCHEMATIC

A Circuit Schematic for the Launcher, Mark 22, using Control Panel, Mark 3, Mod. 3, is shown in figure 27.

Chapter 7

OPERATION AND MAINTENANCE 7".2 ROCKET LAUNCHER, MARK 22

LOADING AND FIRING

Exact loading and firing procedure will be covered in publications from other sources.

To prepare a launcher for firing, two loaders lift the upper set of ways and swing its crutch up in place, locking it with the latches provided. They then raise the lower set of ways and swing its crutch up in place and lock it with the latches provided. **Before loading, the gun captain of the launcher crew must have the safety plug in his possession.** Two loaders are stationed at the ready boxes. They remove the rockets from the ready boxes and pass them to two other loaders, who are stationed at the launchers. The two loaders, last mentioned load the rockets in the ways of the launchers. In loading the rockets, one hand is placed between the fins of the tail ring and the other hand grasps the nose of the rocket. The rocket is then laid in the way about 6 inches above its normal position and pushed down into the contacts. Care must be taken that the motor shrouds seat properly and that the vanes do not interfere with the rear contact. After the shroud of the motor has been placed in contact with the knife edges, the safety clip should be removed if this has not been done previously. The rocket should not be dropped on the motor as a hard blow may cause the two shrouds to short together and make a misfire possible.

MAINTENANCE

The maintenance instructions of page 52 of this pamphlet apply also to the Launcher, Mark 22.

ROCKET PERFORMANCE

The rocket for the Launcher, Mark 22, is exactly the same as the rocket for the Launcher, Mark 20. Therefore, the performance data given on pages 53 through 58 will apply.

Chapter 8

COGNIZANCE

The Bureau of Ordnance will supply and retain cognizance over the following items of equipment:

A 7".2 Rocket Launcher, Mark 22.

B Control Panel, Mark 3, Mod. 1 or Mark 3, Mod. 3, or Control Panel, Mark 7, when supplied.

C Safety plug and receptacle.

D Wiring from launcher to branch box "E" type.

E Ammunition and fuzes.

F Fuze wrenches.

G Batteries.

The Bureau of Ships will supply and retain cognizance over the following items of equipment:

A Foundations for the launchers, including means for securing the launchers thereto.

B All steel sheathing, including the steel deck plates in the area of the direct blast.

C Watertight, metallic stowage lockers for ready-service ammunition.

D Magazine stowage for fuze containers.

E Magazine stowage for assembled rockets (unfuzed).

F All wiring and electrical appurtenances (except safety plug and receptacle) for connecting the launchers to the control panel.

G Such communication or signal facilities as may be authorized in order that the firing station may maintain proper contact with personnel at the launchers.

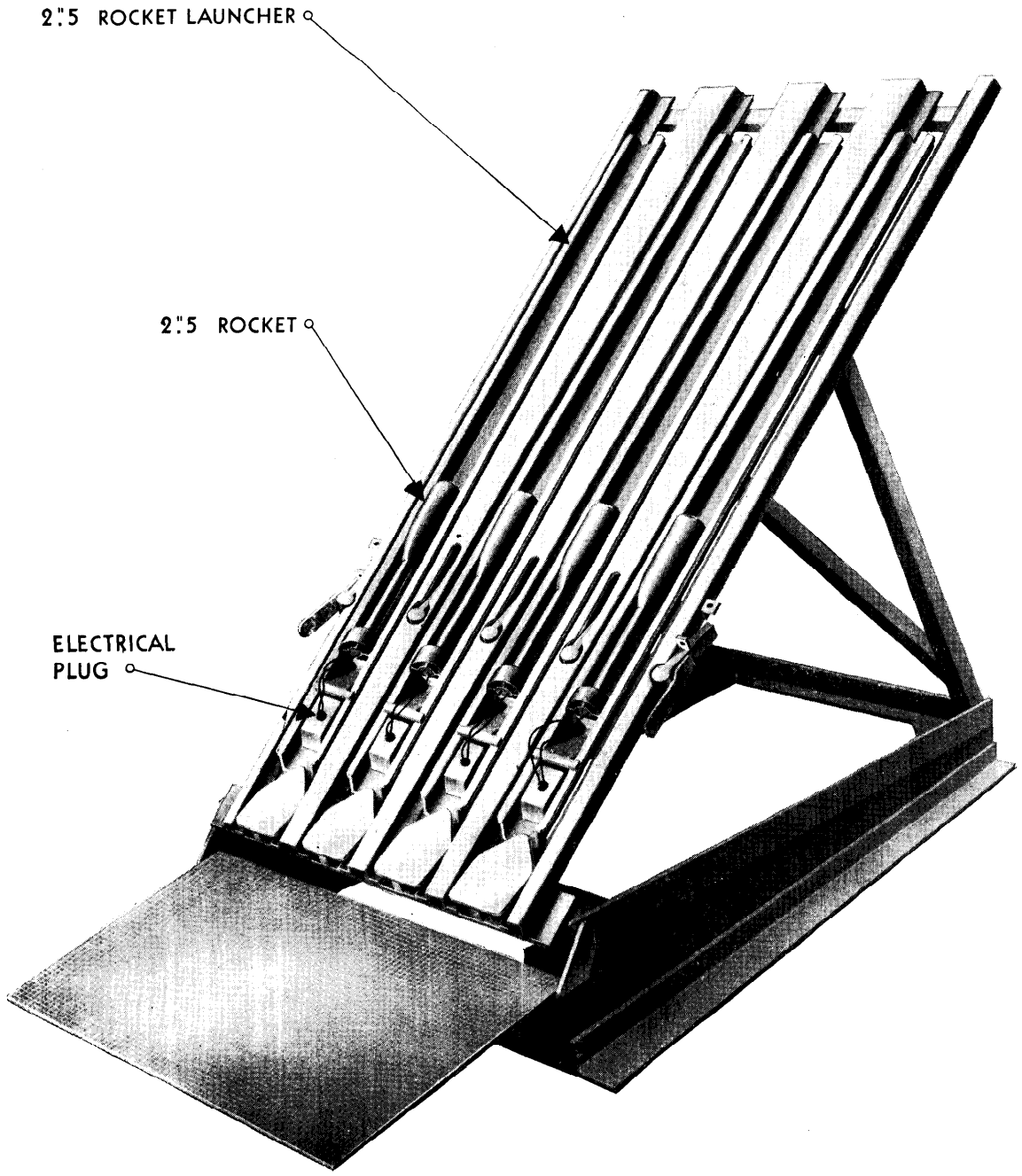


FIG. 28. 7".2 ROCKET LAUNCHER, MARK 20, EQUIPPED WITH 2".5 ROCKET LAUNCHER AND LOADED WITH 2".5 ROCKETS

Chapter 9

2".5 ROCKET LAUNCHER AND 2".5 ROCKETS FOR LAUNCHERS, MARKS 20 AND 22

DEFINITION

2".5 Rocket Launchers, Mark 4 are used as subcaliber attachments on 7".2 Rocket Launchers, Mark 20 and Mark 22 to permit the use of subcaliber ammunition for practice purposes.

USE

2".5 Rocket Launchers and 2".5 Rockets are used for training crews in the use of launchers. 2".5 Rockets are used in practice against target submarines and upon contact with the submarine can be heard by the crews inside, thus enabling each hit to be registered.

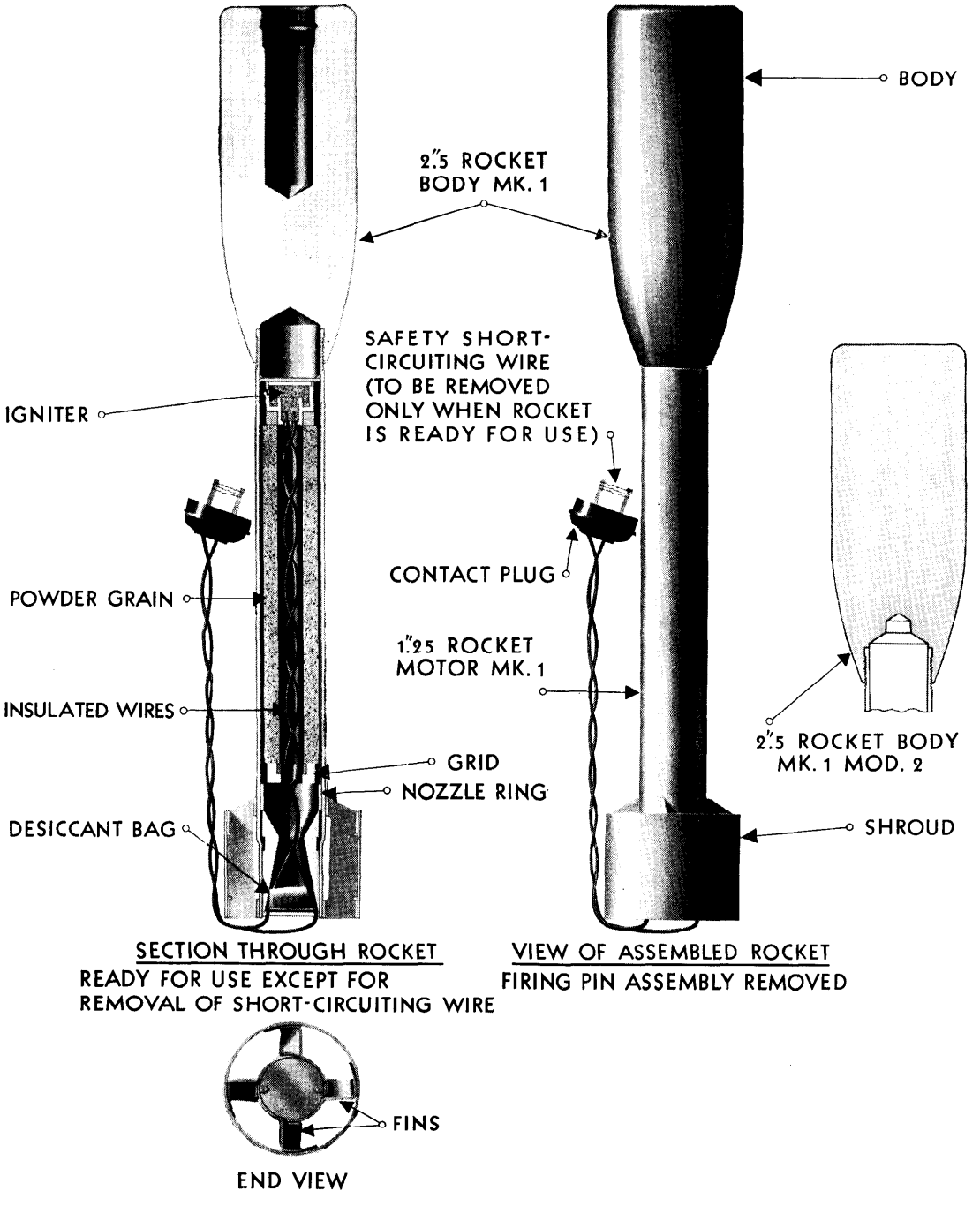


FIG. 29. 2".5 ROCKET (SUBCALIBER)

THE 2".5 ROCKET

GENERAL:

The 2".5 Rocket is approximately 17 inches long and 2".5 in diameter at its widest point. Performance data is given on pages 54 and 58.

INSTALLATION:

The 2".5 Rocket Launchers are installed between the adjacent rails of the 7".2 Rocket launcher in such a way that the guide near the lower end of the 2".5 Launcher fits between the ways of the 7".2 Launcher and the hook on the upper under side of the 2".5 Launcher lies forward of the upper cross member of the 7".2 Launcher.

From this position the 2".5 Launcher is slid down until the lower end is in firm contact with the ground contact on the 7".2 Launcher and the hook of the 2".5 Launcher has engaged the upper cross member of the 7".2 Launcher way assembly. The electrical contact of the 2".5 Launcher should then be bearing on the insulated electrical contact point on the 7".2 Launcher. Care should be taken to insure that no part of the 2".5 Launcher other than the electrical contact is bearing on the insulated electrical contact point of the 7".2 Launcher.

BODY:

The 2".5 Rocket Body, Mark 1 is approximately 6".6 long and 2".5 in diameter. The after section of the body is ogival in shape and terminates in a base threaded internally to engage the thread of the motor tube. The cavity in the nose of the body was originally provided to contain a shotgun shell which was fired when the rocket came in contact with the hull of a submarine. As experience has proven the use of shotgun shells for such a purpose to be unsatisfactory and unsafe for handling, future issues of 2".5 rockts will contain no explosive charge in the body. Shotgun shells will not be used. A later development is the 2".5 Rocket Body, Mark 1, Mod. 2, which is approximately 6".27 long and 2".5 in diameter. It has no cavity provided for any shotgun shell.

MOTOR:

The motor, fabricated of steel, consists of a tube having an external diameter of 1".25, 4 radial fins and a cylindrical shroud surrounding the fins. The forward end of the tube is externally threaded for engaging the base of the body. The fins are inclined 5° relative to the tube axis in order to impart a certain amount of "spin" to the rocket with the object of improving the travel of the rocket in water.

PROPELLANT COMPONENTS:

The propellant components are confined in the motor. A typical assembly of the components is shown in figure 28. The main component is a single grain of extruded ballistite powder with extruded ribs and a perforation through the center. At the forward end of this powder grain is located an igniter which consists of an electrical squib leading to a charge of black powder. Two insulated electrical wires are run from an electrical plug through the powder grains to the igniter. When the electrical circuit is closed, the igniter burns, igniting the propellant grain which burns uniformly on all surfaces. The gases evolved are forced out through the nozzle at high velocity and by their reaction on the motor, propel the unit forward.

LOADING AND FIRING

Before loading, the gun captain of the launcher crew must be in possession of the safety plug. After the 2".5 Rocket Launchers are in place on the 7".2 Launcher, the 2".5 Rockets are placed in the launchers. The short circuiting wire or clip which connects together the two prongs of the contact plug should then be removed and the contact plug inserted in the receptacle. As soon as this is done, the crew takes firing stations which are chosen in such a way that all entrances to the foredeck are guarded and the guards protected out of line of blast of the launchers. The gun captain of the crew takes station at the **Safety Receptacle** and inserts the safety plug on command of the conning officer. From here on the firing procedure is exactly the same as for live ammunition. **As soon as the salvo is gone, the safety plug must be removed and the power switch opened.**

The launchers can then be reloaded.

SAFETY PRECAUTIONS

It should be emphasized that although the rocket body is inert, the ballistite powder in the motor can blow up at elevated temperatures above 120° F. Also, the blast from the motor is extremely intense. **Consequently, when using the 2".5 Rockets, the same safety precautions should be observed as are observed when using 7".2 Rockets.** Pages 47 through to 51 apply to 2".5 Rockets as well as to 7".2 Rockets.

COGNIZANCE

The Bureau of Ordnance will supply, and retain cognizance over the following items of equipment (in addition to the items previously mentioned on page 61):

(*a*) 2".5 Rocket Launchers (Subcaliber Ways).

(*b*) 2".5 Rockets.

DISTRIBUTION

Requests for OP 1002 1st. Revision, should be addressed to the nearest BuOrd Publications Distribution Center:

Commandant and Superintendent,
U. S. Naval Gun Factory, Navy Yard,
Washington 25, D. C.
(Attn: OrdPubSubcen).

Commandant,
Navy Yard,
Mare Island, Calif.,
(Attn: OrdPubSubcen).

Commander Service Force, SEVENTH FLEET,
Ordnance Publications Subcenter,
c/o Fleet Post Office,
San Francisco, Calif.

Officer in Charge,
Ordnance Publications Subcenter,
Naval Supply Depot,
Pearl Harbor, T. H.

DISTRIBUTION:

Standard Navy Distribution List No. 18.
2 copies each unless otherwise noted.

1. a–e, g, h, k, l, r–t, x, z, aa–ff, ii–ll, nn, ss, tt, zz; 2. e–h, m, o, p, r–t, v, x; 3. c*, e*, k*, l*, r*, y*, cc*, nn*, vv*, xx*, yy*; B3. (5 copies), LIONS, CUBS; E3.; 4. e*, g*, k*, p*, r*–w*, gg*, mm*, oo*, pp*, qq*; 5. b (Alusna, London only); 6. (25 copies), a–p; 7. f–j, o, p, s, u (except Naval Clothing Depot), x, ee; 7. (5 copies), 1; 7. (25 copies), b, c; 8.h (NOL and No. Beach only), i, j, l, n (SPECIAL LIST G, K, L, Q, S, AA), hh; 8. (50 copies), b, n (10); 10. i (except Chicago), j, t; 10. (15 copies), i, (Chicago); 10. (25 copies), nn; 11.a (BuShips, CNO, SecNav); 12.; 14.a; 14. (50 copies), s.

*Applicable ships

16—39136-1 U. S. GOVERNMENT PRINTING OFFICE