NAVORD OP 769

CHANGE 1

16-INCH THREE GUN TURRETS

BB 61 CLASS

PUBLISHED BY DIRECTION OF
COMMANDER, NAVAL ORDNANCE SYSTEMS COMMAND

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FOREWORD

Ordnance Pamphlet OP 769, dated 15 October 1967, supersedes OP 769 (Preliminary) dated June 1943 and OP 769 1st Revision (Preliminary) dated December 1953.

This technical manual, OP 769 dated 15 October 1967, reflects the configuration of the three 16-inch 50-caliber turrets in USS NEW JERSEY (BB62) at the scheduled completion of ship reactivation on 30 April 1968.

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DEPARTMENT OF THE NAVY
NAVAL ORDNANCE SYSTEMS COMMAND
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The reason for this change is to incorporate color coding in those Schematics where indicated.

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Chapter 1

GENERAL DESCRIPTION OF THE TURRET

Four ships, the U.S.S. IOWA, U.S.S. NEW JERSEY, U.S.S. MISSOURI, and U.S.S. WISCONSIN comprise the IOWA class battleships. These ships have main batteries consisting of three 16-inch 3-gun turrets.

Main battery ordnance of each ship comprises nine 16-inch 50-caliber turret-mounted guns which are chambered for bagged powder charges and are equipped with carrier-type breech mechanisms. The guns, which may be fired at the rate of two rounds per minute, have a maximum range of approximately 41,000 yards (refer to ballistics data, chapter 3, page

All three turrets of each ship are located on the centerline, two forward and one aft of the superstructure. The gun house of turret II extends above the level of the first superstructure deck. The turret III gun house is higher above the main deck than the gun house of turret I. Turret distances from the ship's bow and from the base line to the gun trunnion axes are listed in the turret emplacement data below. Turret positions and the large arcs of train provide fire concentration of nine guns on either beam, six forward, and three astern.

Purpose

The main battery ordnance design provides for accurate firing of either armor piercing or high capacity projectiles at targets which include surface ships and shore installations. Armor piercing projectiles are capable of penetrating up to 16 inches of armor plate. High capacity projectiles, fired at ships and shore installations, are fuse-set to detonate on contact or at a predetermined time.

Ship class

The IOWA class battleships have an overall length of 888 feet, a beam of 108 feet, and a maximum draught of 34.6 feet. Ships of this class have a standard displacement of 45,000 tons (approximately 57,250 tons full load displacement) and are capable of a speed in excess of 32 knots. Extensive hull belt and deck armor protect the turrets and engine room spaces below the main deck level.

Emplacement data

Distances of the turret centers (turret vertical axes) from the ship's bow, and the gun trunnion axes above the base line (34.6 feet below the waterline) are tabulated below. The limits of gun elevation and depression and of turret train are given in chapters 5 and 6 respectively.

TURRET EMPLACEMENT DATA

Turret Number	Vertical Axis (feet from bow)	Trunnion Axis (feet above base line)
I	224	60.75
II	296	69.25
III	642	63.00

Turret arrangements and differences

Virtually identical, each turret comprises a gun house and rotating structure, a barbette and fixed structure, magazines, and ordnance installations. These differ only in minor details, adapting each turret to its ship location and the fire control plan. The gun house, 50.63 feet long with a maximum width of 36 feet, is mounted above and attached to the rotating structure. Cylindrical and conical in section, with a maximum diameter of 35 feet, the rotating structure is supported by a roller path and consists of six floor levels. Turret II has a seventh floor level which is a part of the fixed structure.

The rotating structure, protected on top by heavy armor plate of the gun house, is enclosed within the upper and lower barbette sections. Cylindrical and made of heavy armor plate, the upper barbette and armor deck plates protect the rotating structure, roller path, and foundation. The three upper barbettes, each 37.25 feet in diameter, have different heights because of trunnion axis elevation differences. Conical and made of heavy steel plate, the lower barbette is a supporting structure for the upper and differs in height for each turret.

Components

Each turret consists of the structural units and equipment installations listed below and described in following paragraphs of this chapter.

List of design components:

Structural assembly
- Rotating structure
- Suspended structure
- Turret roller bearing
- Fixed structure

Ordnance installations
- Gun and slide assemblies
- Gun laying equipment
- Projectile stowing and handling equipment
- Ammunition hoist and gun loading equipment
- Fire control equipment

Auxiliary installations
- Power supply
- Illumination supply
- Ventilating system
- Sprinkling system
- Sprinkling system, electrical

Communications
- Depression and train stop signal system (circuit DS)
- Intra-turret emergency alarm (circuit RA)
- Train warning signal system (circuit TW)
- Turret announcing system (circuits MC)
- Battle telephone system (circuits JA)
- Supplementary telephone system (circuit XJ)
- Sound powered telephone and voice tube call bell system (circuit E)
- Ship's service telephone system (circuit J)

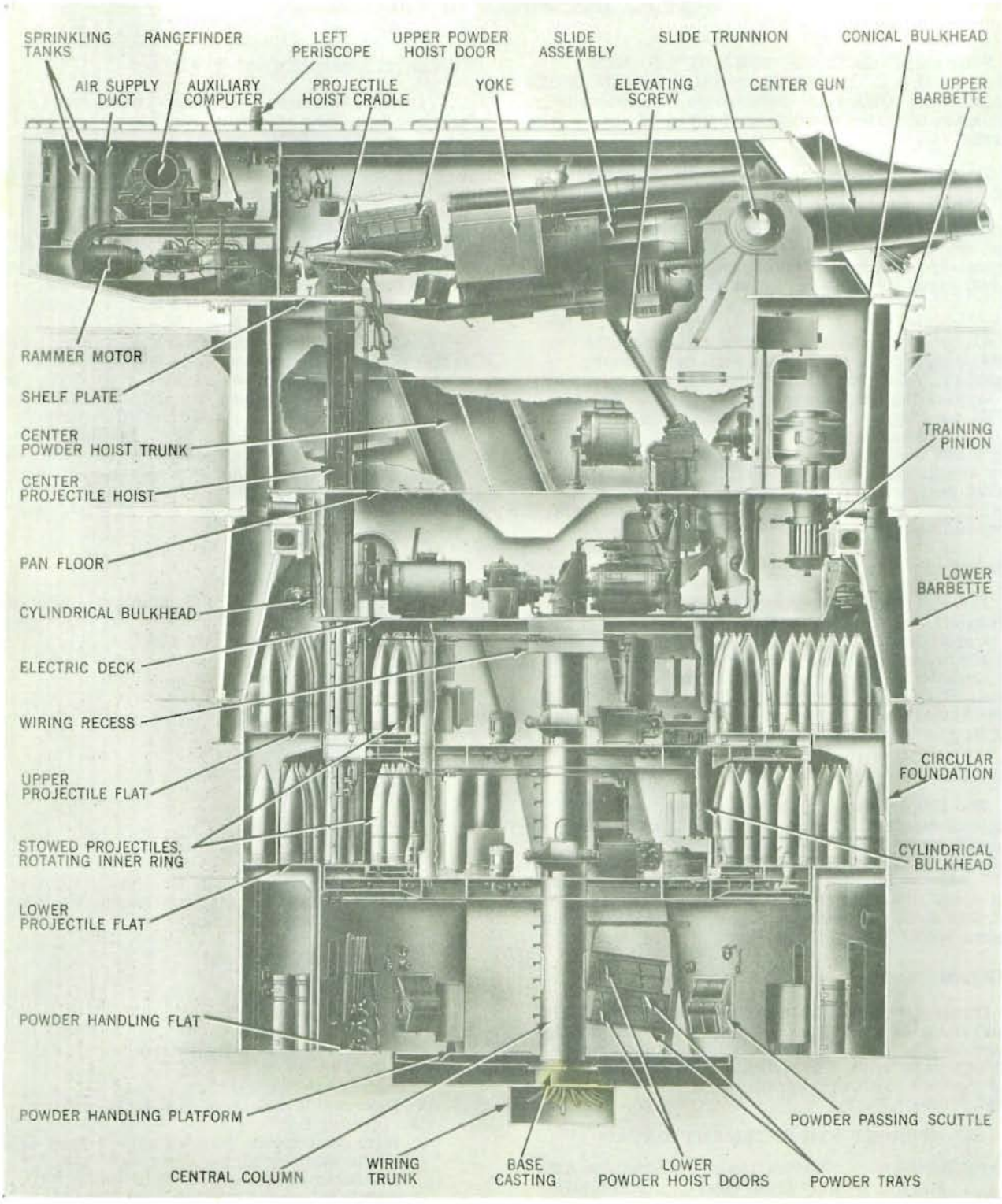


Figure 1-1. Turret General Arrangement - Longitudinal Section

Illumination

General turret illumination
Instrument illumination
Rangefinder de-icing
Gas ejector supply

Structural assembly

The structural assembly comprises the fixed structure, the turret roller bearing, and the rotating and suspended structures. Rotable, the two latter structures are attached to each other and are supported by the fixed structure. These two structural members bear directly on the turret roller bearing which is between the fixed and rotating structures.

The fixed structure, described on page 1-7 consists of parts built into the ship to support and protect the rotating structures. These parts are the foundation bulkhead, barbette, and other fixed elements.

The turret roller bearing, described on page 1-6 is the movable support for the rotating parts.

The rotating and suspended structures, described in the following paragraphs, are the parts that seat on the roller bearing. Ordnance and auxiliary installations are mounted in and are enclosed by these rotating parts which include the gun house and the structure beneath it.

Rotating structure. The rotating structure (fig. 1-1) is an assembly of steel weldments that weighs over 2000 tons with ordnance and auxiliary units installed. It is a six-level structure erected in the form of a rectangular gun house above a cylindrical assembly of five levels. The height of the structure from the powder handling platform to the top of the gun house is 53.75 feet for turret I, 62.25 feet for turret II, and 51.25 feet for turret III.

The six deck levels of the rotating structure are identified as follows: the shelf plate at the bottom of the gun house, the pan floor at the bottom of the gun pits, the electric deck (machinery floor) beneath the gun pits, two levels called the upper and lower projectile flats, and the powder handling platform at the lowest level. These deck levels are joined together by cylindrical and conical bulkheads, and gun girder weldments between the shelf plate and electric deck. Below the electric deck another cylindrical bulkhead extends to the lowest projectile flat. A central column within the latter cylindrical bulkhead extends from the machinery floor to the powder handling platform. The column, the conical bulkheads, and the outer edges of all deck plates below the shelf plate are concentric with the turret center of rotation. This arrangement - together with the welded construction of all plates, girders, and bulkheads - ties the entire rotating structure together in one rigid unit. It divides the turret into its principal functional spaces of gun compartments, machinery compartments, and ammunition handling compartments. The following overall measurements include these spaces:

Dimensions, Rotating Structure

Vertical distances, feet	
Powder handling platform to lower projectile flat	
Turret I	11.10
Turret II	19.60
Turret III	8.60
Lower projectile flat to upper projectile flat	7.75
Upper projectile flat to machinery floor (electric deck)	6.40
Machinery floor to pan floor	7.25
Pan floor to shelf plate	11.25
Shelf plate to turret roof	10.00
Gun house length, feet	50.62
Gun house width, feet	39.95
Pan floor diameter, feet	34.58
Electric deck diameter, feet	29.67
Upper projectile flat diameter, feet	28.12
Lower projectile flat diameter, feet	28.12
Cylindrical bulkhead between machinery floor and lower projectile flat, diameter, feet	17.00
Powder handling platform diameter, feet	19.50
Central column inside diameter, feet	2.50

Gun house structural plan. The space between the gun house roof and the pan floor is subdivided by portable plates, flame barriers, and structural members. Comprising the turret officer's compartment, the sight stations, and the gun room compartments, this space is 21.25 feet high and is formed and subdivided by the following design arrangements.

Gun pit details. Extending vertically above and supported by the pan floor are five major components of the turret (fig. 1-5). These are the enclosing conical bulkhead and the four gun girders. Longitudinally parallel and vertical, the gun girders divide the gun pit into three gun pockets.

Each gun pocket is six feet wide and is 15.5 feet deep from the trunnion centerline to the pan floor. There is an 8.25-foot long trough-like depression in the pan floor parallel to and aft of the turret transverse centerline. A part of the gun pocket, this is 2.75 feet deep and provides clearance space for the loader's platform when the gun is at full elevation. Varying in length within the curving end walls, the approximate lengths of the gun pockets are 22 feet for the wing guns and 25 feet for the center gun. The gun girders that form the parallel sides of the pockets are different design types. The outer, or wing, girders are plate structures and the center units are box girder weldments.

Wing girders isolate two small spaces, which form ventilation trunks, between their outboard sides and the conical bulkhead. In each space vertical plates transversely placed and welded between the bulkhead and the wing girder stiffen the girder and the pan floor.

Each box girder is a unit consisting of two parallel plates with web bracing and vertical plates transversely placed and welded between the parallel plates; In the spaces between the parallel plates, the powder hoist trunks rise to the gun room compartments. Both box girders have provisions for access to the powder hoist machinery spaces and the trunnion bearings.

All four gun girders, covered with cap plates, extend 4.25 feet above the shelf plate. Portable vertical plates above the cap plates provide flame barriers and access for powder hoist machinery removal. Two parallel structural members of the forward portion of each box girder extend toward the turret roof to positions immediately behind the front plate. A structural member of the forward end of each wing girder extends to a similar position behind the front plate. These structural members are aligned to locate the positions of the deck lugs as described on page 4-1, chapter 4.

The four gun girders have six vertical structural members that extend rearward horizontally above the shelf plate to the gun house rear plate. These structural members, parallel cantilever beams which are connected to each other by vertical web bracings, provide attachment for the shelf plate.

Gun house details. The shelf plate, attached to the above-described gun pit structure, rests on the conical bulkhead. It extends beyond the conical bulkhead, overhanging slightly at the front and sides and 14.50 feet at the rear. Cut away in the area between the wing girders and conical bulkhead to provide a clear opening above the gun pits, the shelf plate extends 5.40 feet into the rear of the enclosure of the conical bulkhead. Flat throughout most of its area, the shelf plate forms a floor in the sight control stations and is bent up 13 degrees and 8 minutes along a line parallel to and 24.46 feet aft of the turret transverse centerline.

Parallel to the flat portion of the shelf plate and 2.80 feet above it, are the floor plates which form a flooring in the turret officer's and wing gun room compartments. This flooring has both fixed and portable sections and is broken to provide for installation of the rammer assemblies and rangefinder carriage.

Under the floor plates the cantilever beams and braces, together with the shelf plate, form a rigid box structure. This structure is designed to receive and support the gun house armor at its outer edges, and, in the space between shelf and floor plates, to accommodate units of the ventilating system (fig. 1-12).

The gun house roof plates are supported 6.25 feet above the floor plates by four 10-inch transverse beams. These are supported by three transverse webs and the gun house transverse bulkhead, all of which rise vertically from the shelf plate. With the shelf plate and armor plates, the webs, beams, and bulkhead constitute the gun house structure.

Armor. The armor plates consist of eleven pieces shaped, fitted, and bolted together to form an integral structure. Their identities and thicknesses are:

Front plate, inches	17.00
Front side plates, right and left, inches	9.50
Rear side plates, right and left, inches	9.50
Rear plate, inches	12.00
Roof plates, inches	
Front	7.25
Front intermediate	7.25
Center	7.25
Rear intermediate	7.25
Rear	7.25

The gun house outside arrangements include attached foot and hand rails, ladders, and platforms. These attachments differ for the three turrets. The armor front and side plates slope inward at the top; the rear plate is vertical.

The armor openings of the three turrets vary somewhat. Each turret has 11 virtually identical openings - three gun ports, two access openings, four sight hood openings, and two periscope openings. Turrets II and III, however, each have two additional openings for the rangefinder hood. In addition, on all ships of the class Turret III has a hole in its rear roof plate for electrical cables to the antiaircraft mount on its top; on some ships of the class Turret II also has a hole for a similar mount. Access openings in all turrets are located in the shelf plate overhang. These and all other openings are fitted with gasket seals or bucklers which make the gun house a weather and gas sealed enclosure.

Gun ports. Arrangements for sealing the three gun ports comprise fixed and moving parts (fig. 1-2). These consist of a weldment of splinter plates on the rear side of the front plate, shield plates on the gun slide, and a buckler (made of three-ply rubberized fabric) on the outside.

Attachment of the buckler to the front plate is provided for by a frame angle which encircles and is bolted to the gun port in the front plate. The buckler, clamped to the frame angle by a galvanized steel band, is distended by three expansion tubes (one at the top, two at the bottom). The inside of the buckler has arrangements for lashing it to the tubes which are free to move as the gun elevates or depresses. An additional clamping band attaches the front end of the buckler to the forward end of the gun slide cylindrical gun cover.

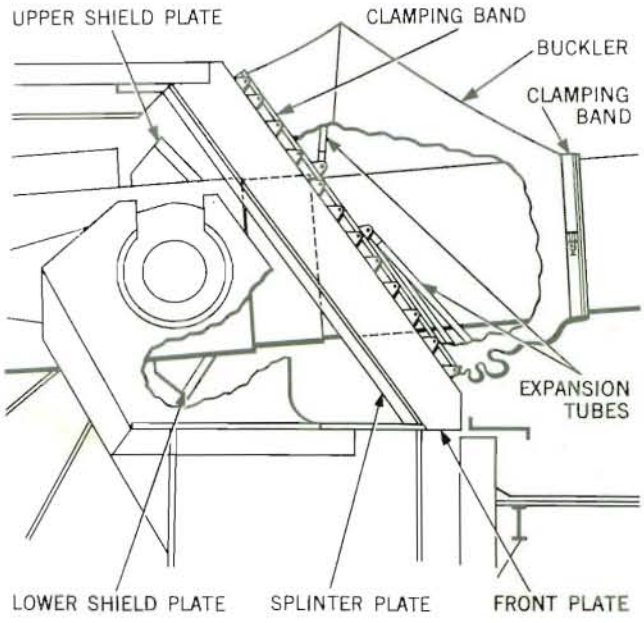


Figure 1-2. Gun Port Arrangement

Gun house subdivisions. The gun house interior is subdivided into six compartments (fig. 1-6) by interior arrangements which include the transverse bulkhead and webs, the plates and flame barriers above the gun girders, and the access doors in these structures. These gun house interior arrangements also isolate the powder hoist trunk and machinery spaces, and the hoist operators' stations.

The turret officer's compartment is formed by the transverse bulkhead 17.0 feet aft of and parallel to the turret transverse centerline and by the armor side and rear plates. Forward of the transverse bulkhead the three gun room compartments are formed by the gun house side plates and the plates, flame barriers, and transverse webs that rise vertically to the gun house roof above the gun girders and shelf plate. The two sight control stations are separate compartments, isolated from the wing gun rooms by the transverse webs between the side plates and the plates above the wing gun girders.

Access to these six compartments is provided by the following arrangements. The turret officer's compartment is accessible through a hatch in the bottom of the overhang. Six doors in the transverse bulkhead permit entrance into the three gun room compartments and the three powder hoist operators' stations. An additional door in each transverse web provides access to the sight control stations. Ladders at the rear of the gun pits permit passage to the pan floor level.

Suspended structure. The rotating structure that extends below the pan floor is a suspended structure that is isolated from the gun house and gun pits except for three flame tight hatches, one in each gun pit. Comprising the four lower levels of the turret, the structure is suspended from the pan floor and the upper roller path.

Upper roller path. The upper roller path (fig. 1-5) is a forged steel ring, 34.50 feet in diameter, secured to the pan floor beneath the conical bulkhead. Concentric around the train axis with the conical bulkhead, the upper roller path is the upper race of the turret roller bearing. The bottom face of the upper roller path is a machined horizontal bearing surface 16.0 feet below the gun trunnion axis. The suspended structure of turret I hangs 32.0 feet from this bearing surface to the level of the powder handling room (40.50 feet in turret II; 29.50 feet in turret III).

Suspended structure details. The suspended structure comprises the following units: the electric deck and enclosing cylinderical bulkhead, the upper and lower projectile flats and circular bulkhead, the central column, and the powder handling platform.

The central column is a continuous steel column fastened to and supporting the electric deck at its upper end. It passes through the powder handling platform and both projectile flats and supports these structures in addition to the electric deck. Between the lower projectile flat and the electric deck, a circular bulkhead provides additional support for the three floor structures it connects. On the projectile flat levels the bulkhead has cutaway sections which provide access to the projectile flat machinery spaces from the projectile handling spaces. The powder handling platform, supported by the central column, provides support for the lower ends of the powder hoist trunks. These rise upward to the gun room compartments and pass through both projectile flats (within the circular bulkhead), the electric deck, and the pan floor.

Both the upper and lower projectile flats are identical in compartment subdivisions and space arrangements. Each projectile flat is separated into two compartments, inner and outer, by the circular (cylindrical) bulkhead. Enclosed within the circular bulkhead, the 17.0-foot diameter inner compartment is the projectile ring power drive machinery space. The outer compartment is subdivided into three concentric, ring-shaped platforms with the outer ring attached to the fixed turret foundation. The inner ring, which may be rotated independently in either direction, is mounted on rollers that are supported by the turret rotating structure. A part of the turret rotating structure, the center ring is the projectile handling platform and provides support for the three projectile hoist tubes. The top surfaces of all rings are flush with each other. Each inner ring (called projectile ring) is an integral platform weldment with a low cylindrical coaming mounted around the inner edge. The platform provides sufficient space for stowing two concentric rows of projectiles and is arranged with chain lashings and other details shown in figure 7-1.

A cross web of cantilever I-beams, passing through the circular bulkhead, supports the inner compartment floor plates and the inner and center rings of each projectile flat. It is a heavy duty structure, cross braced by other beams and stiffened by the platform plates. This portion of the suspended structure is designed to carry the great weight of stowed projectiles and loaded projectile hoist tubes without apparent deflection. The upper and lower projectile flat construction is similar, the only differences being the sizes and locations of the powder hoist trunk and projectile hoist tube apertures.

The circular bulkhead between the pan floor and electric deck encloses a space 29.67 feet in diameter. This space is vertically subdivided into five compartments by the gun girders and a transverse bulkhead within the cylindrical bulkhead. Longitudinally arranged, the electric deck compartments comprise a void compartment in addition to one compartment for each elevating gear and training gear power drive. Access to these compartments is provided by cutaway sections and arches in the gun girders and by ladders to adjacent floor levels. The transverse bulkhead, 10.50 feet forward of and parallel to the turret transverse centerline, isolates the training pinions from the electric deck compartments. This is a rigid structure braced with a circular intercostal girder that is concentric within the cylindrical bulkhead.

Vertical portable ladders in the forward part of the projectile flat center ring give access from one projectile flat to the other. Steel rings attached to the rear of the central column permit passage to the powder handling room from either projectile flat. All hatches are of the raised non-flame-tight type except the hatch between the lower projectile flat and powder handling room. This is a raised flame-tight type hatch. The removal and installation of equipment in lower turret spaces is provided for by portable plates in the inner projectile flat compartments. These are arranged in vertical alignment.

Skirt plate. A cylindrical plate extends from the bottom of the pan floor into the electric deck space. Called the circular skirt plate, it is a tight fit within the enclosing cylindrical bulkhead of the electric deck. A structural element, it provides for riveted attachment of the suspended structure to the rotating structure.

Turret roller bearing. The rotating structure turns on the roller bearing assembly (fig. 1-3). This unit is supported on a lower roller track unit of the fixed structure described on page 1-9.

Bearing components. The turret roller bearing comprises 72 rollers assembled in 12 cage sectors of 6 rollers each. Attached together by inner and outer ring butt straps, the sectors form a 360 degree bearing ring with an outside diameter of approximately 35 feet.

Rollers. All rollers are identical steel forgings made with integral flanges. Each is 22.70 inches long across the flanges with a roller track contact surface between flanges of 17.58 inches in length. These are tapered rollers with maximum diameters across the inner and outer flanges of 14.25 and 15.19 inches, respectively. Weighing 546 pounds, each roller is drilled, bushed, and fitted with a spindle bolt which locates and retains the roller in a precisely allotted position in the cage sector.

Cage sectors. The cage sectors are identical in their construction, but differ as to the assembled positions of the six rollers retained by each. This difference applies to variations in the spaces between the axes of the 18 rollers in each of four identical quadrants. In each quadrant of three 30-degree sectors, the spaces between rollers vary by increasing increments that are constant for each sector but differ in value for the three sectors (fig. 1-4). In sector number 1, the distances between rollers increase clockwise by increments equal to four minutes of arc, in sector number 2 by six minutes of arc,

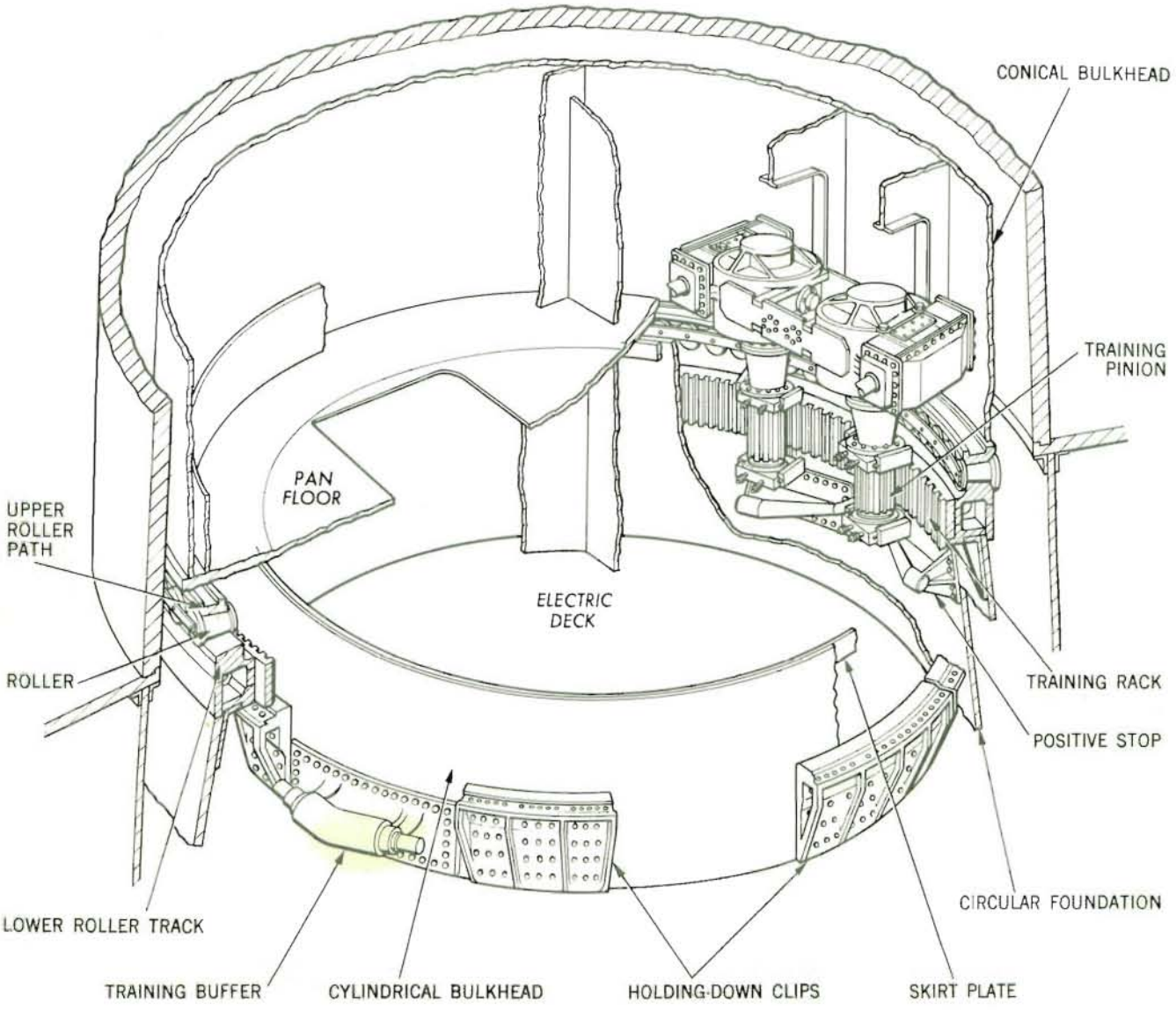


Figure 1-3. Turret Roller Carriage Arrangement

and in sector number 3 by eight minutes of arc. This design arrangement is to prevent roller path deformation from developing at the points of roller contact — a condition that would develop under firing and seaway load stresses if the roller spaces were equal.

Roller access. The cage sector and turret structure arrangements provide for inspection, lubrication, and replacement of rollers without dismantling the turret. Openings in the cylindrical bulkhead (enclosing the electric deck space) permit access to any and all rollers from inside of the electric deck space, by training the turret. To remove a roller the turret must be trained to one of six different angles (depending upon which sector the roller is to be removed from) to line up the desired sector with the access openings in the cylinderical bulkhead. The inner ring of the sector is removed through an access opening after the roller spindle bolts and the inner ring bolts of the left and right separators are removed. The rollers above the portable section of the lower roller track are then separated and the track section removed. Number 3 roller may be removed and removal of the remaining rollers follows without disturbing the outer ring.

Fixed structure. The fixed, or non-rotating, turret structure comprises the turret circular foundations, powder handling flat, lower roller track, base casting, and barbette. These components are shown in figures 1-1 and 1-5.

Turret circular foundations. Turret circular foundations differ for the three turrets. Each is a cylindrical and conical steel weldment, 37.25 feet in diameter at the bottom, which tapers to a 34.10-foot diameter at the top. The weldment is supported and secured at the ship's third platform deck in turrets I and II, and at the second platform deck in turret III. The weldment extends upward 29 feet above the third platform deck in turret I and 38.50 feet in turret II. In turret III the weldment extends upward 27.50 feet above the second platform deck.

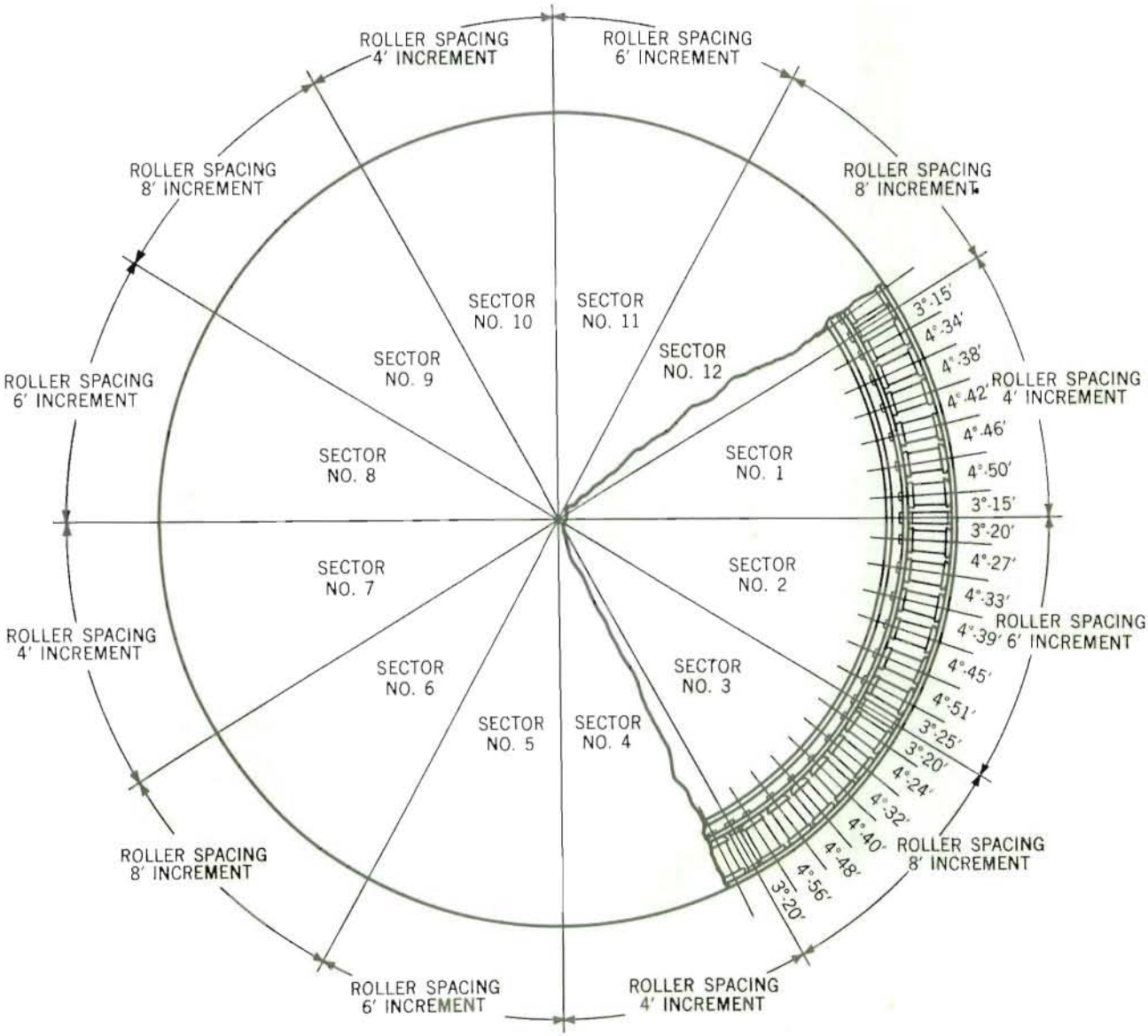


Figure 1-4. Cage Sector and Roller Spacer Details

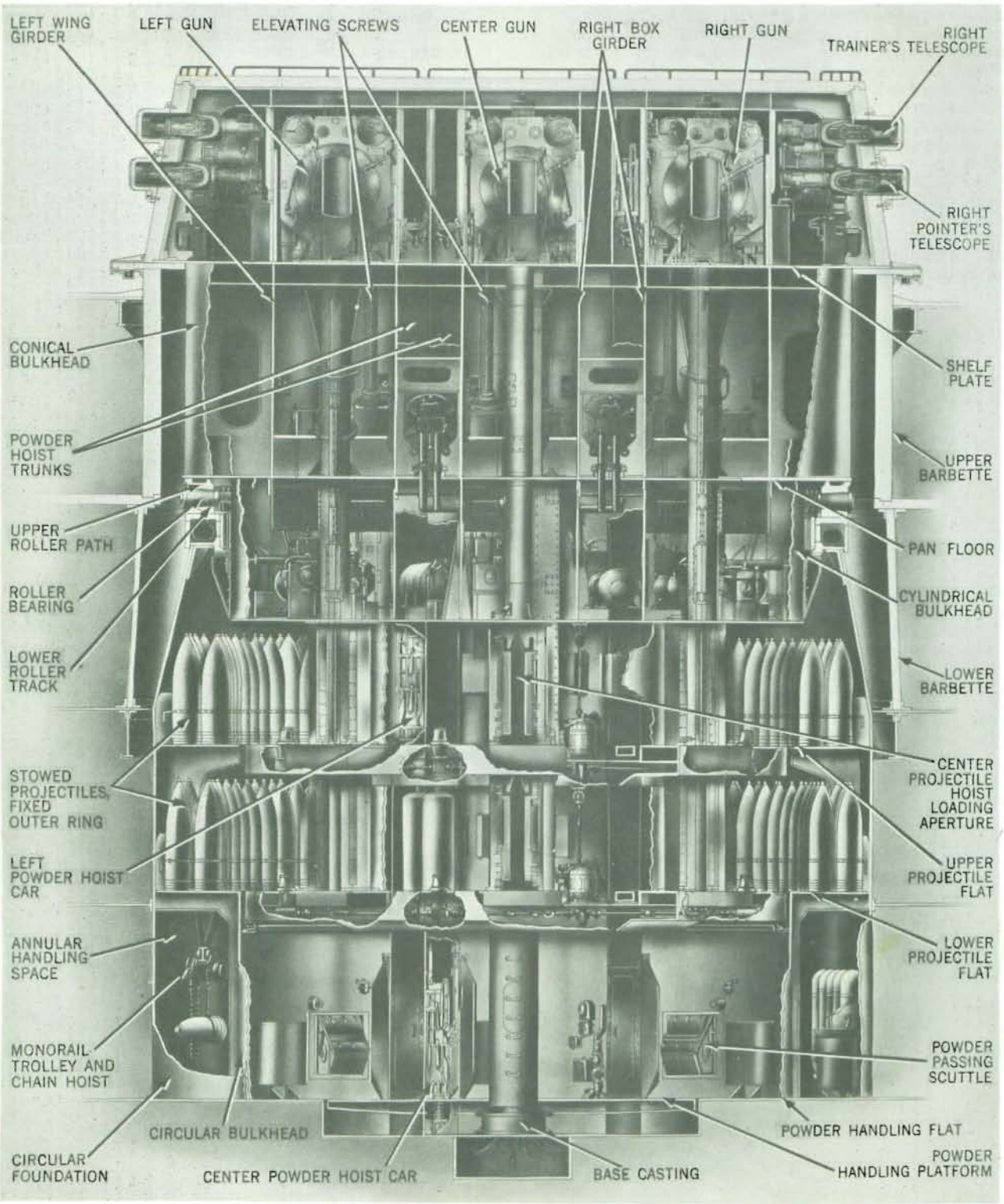


Figure 1-5. Turret General Arrangement - Transverse Section

Each circular foundation is a stand for the lower roller track (described below). In addition, it is an enclosing bulkhead for the projectile flats and the annular handling space. It also provides attachment for the training stops, flame seals, and powder scuttles.

There are two positive training stops. These are located near the top of the circular foundation (fig. 1-3) in the way of the training buffer.

The flame seal, located beneath the lower projectile flat, isolates the powder handling room from the rest of the turret. The seal, an angle bracket formed into a complete ring, is mounted on the concentric circular bulkhead enclosing the powder handling room. The ring mates with a complementary ring at the bottom of the lower projectile flat to provide a mechanical barrier. This arrangement permits free turning of the turret.

There are six powder passing scuttles in the lower part of each circular foundation (four scuttles in turret I) that align with similar scuttles in the powder handling room circular bulkhead. In addition, there are two watertight doors in each circular foundation that align with similar doors in the circular bulkhead. These arrangements provide access and communications between the powder handling room and magazines. The scuttles are manually rotated, horizontally positioned cylinders. They transfer powder bags (singly) from the magazines to the annular handling space and from this handling space to the powder handling room. During this transfer procedure a mechanical seal is maintained between the turret and magazine compartments.

Powder handling flat. At the bottom of the circular foundation, a ring-shaped floor structure forms the powder handling flat. The floor plates of the flat, flush with the powder handling platform of the rotating structure, form a working area 4.50 feet wide in front of the scuttles.

Lower roller track. The lower roller track is a ring-shaped weldment of box-section (fig. 1-3) which is attached to the top of the circular foundation. Machined after installation, the top of the roller track is a bearing surface of the same form, finish, and size as the similar surface of the upper roller path (34.50 feet in diameter). The inner face (roller flange surface) is a true cylindrical surface concentric with the roller paths and the axis of the rotating structure. Six portable roller track sections, keyed and tapped for accurately seating and securing to the weldment, provide for roller bearing access and removal. The weldment is also keyed and tapped for accurately seating the six segments of the annular training gear power drive, is a 360-degree of 210 teeth and 359.29-inch pitch diameter.

Base casting. The lowest element of the fixed structure is the base casting. This is a flanged and hollow pintle of 48-inch diameter, 15 inches high, that is secured below the platform level of the powder handling room. Accurately centered beneath the turret center of rotation, it is a dual purpose component that aligns the rotating structure and leads in the communications, power, and air supplies. The casting extends into and provides a radial bearing for the lower end of the central column. A ring-shaped insulation bushing horizontally placed at the bottom prevents the electrical cables from chafing.

Barbette. The barbette is made in two sections. The upper barbette is an assembled cylinder of heavy armor plate comprising seven cylindrical segments in turret I, twelve segments in turret II, and eleven segments in turret III. These segments, joined by a special welding procedure, form a built-in unit that encloses the turret above the second deck. With an inside diameter of 37.25 feet, the upper barbette extends vertically upward through the main deck to a plane two inches below the shelf plate. The ship's three upper barbettes have different heights because of the different heights of circular foundations. This dimension of the barbette is 142.16 inches for turret I, 253.03 inches for turret II, and 178.03 inches for turret III. Armor plate thicknesses vary from a standard 17.30 inches for all turrets to 11.60 inches at the front and rear sides. Upper barbettes are supported at their lower edges by the 4.75-inch thick second deck armor and the lower barbette.

The lower barbette is an assembled conical cylinder of heavy steel plate comprising eight cylindrical segments. These segments, joined by tapered keys, form a built-in unit that encloses the turret between the second and third decks. With an outside diameter of 40.50 feet at the bottom (39.67 feet at the top), the ship's three lower barbettes have different heights because of the different heights of circular foundations. This barbette dimension (maximum) is 140.08 inches for turret I, 118.88 inches for turret II, and 109.88 inches for turret III. With a plate thickness of approximately three inches, the lower barbettes are supported at their lower edges by the third deck.

Ordnance installations

The ordnance installations mounted in the turret rotating structure (described on page 1-3) comprise the units shown in figures 1-1 and 1-5 and in the turret floor plans (figs. 1-6 to 1-10 inclusive). These installations are of the following types and design identities.

Ordnance types. Each turret ordnance assembly comprises units of the following types:

Gun and slide assemblies
Gun laying equipment
Projectile stowing and handling equipment
Ammunition hoist and gun loading equipment
Fire control equipment

Ordnance design identities. Ordnance equipment of the above types include one or more units of the following 16-inch design identities.

GUN AND SLIDE ASSEMBLIES, 16-INCH

Gun Mk 7 Mod 0
Beech Mechanism Mk 4 Mod 0
Firing Lock Mk 14 Mod 0
Gas Ejector Mk 5 Mod 0
Yoke Mk 5 Mod 0
Slide Mk 6 Mod 0
Deck Lug Mk 7 Mod 0

GUN LAYING EQUIPMENT, 16-INCH

Training Gear Mk 2 Mod 0
Train Receiver-Regulator Mk 18 Mods 5, 6, and 7
Elevating Gear Mk 5 Mods 0, 1, and 2
Elevation Receiver-Regulator Mk 10 Mod 0

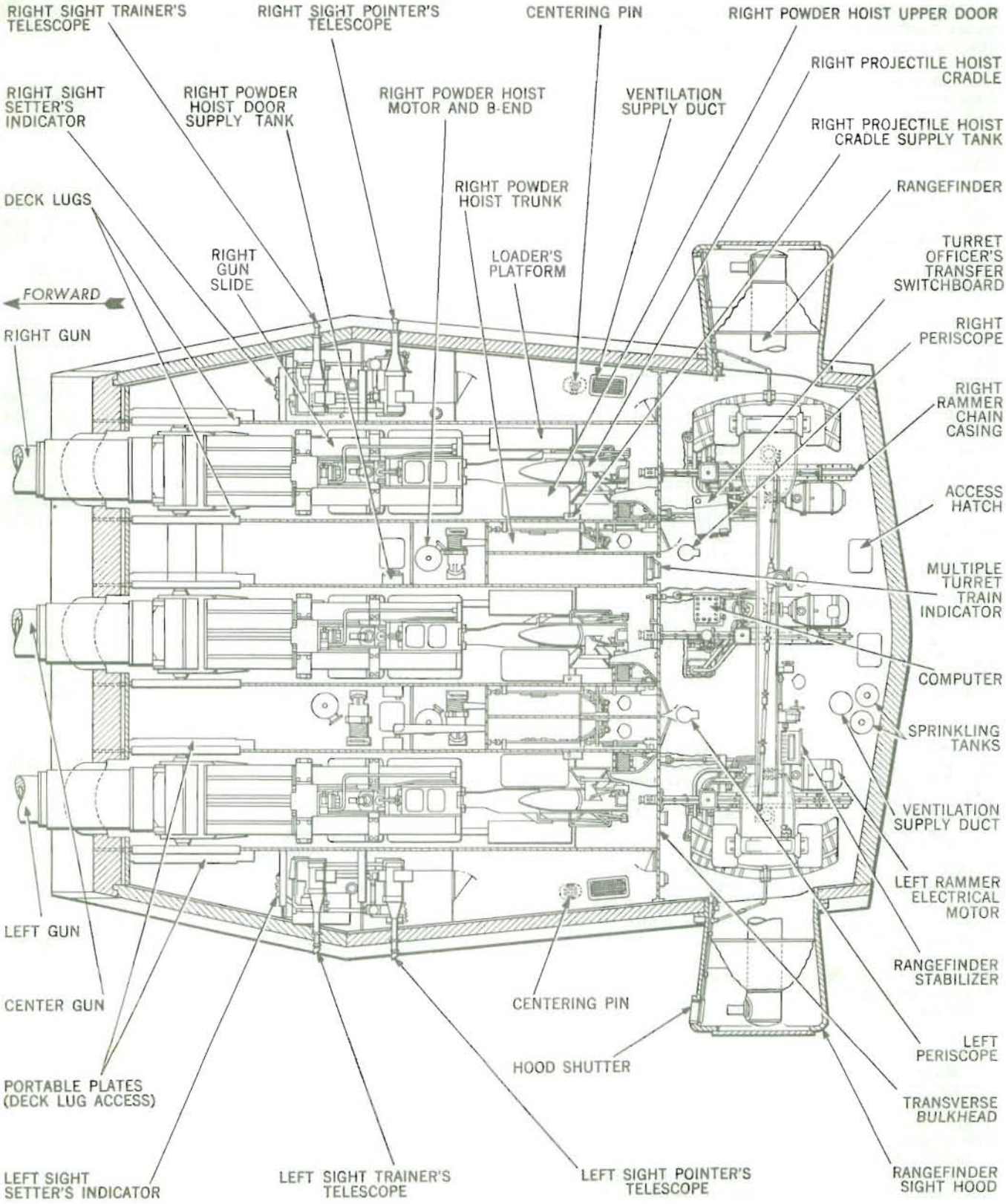


Figure 1-6. Ordnance Equipment in Gun House - General Arrangement - Plan View

PROJECTILE STOWING AND HANDLING EQUIPMENT, 16-INCH

Projectile Ring Mk 2 Mod 0
Parbuckling Gear Mk 1 Mod 0

AMMUNITION HOIST AND GUN LOADING EQUIPMENT, 16-INCH

Projectile Hoist Mk 8, Mods 0, 1, and 2
Rammer Mk 5 Mods 0, 1, and 2
Powder Hoist Mk 9 Mods 0 to 8 inclusive

FIRE CONTROL EQUIPMENT

16-inch Sight Mk 4 Mods 2 and 3
Sight Setters Indicator Mk 3 Mods 2, 3, 4, and 5
Gun Elevation Order Transmitter Mk 2 Mods 0 and 1
Gun Elevation Indicator Mk 33 Mods 3 and 4
Turret Train Indicator and Transmitter Mk 37 Mods 4, 5, and 6
Multiple Turret Train Indicator Mk 12 Mods 5, 6, 7, and 9
Computer Mk 3 Mod 2
Rangefinder Mks 52 and 53 Mod 0 *
Rangefinder Stand Mk 52 Mod 0 *
Firing Circuit Mk 3 Mod 0
Lighting Circuit Mk 3 Mod 0
Telescope Mk 66 Mod 0
Battle Order Indicator Mk 28 Mod 0

Turret ordnance assembly references. The exact number and identity of each of these turret assembly components are listed in the tabulations of 16-inch Turret Assemblies appended at the back of this book. These lists include references identifying the Fire Control Equipment Lists of Drawings of Assemblies and the Turret Ordnance Equipment Lists of Drawings of Assemblies for every turret installation of the IOWA class.

Turret ordnance location arrangements. All ordnance items listed above and on page 1-9 are mounted in the rotating structure as indicated in the following description of the turret floor levels.

Gun house ordnance arrangement. The location arrangement of the gun house ordnance equipment is shown in figure 1-6. In addition, the positions and relative sizes of some elements of the ventilating and sprinkling systems (pages 1-18 and 1-19) are shown.

In the gun house are located all units of all three guns (except the forward portions of the (barrels), the rammers, projectile cradles, and the upper doors of the powder hoists. In addition, this space encloses components of the fire control equipment. These are grouped in three locations as follows: The turret officer's compartment and identical left and right sight control stations. The latter two each have a sight setter's indicator, a pointer's and a trainer's telescope, and a gun elevation order transmitter. In the turret officer's compartment are the rangefinder, multiple turret train indicator, turret officer's and turret captain's indicator panels and periscopes, auxiliary computer, transfer switchboard, and communication facilities. These are identified in the descriptions of the fire control arrangements (page 1-16).

*Turrets II and III only

Within the box girder weldments are the powder hoist power drives and the hoist operators' stations.

Access to the gun house is provided by the large hatch toward the rear of the gun house overhang. The small hatch is for emergency use.

Pan floor ordnance arrangement. The location arrangement of the pan floor ordnance equipment is shown in figure 1-7. In the pan floor spaces (gun pockets) are the elevating gear B-ends and oscillating bearings. Within the box girder weldments and above the pan floor level are the training gear B-ends and brake assemblies. The wormwheel and pinions are in a separate compartment forward of the center gun pit together with training and elevating gear expansion tanks. The powder hoist trunks are enclosed and rise within the box girder weldments. The upper portion of the projectile hoists and the primerman's platforms are in the rear part of each gun pit.

Electric deck (machinery floor). The location arrangement of the pan floor ordnance equipment is shown in figure 1-8. In the electric deck spaces between the wing gun girders and box girder weldments are left and right gun elevating gear and projectile hoist power drive components and left and right gun layers' stations. The space between the two box girder weldments contains training gear power drive components and the main pump of the center projectile hoist. Within the right box girder (accessible through archways) are the center gun elevating gear power drive components and gun layer's station, and the right powder hoist trunk. Within the left box girder are components of the center projectile hoist power drive. The projectile hoist tubes rise through the rear part of each space between gun girders.

Fire control equipment in the electric deck spaces includes the elevation indicators, turret train indicator and transmitter, and other accessories at the gun layers' and train operator's stations.

Upper projectile flat ordnance arrangement. The location arrangement of the upper projectile flat ordnance equipment is shown in figure 1-9. In the projectile flat space within the circular bulkhead are the projectile ring power drive components, the powder hoist trunks, parbuckling gear motor, power drive electric controllers, and the central column and wiring recess. The projectile flat space between the circular bulkhead and circular foundation is divided into three concentric rings (two projectile stowage rings and a handling ring). The handling ring has six gypsy heads of the parbuckling gear, and three projectile hoists and loading apertures. In addition there are projectile ring and hoist control stations and an access hatch. The projectile rings are fixed and rotating stowage areas, the rotating (inner) ring being provided with a centering pin. Projectiles stowed on the rings are lashed in position.

Lower projectile flat ordnance arrangement. The arrangement of the lower projectile flat ordnance equipment is similar to that of the upper projectile flat with respect to the ammunition hoists, parbuckling gear, and projectile ring power drive installations. Projectile stowage is the same on the inner rings of each. Outer ring projectile stowage is different for the three turrets as described in chapter 7.

Within the circular bulkhead, the arrangement of power drive electric controllers differs from that of the upper deck.

Powder handling flat ordnance arrangement. The location arrangement of the powder handling flat ordnance equipment is shown in figure 1-10. In the rotating platform are the lower ends of the three powder hoist trunks with their lower doors and loading trays. The central column passes through the center of this platform which is centered within a fixed platform. A part of the fixed turret structure, this platform is enclosed within a circular bulkhead which is equipped with powder passing scuttles. The fixed platform also has powder bag immersion tanks. Additional powder passing scuttles are arranged in the circular foundation to align with those in the circular bulkhead.

Ordnance designs

The turret ordnance designs listed on page 1-9 have the following design features and characteristics.

Gun and slide assemblies. The assembled arrangements of a gun and slide assembly are shown in figures 3-1 and 4-4. This assembly comprises the following:

Gun
Breech mechanism
Firing lock
Gas ejector
Yoke
Slide
Deck lug

Gun. The gun is a rifled light weight type 16-inch, 50-caliber design. Built-up, it consists of a liner, tube, jacket, hoops, locking rings, a liner locking ring, and a yoke ring. The gun is chambered for a bag charge and is equipped with a carrier-type breech mechanism.

Breech mechanism. The breech mechanism is of the rotating plug and swinging carrier type with closure of the breech by a breech plug and obturator unit assembly. The breech plug and mating screw box liner are segmented with stepped screw threads.

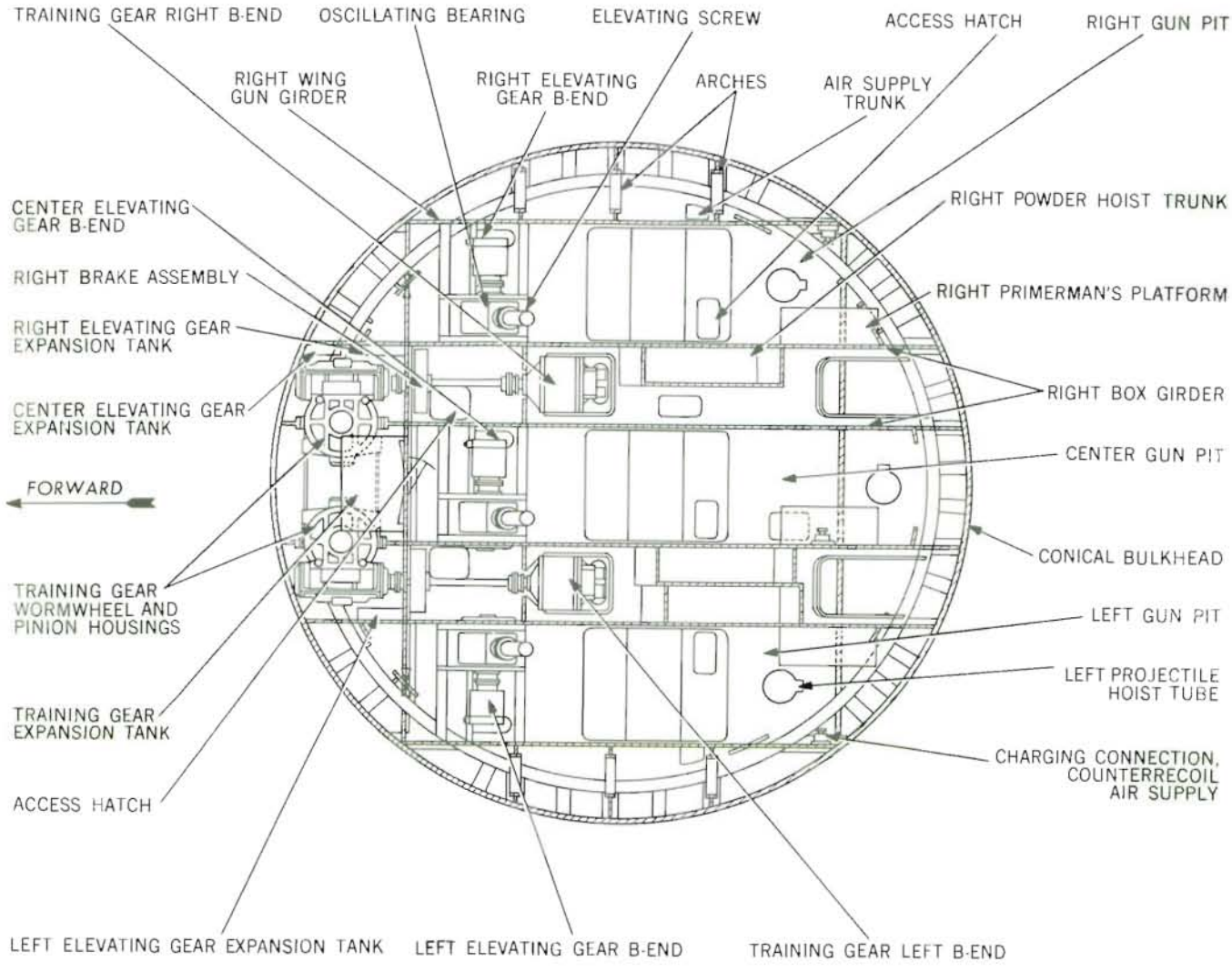


Figure 1-7. Ordnance Equipment on Pan Floor - General Arrangement - Plan View

Firing lock. The firing lock is a hand-primed wedge type automatically actuated by crosshead linkage of the breech mechanism. Normally the primer is fired electrically; however, the firing lock design provides for percussion firing in emergency.

Gas ejector. The gas ejector is an automatic, low-pressure air porting system which clears the bore when the breech is opened after a round has been fired. The system also provides air for the breech closing cylinders.

Yoke. The gun yoke is a large counterbalancing unit, mounted on the gun shoulder, that provides integral lug seats for the recoil cylinder piston rod and the counterrecoil cylinder yoke rods.

Slide. The slide is a large trunnion-pivoted assembly in which a single gun is mounted. A gun-supporting structure, the slide is also a gun recoil brake and a gun counterrecoil mechanism. In addition, the slide assembly has devices that secure the gun in battery position and the slide in stowed position.

Deck lug. The deck lug is a bearing block and roller bearing assembly that provides for frictionless elevating movement of the slide gun. Each deck lug is arranged with a bearing block and roller bearing assembly on either side of each slide.

Gun laying equipment. The gun laying equipment comprises the turret turning mechanism and gun elevating drives and their controls. These units consist of the training gear electric-hydraulic drive units and the train receiver-regulator, and three elevating gear electric-hydraulic drive units and receiver-regulators. In addition, there is sight control station equipment for train and elevation.

Training gear. The training gear is an annular stationary gear rack type with pinion gears driven by an electric-hydraulic power drive, through twin worms and wormwheels.

The power drive consists of a 300-horsepower electric motor coupled to a reduction gear which drives an A-end pump assembly. The pump valve plate is hydraulically connected by a system of pipe manifolds to two B-end motors each of which drives a pinion gear through a worm and wormwheel assembly.

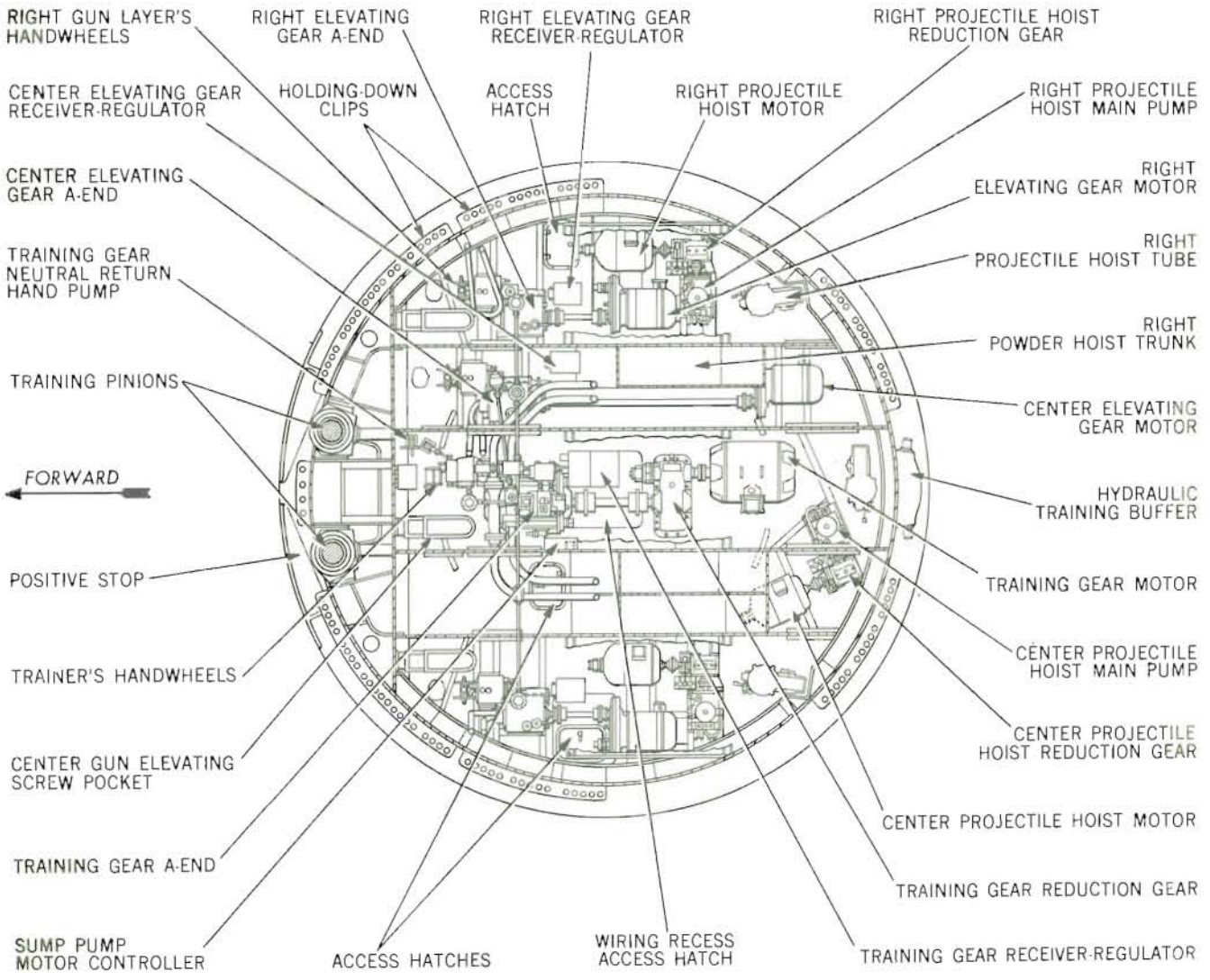


Figure 1-8. Ordnance Equipment on Electric Desk - General Arrangement - Plan View

Training gear control. Hydraulic fluid delivery to the B-end motors is controlled by varying the A-end pump displacement by an arrangement of hand and automatic servo controls. A control selector permits control selection of turret train either automatically from a remote station or by hand from a local trainer's station. The control method is selected by the train operator.

Train operator's control equipment. Control devices at the train operator's station enable him to start and stop the power drive, to select the method of control, and to control turret train in HAND control. The manner in which these devices are employed in the different control methods is explained in chapter 2.

Elevating gear. The turret elevating gear consists of three independent mechanisms. Each elevating gear is an electric-hydraulic power drive with an elevating-screw and oscillating-bearing type of final drive.

The power drive consists of a 60-horsepower electric motor directly coupled to a speed reducer, the output shaft of which drives an A-end pump assembly. The pump valve plate is hydraulically connected to a B-end hydraulic motor by two pipes, and the B-end output shaft is coupled to the elevating screw.

Elevating gear control. Hydraulic fluid delivery to the B-end motor is controlled by varying the A-end pump displacement by an arrangement of hand and automatic servo controls. The independent control selector for each gun permits control selection of gun laying from a remote station or hand control of gun laying from a local pointer's station. The control method is selected by the gun layer.

Gun layer's control equipment. Control devices at each gun layer's station enable him to start and stop the power drive, to select the method of control, and to control gun elevation in HAND and LOAD control. The manner in which these devices are employed in the different control methods is explained in chapter 2.

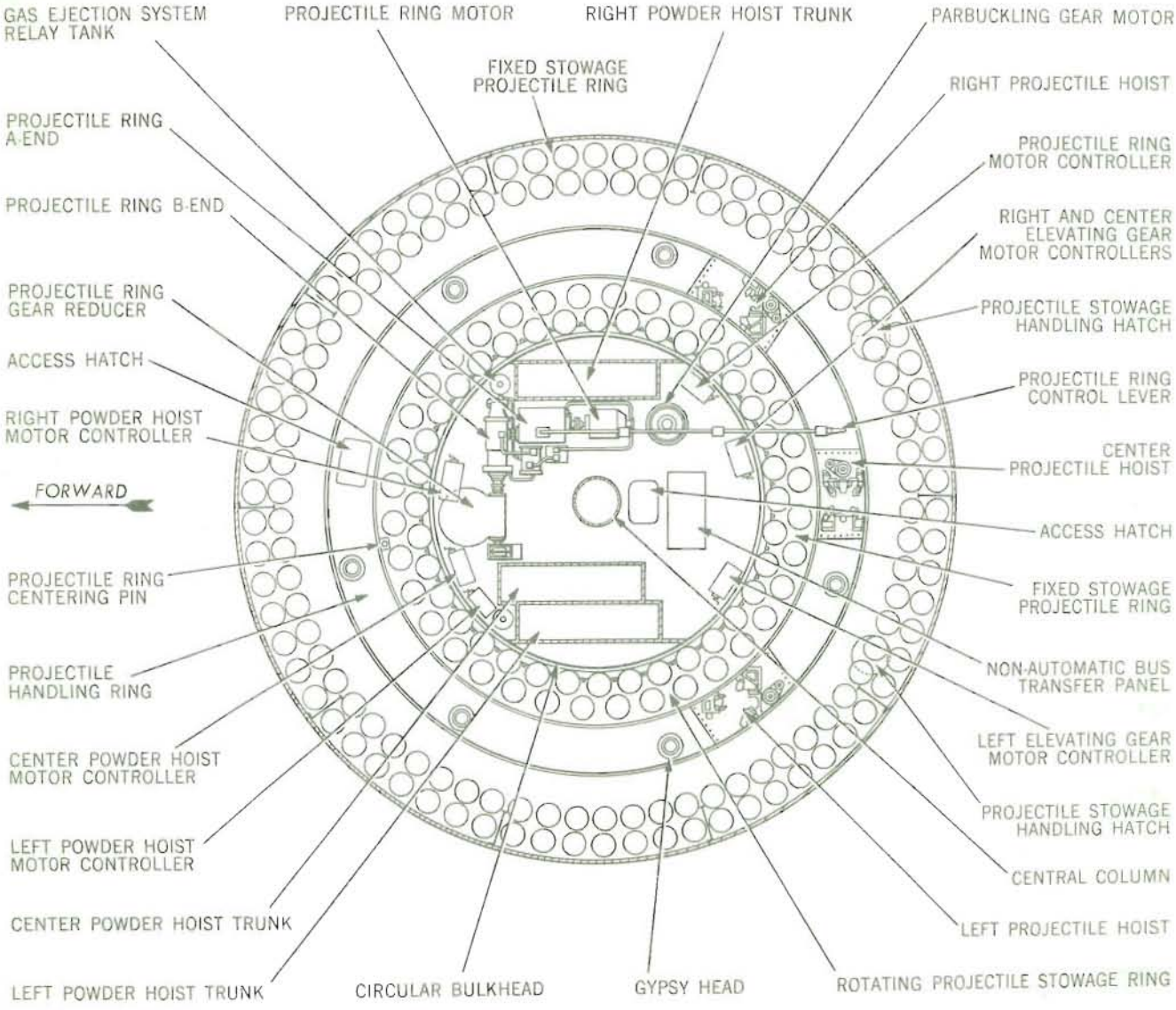


Figure 1-9. Ordnance Equipment on Projectile Flat - General Arrangement - Plan View

Projectile stowing and handling equipment. The two groups of equipment for stowing and handling projectiles include four power-driven assemblies installed in the projectile flats. These units are two projectile ring drives and two parbuckling gears.

Projectile ring drive. Each projectile ring has an attached annular rack which is driven by a spur pinion through a worm gear speed reducer and an electric hydraulic power drive. The ring, power drive, and control arrangements permit the ring to be driven clockwise or counterclockwise.

Identical installations, each power drive consists of a 40-horsepower electric motor, an A-end pump and control assembly, a B-end hydraulic motor and brake mechanism, and a manual control mechanism.

The A-end is a variable displacement pump with an automatic cycling control. This control device is a manually initiated type that operates the ring for a short arc of movement and then automatically decelerates, stops, and locks the ring.

The manual control mechanism is an arrangement of a hand lever, gears, and shafts coupled to the A-end control input. The direction of hand lever movement is the same as ring rotation.

Parbuckling gear. The two parbuckling gear installations are identical. Each consists of a 7.5-horsepower motor which drives a system of gear boxes and shafts that operate six gypsy heads. Three are located adjacent to the loading apertures of each projectile hoist; the other three gypsy heads are located at the forward part of the projectile flat. Driven at constant speed, all gypsy heads are in the center projectile flat ring.

Ammunition hoist and gun loading equipment. The projectile cradle and spanning tray for each gun are served with projectiles and powder bags by two separate ammunition hoists. The gun must be brought to a fixed loading position to permit delivery of the ammunition to the gun. The turret ammunition hoists are three similar projectile hoists and three similar powder hoists. Ammunition delivery (gun loading) is by three similar rammer installations.

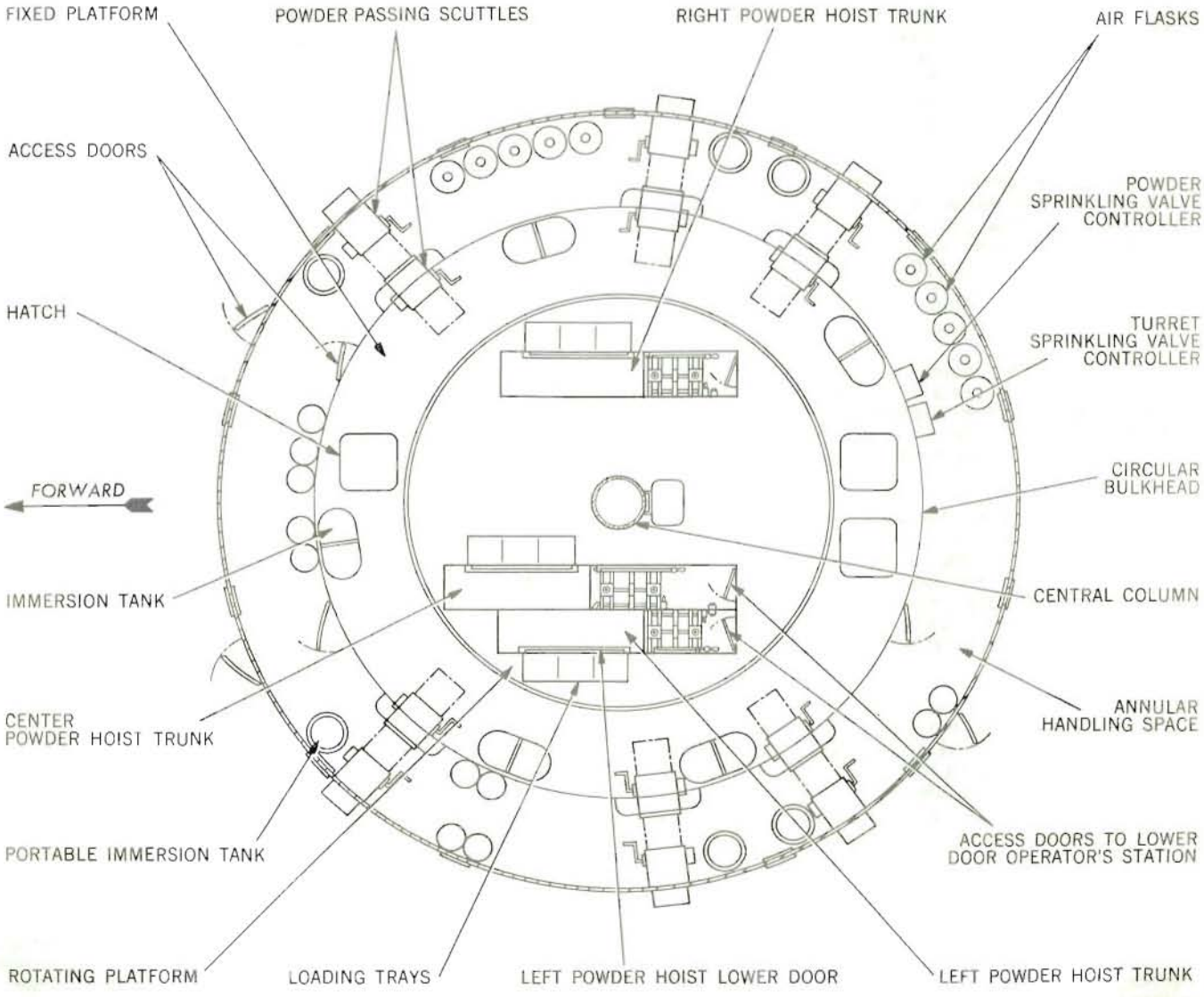


Figure 1-10. Ordnance Equipment on Powder Handling Flat - General Arrangement - Plan

Projectile hoists. Each projectile hoist assembly is a reversible rack and pawl tubular lift electric-hydraulically power driven. It is equipped with an independently controlled, hydraulic power-drive cradle assembly. The hoist supplies a projectile to the cradle assembly which aligns the projectile with the gun. When lowered (spanned), the cradle assembly extends the rammer track to the gun breech.

The tubular hoist courses, extending from the lower projectile flat to the projectile cradles, are each equipped with four stationary tube pawls. These tubular courses have integral tracks to guide the vertical movement of the rack which is equipped with five pawls. Projectiles when lifted by the rack are supported at the end of each of the first four lifting strokes by the tube pawls. The fifth lifting stroke places a projectile in the cradle.

At each projectile flat there is a loading aperture with shutter and control devices.

Hoist controls. An arrangement of hydraulic valves controls the actions of the hoist and cradle and reverses the pawls to lower the projectiles. Hoisting action control devices are arranged in duplicate, there being a manual control operating lever with indicators and interlock devices on each projectile flat adjacent to the hoist loading aperture. Cradle spanning control devices and controls for the hoist reversal mechanism are located in the gun room compartment at the cradle operator's station.

Hoist power drive. The hoist power drive consists of a 75-horsepower electric motor coupled to brake and reduction gear units. The reduction gear output shaft drives the main pump assembly, the valve plate of which is hydraulically connected to the upper and lower ends of the rack operating cylinder by two pipes. This arrangement is a hydraulic ram which raises or lowers the rack.

Rammer. The rammer is an electric-hydraulic mechanism that drives a folding chain through ramming and withdrawing movements. Manually controlled from the operator's station in the gun room compartment, the mechanism delivers ammunition to the gun.

Each power drive, identical for each gun, consists of a 60-horsepower electric motor directly coupled to a speed reducer, the output shaft of which drives an A-end pump assembly. The pump valve plate is hydraulically connected to a B-end hydraulic motor by two pipes with the B-end output shaft coupled to the chain driving sprocket.

Hydraulic fluid delivery to the B-end motor is controlled by varying the A-end pump displacement through a stroking control mechanism. A limit stop mechanism that is built into the B-end valve plate stops the rammer just ahead of its mechanical limit stops at the end of the ram stroke and at the end of the withdraw stroke.

Powder hoist. A functionally independent assembly, each powder hoist delivers a full service powder charge (of six bags) to a gun during each hoisting cycle. It is a vertical lift, electric-hydraulically driven, which raises or lowers a powder car confined within the spaces of a trunk. The car is loaded through the trunk lower doors and is unloaded in two stages through the trunk upper door.

The power drive consists of a 100-horsepower electric motor which is coupled to and drives an A-end pump assembly. Two pipes hydraulically connect the pump valve plate to a B-end motor. The B-end output shaft is connected to a hoisting drum which winds or unwinds the powder car hoist rope to raise or lower the car.

Hydraulic fluid delivery to the B-end motor is controlled by varying the A-end pump displacement by an arrangement of hand and servo controls the selection of which is made by the hoist operator. The hoisting and lowering acceleration and deceleration rates are controlled by B-end cams.

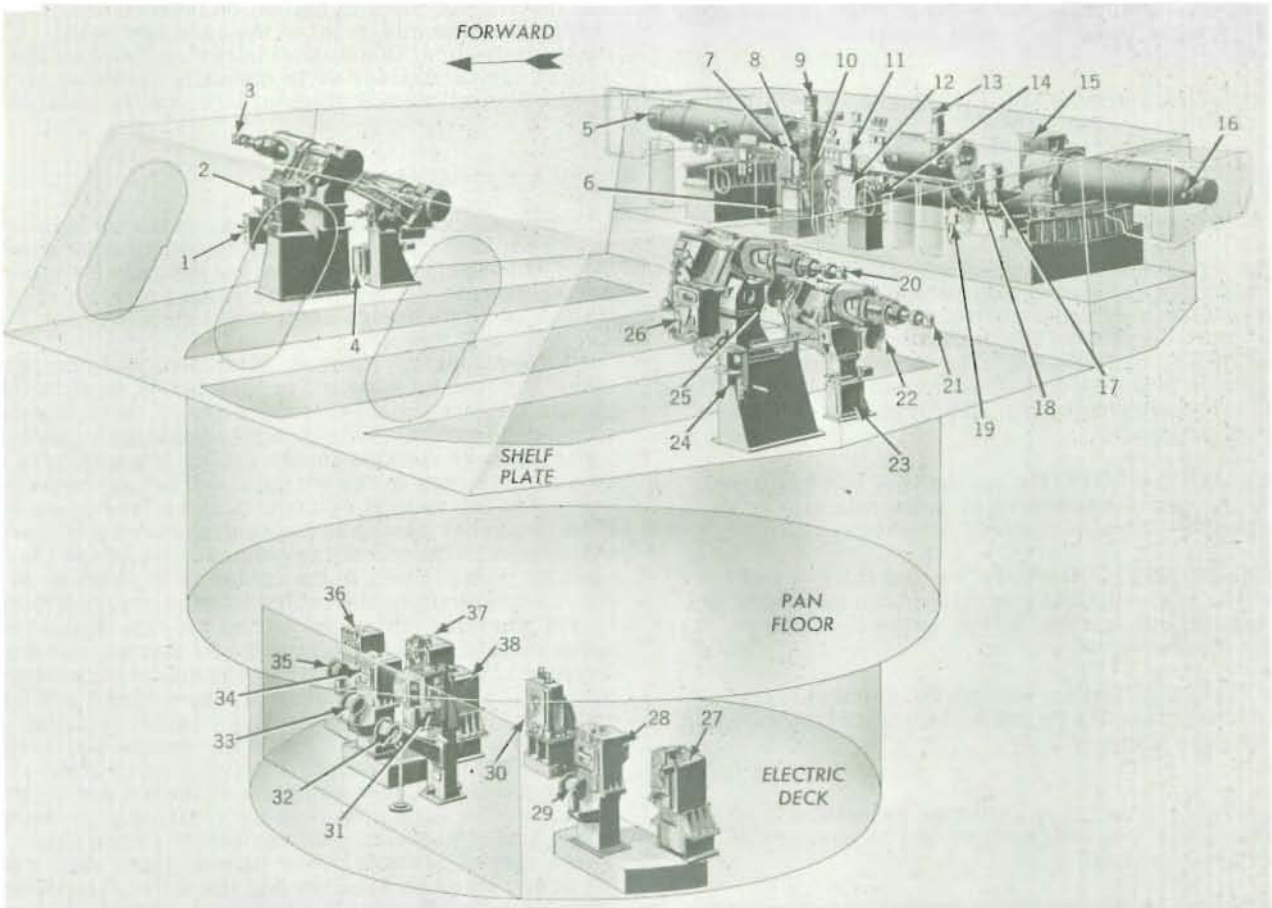
Fire control equipment. The sights and gun attachments, control instruments, and rangefinder listed on page 1-11 comprise the turret fire control equipment (fig. 1-11). This is supplemented by switching and communication devices and an extensive system of wire circuits of Bureau of Ships design and cognizance.

Sights and gun attachments. Turret local fire control arrangements comprise two interconnected sight assemblies and attached or associated instruments. The design is a carriage sight arrangement which functions as a directing type fire control assembly. Control may be selectively arranged to direct gun laying and turret train from either sight station.

Each sight station is a pedestal and bracket mounted arrangement of a sight trainer's and sight pointer's line-of-sight optic with a sight setter's indicator. The lines of sight are mechanically connected for simultaneous offset in deflection and sight angle from the sight setter's input. All lines of sight move together in response to the sight pointer's handwheel movement as the controlling sight pointer manipulates his handwheels to hold his telescope on the target. Sight angle and sight pointer's movements are transmitted electrically to instrument dials at the gun layer's stations. They are gun order directing movements and do not position the gun laying controls. Sight train is selectively arranged so that the sight trainer's handwheels may be clutched to the servo control of the training gear power drive. The mechanical system of gun order transmission extends transversely between the two sight stations and connects line-of-sight and sight setter outputs to all indicating instruments. Interconnected with manually operated, interlocked, synchronized selectors, either sight station can quickly assume control of gun direction.

Manual input movements at the sight setters' indicators (made in response to synchro-received, dial-indicated orders) offset the lines-of-sight in deflection and depression from parallelism with the guns. These values (sight deflection and sight angle) are transmitted mechanically to and simultaneously move the sight trainers' and sight pointers' optics. Transmitted mechanically to the gun elevation indicators, sight angle value is one of the factors used in computing erosion correction; the other factor being initial velocity loss.

Trainer's station. The optic at this station has deflection and depression controlled by the sight setters' indicator as described in the previous paragraph. This arrangement keeps the sight trainer on the target in elevation as the pointer elevates or depresses the guns. However, the trainer is compelled to operate his handwheels to train the turret for every change in sight deflection input or change in ship's course.



1. SIGHT ANGLE SYNCHRONIZING CLUTCH AND INTERLOCK
2. RIGHT SIGHT SETTER'S INDICATOR
3. RIGHT SIGHT TRAINER'S TELESCOPE
4. GUN ELEVATION ORDER TRANSMITTER
5. RANGEFINDER SIGHT
6. MULTIPLE TURRET TRAIN INDICATOR
7. TURRET OFFICER'S INDICATOR PANEL
8. TURRET OFFICER'S SELECTIVE SWITCH
9. TURRET OFFICER'S PERISCOPE
10. TURRET OFFICER'S TRANSFER SWITCHBOARD
11. REPRODUCER
12. TRANSMITTER CONTROL BOX
13. TURRET CAPTAIN'S PERISCOPE
14. AUXILIARY COMPUTER
15. RANGEFINDER STABILIZER CONTROL PANEL
16. RANGEFINDER SIGHT
17. TURRET CAPTAIN'S INDICATOR PANEL
18. RANGEFINDER STABILIZER
19. SHIP'S SERVICE TELEPHONE
20. LEFT SIGHT TRAINER'S TELESCOPE
21. LEFT SIGHT POINTER'S TELESCOPE
22. LEFT SIGHT POINTER'S HANDWHEELS
23. GUN ELEVATION ORDER TRANSMITTER
24. SIGHT ANGLE SYNCHRONIZING CLUTCH AND INTERLOCK
25. LEFT SIGHT TRAINER'S HANDWHEELS
26. SIGHT SETTER'S INDICATOR
27. LEFT GUN ELEVATION RECEIVER-REGULATOR
28. LEFT GUN ELEVATION INDICATOR
29. LEFT GUN LAYER'S HANDWHEELS
30. TRAIN RECEIVER-REGULATOR
31. TURRET TRAIN INDICATOR AND TRANSMITTER
32. TRAIN OPERATOR'S HANDWHEELS
33. CENTER GUN LAYER'S HANDWHEELS
34. CENTER GUN ELEVATION INDICATOR
35. RIGHT GUN LAYER'S HANDWHEELS
36. RIGHT GUN ELEVATION INDICATOR
37. RIGHT GUN ELEVATION RECEIVER-REGULATOR
38. CENTER GUN ELEVATION RECEIVER-REGULATOR

Figure 1-11. Turret Fire Control Installation - General Arrangement

Pointer's station. Similar to the optic at the sight trainer's station, the pointer's optic has deflection and depression controlled by the sight setter's indicator as described previously. This arrangement compels the sight pointer to manipulate his handwheels to hold his line-of-sight on the target as the ship rolls or the sight angle is changed. Because of the offset value of the sight angle, the sight pointer is constantly holding the gun in correct range position.

Turret officer's control equipment. The turret officer's control equipment are optical, mechanical, and electrical devices for visual observation of fall of shot, for local communication, for local solution of firing problems, and for selection of alternative control methods.

The equipment is arranged with the ship's director system so that the turret may be operated in any one of several basic types of control and their variations. These control methods are designated: PRIMARY, SECONDARY, and LOCAL. The master selector for all controls is the large cabinet called the turret officer's transfer switchboard. Through this unit the turret is placed in:

PRIMARY CONTROL, so that the gun and turret drives are remotely controlled (automatically or by indicating) by the main battery directors; or,

SECONDARY CONTROL, so that the gun and turret drives are remotely controlled (automatically or by indicating) by another turret or the secondary battery directors; or,

LOCAL CONTROL, so that the gun and turret drives are controlled by the local gun sights, rangefinder, and computer.

Alternatives to these switching selections are included in the transfer switchboard to permit the following variations:

In "primary automatic" or "primary indicating" control, either selection can be controlled from Forward Plot or After Plot, using the forward or after main battery director.

In "secondary automatic" or "secondary indicating" control, either selection can be controlled from another turret or from Forward Plot or After Plot, using secondary battery directors.

Turret local control methods include sight control, rangefinder control, periscope control, and combinations of these. All use the local computer for solution of external ballistics.

Gun firing control. The firing lock and primer designs provide for electrical or percussion firing, with safety devices and special arrangements included in the electrical system. This is a selective firing control that interlocks with the gun loading and gun laying actions and permits local or remote firing. Safety features of the electrical circuit (in addition to automatic danger zone cutout switches) include manually operated firing stop switches accessible to the turret officer, each gun captain, each gun layer, each sight pointer, and the train operator.

Rangefinder equipment. Turrets II and III are equipped with rangefinder mount equipment located and arranged at the rear of the turret. The rangefinder is mounted on a stand which supports the rangefinder horizontally in a carriage which pivots the instrument for both elevation and azimuth movements. The instrument rotates in carriage bearings for elevation of the lines-of-sight (movement counter to roll of ship). For azimuth movement, the entire carriage and instrument pivot in deflection through slight arcs centered at the mid-point of the carriage beam. Elevating movement is automatically stabilized by the rangefinder stabilizer or is manually operated by hand gear. The azimuth movement is manually operated.

Auxiliary installations

Turret auxiliary installations, which include power supply, illumination supply, ventilating systems, and sprinkling systems are described in following paragraphs. These facilities are units of Bureau of Ships design and cognizance.

Power supply. Normal, alternate, and emergency electric power is supplied to each turret from two of the ship's four main 440-volt, 3-phase, 60-cycle twin turbo-generators. This power is supplied to each turret through flexible feeder cables originating at connection boxes in the wiring trunk below the base casting of the central column. Cables lead upward through spacer blocks in the central column to a wiring recess at the top of the column, just below the electric deck. Slack in the cables at the bottom of the column permits the cables to twist and flex during turret rotation. From the wiring recess, the normal and alternate cables are routed to a manual bus transfer panel located in the machinery space of the upper projectile flat. The panel is equipped with switches and indicator lights for selection of either normal or alternate power supply. From the manual bus transfer panels power is supplied to five circuit breaker power panels. These comprise three for gun equipment (one for each gun), one for training gear equipment, and a miscellaneous equipment power panel. These circuit breaker power panels supply power to all power drive controllers and the several auxiliaries, except for the illumination system. The emergency cable is routed to the I.C. and F.C. power panel located in the electric deck.

Illumination supply. Power for the illumination system is supplied to each turret form the 120-volt, 60-cycle ship's electric service system. The power is supplied to the turret by flexible cable, through the central column, similar to the arrangements described in the preceding paragraph. From the wiring recess at the top of the central column, the cable is routed to two automatic bus transfer panels located on the electric deck and pan floor. The panels automatically transfer the 120-volt supply from normal to emergency, or visa versa, when required.

Ventilating system. Eight self-contained ventilating systems (fig. 1-12) supply fresh air under forced draft to all turret levels and spaces, except the powder handling room. All systems have fresh air intake through the gun house overhang and are provided with two-speed remote push-button operating controls. Each system comprises an electric motor-driven fan set and necessary air supply ducts. The fan sets are equipped with three- or four-horsepower motors and supply air (at the rate of 4000 or 6000 cubic-feet-per minute respectively) as follows:

4000 Cubic Feet Per Minute Sets

Set 1 supplies air to the turret officer's booth through a vertical supply duct located near the rear armor plate, left of the turret center line. The system intake and supply trunk is at the rear of the gun house with an air supply passage directly below the fan set and duct. The ON-OFF and speed selection push-button control is located in the turret officer's booth on the transverse bulkhead (left end).

Set 2 supplies air to the left gun chamber through a horizontal duct with exhaust into the passage to the left sight control station. The system intake and supply trunk is at the left, rear corner of the gun house with an air supply passage leading to the fan set and duct. The ON-OFF and speed selection push-button control is located in the left gun chamber adjacent to the gun captain's station.

Set 3 supplies air to the right gun chamber through a horizontal duct with exhaust into the passage to the right sight control station. The system intake and supply trunk is at the right, rear corner of the gun house with an air supply passage leading to the fan set and duct. The ON-OFF and speed selection push-button control for this system is located in the right gun chamber adjacent to the gun captain's station.

Set 4 supplies air to the center gun chamber through a horizontal duct with exhaust in the rear of the gun chamber below the shelf plate. The system intake and supply trunk is at the rear of the gun house (right of the turret center line) with an air supply passage leading to the fan set and duct. The ON-OFF and speed selection pushbutton control for this system is located in the center gun chamber adjacent to the gun captain's station.

6000 Cubic Feet Per Minute Sets

Set 1 supplies air to the right side of the electric deck, and the right side of the upper and lower projectile flats. The system intake and supply trunk is forward of the right, rear corner of the gun house with a vertical air passage aft of the fan set. The ON-OFF and speed selection push-button control for this system is located in the turret officer's booth on the transverse bulkhead (right end).

Set 2 supplies air to the righ sight control station, right powder hoist and hoist power drive spaces, training gear right B-end, and the right side of the electric deck and upper and lower projectile flats. The system intake and supply trunk is forward of the right, rear corner of the gun house (common with the intake and supply trunk for Set 1). The ON-OFF and speed selection push-button control for this system is located in the turret officer's booth on the transverse bulkhead (right end).

Set 3 supplies air to the left side of the electric deck, and the left side of the upper and lower projectile flats. The system intake and supply trunk is forward of the left, rear corner of the gun house with a vertical passage aft of the fan set. The ON-OFF and speed selection push-button control for this system is located in the turret officer's booth on the transverse bulkhead (left end).

Set 4 supplies air to the left sight control station, left and center powder hoists and hoist power drive spaces, training gear left B-end, and the left side of the electric deck and upper and lower projectile flats. The system intake and supply trunk is forward of the left, rear corner of the gun house (common with the intake and supply trunk for Set 3). The ON-OFF and speed selection push-button control for this system is located in the turret officer's booth on the transverse bulkhead (left end).

In addition to the intake and supply trunks, and the fan sets described above, the ventilation systems have other equipment described below.

There are intake and exhaust holes in the shelf plate (overhang). Arranged between the intake and supply trunks, and the system air supply passages, the intake holes permit air circulation while providing less armor protection. Exhaust holes permit regulated air escape from exhaust passages.

An air circulation duct in each sight station aids in circulating air through the sight station.

A manually-operated airtight cover over the turret officer's booth exhaust opening provides for regulation of air pressure build-up and for wet weather closure of the exhaust opening.

Air circulation and exhaust holes in the foundation and electric deck bulkheads aid in keeping air in motion.

A gas and air seal between the powder handling room and lower projectile flat maintains air pressure in the upper turret spaces.

Pressure relief and automatic exhaust shutters in the powder hoists and box girders prevents excessive air pressure build-up in these spaces.

Exhaust shutters in the gun chambers and powder hoist operators' stations maintain air pressure at these stations.

The ventilating systems maintain air pressure slightly in excess of 1.0 pound per square inch. This is controlled by exhaust arrangements which include spring- and weight-loaded automatic shutters. Manually-operated doors in intake and exhaust ducts prevent entrance of water in heavy weather.

Electrical components of the ventilating systems, described in chapter 15, include eight motors provided with individual controllers, and push-button stations. Each push-button station is labeled with a designation of the system it operates.

Sprinkling system. The turret sprinkling system (fig. 1-13) is designed to provide a quick and efficient means of sprinkling all ammunition in the turret -- whether in transit via the ammunition hoists, ready for transit in the loading trays, or ready for loading into the gun. It is a mechanically and hydraulically operated system which permits selective or overall control of sprinkling from both local and remote stations within the turret, as well as from a station outside the turret.

The sprinkling system includes a primary source of water from the ship's firemain, and two sprinkling tanks for water storage within the gun house. In addition the system has an air supply to maintain water pressure in the tanks and an assortment of control and operating valves, and associated nozzles, piping, and tubing described in chapter 16.

LEGEND FOR FIGURE 1-12

4000 Cubic Feet per Minute Sets

Set 1 From turret overhang (rear, left of centerline) to turret officer's booth

4. Intake and supply trunk
5. Fan set and air supply duct

Set 2 From turret overhang (left rear corner) to left gun chamber and left sight station passage.

11. Intake and supply trunk
15. Air supply duct

Set 3 From turret overhang (right rear corner) to right gun chamber and right sight station passage.

1. Intake and supply trunk
55. Air supply duct

Set 4 From turret overhang (rear, right of centerline) to center gun chamber

2. Intake and supply trunk
53. Fan set and air supply duct

6000 Cubic Feet per Minute Sets

Set 1 From turret overhang (forward of the right, rear corner), to right side of electric deck and upper and lower projectile flats

44. Air supply ducts, lower projectile flat
45. Air supply duct, upper projectile flat
46. Air supply duct, electric deck
48. Fan set
52. Air passage opening
56. Intake and supply trunk

Set 2 From turret overhang (forward of the right, rear corner) to right sight control station, right powder hoist, powder hoist and training gear power drive spaces, and right side of electric deck and upper and lower projectile flats

7. Air supply duct, hoist operator's station
13. Automatic air supply shutter
23. Air supply duct, right sight station
24. Air supply duct, powder hoist machinery space
35. Air supply duct, training gear right B-end
36. Air supply duct, center gun layer's station
37. Air supply duct, right gun layer's station
38. Air supply duct, machinery space upper flat
41. Air supply duct, lower projectile flat
42. Air supply duct, machinery space lower lower flat
47. Fan set
52. Air passage opening
56. Intake and supply trunk

Set 3 From turret overhang (forward of the left, rear corner) to left side of electric deck and upper and lower projectile flats

12. Intake and supply trunk
17. Air passage opening
25. Air supply duct, electric deck
26. Fan set
31. Air supply duct, upper projectile flat
39. Air supply duct, lower projectile flat

Set 4 From turret overhang (forward of the left, rear corner) to left sight control station, left and center powder hoists, powder hoist and training gear power drive spaces, and left side of electric deck and upper and lower projectile flats

9. Air supply duct, center hoist operator's station
10. Air supply duct, left hoist operator's station
12. Intake and supply trunk
14. Automatic air supply shutter
16. Air supply duct, left and center powder hoist machinery space
17. Air passage opening
19. Air supply duct, left sight station
20. Automatic air supply shutter
21. Air supply duct, left powder hoist machinery space
22. Air supply duct, center powder hoist machinery space
27. Fan set
30. Air supply duct, left gun layer's station
32. Air supply duct, training gear left B-end
33. Air supply duct, train operator's station
34. Air supply duct, upper projectile flat
40. Air supply duct, upper projectile flat

Allied Equipment

3. Intake holes in overhang
6. Exhaust holes in overhang
8. Manually operated airtight cover (exhaust opening) turret officer's booth
18. Air circulation duct, left sight station
28. Air circulation holes
29. Air exhaust holes in foundation bulkhead
43. Gas and air seal
49. Pressure relief shutters from powder hoists
50. Automatic exhaust shutters in right and left box girder weldments
51. Air circulation duct, right sight station
54. Exhaust shutters from powder hoists and gun chambers

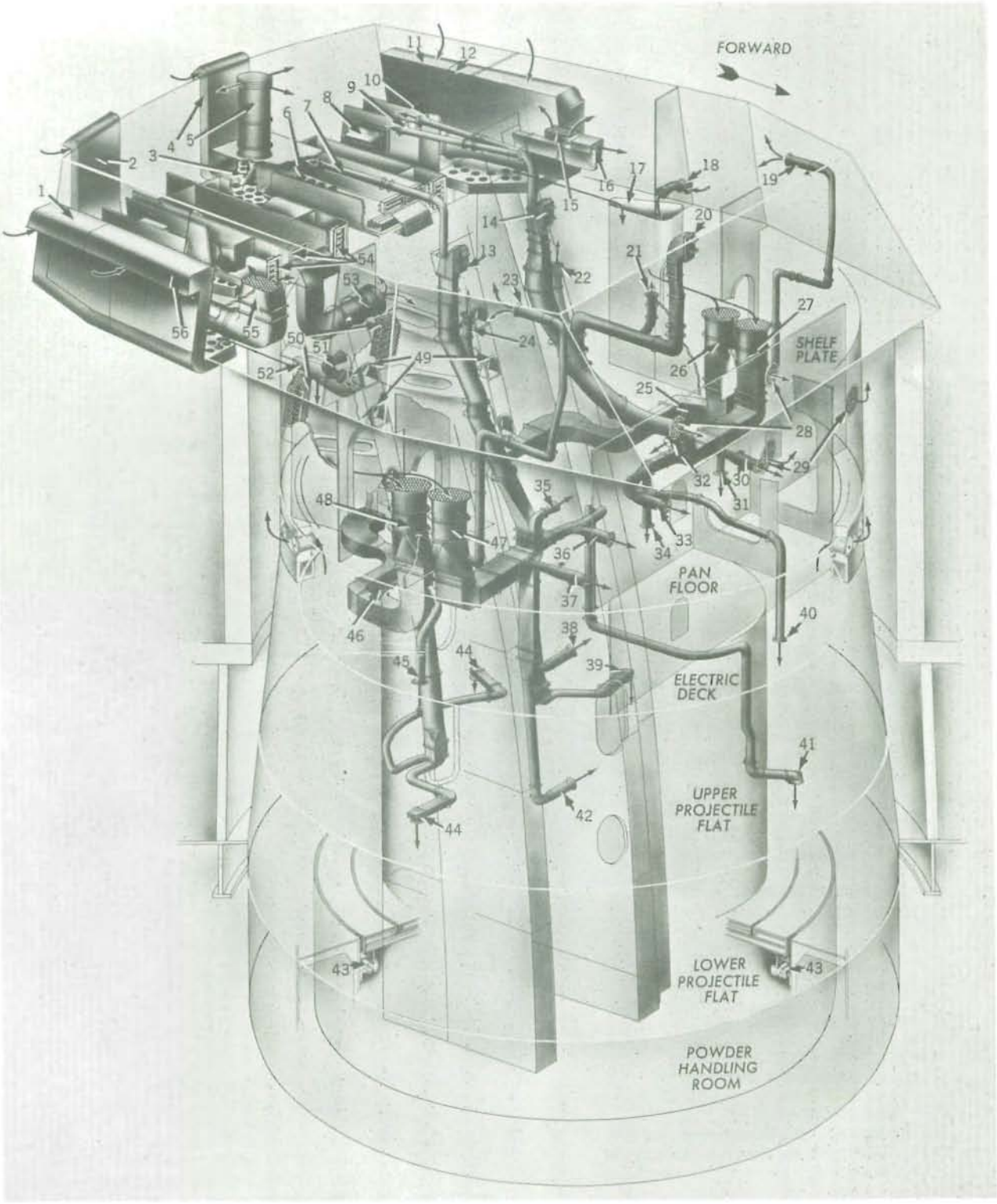


Figure 1-12. Turret Ventilating Systems - General Arrangement

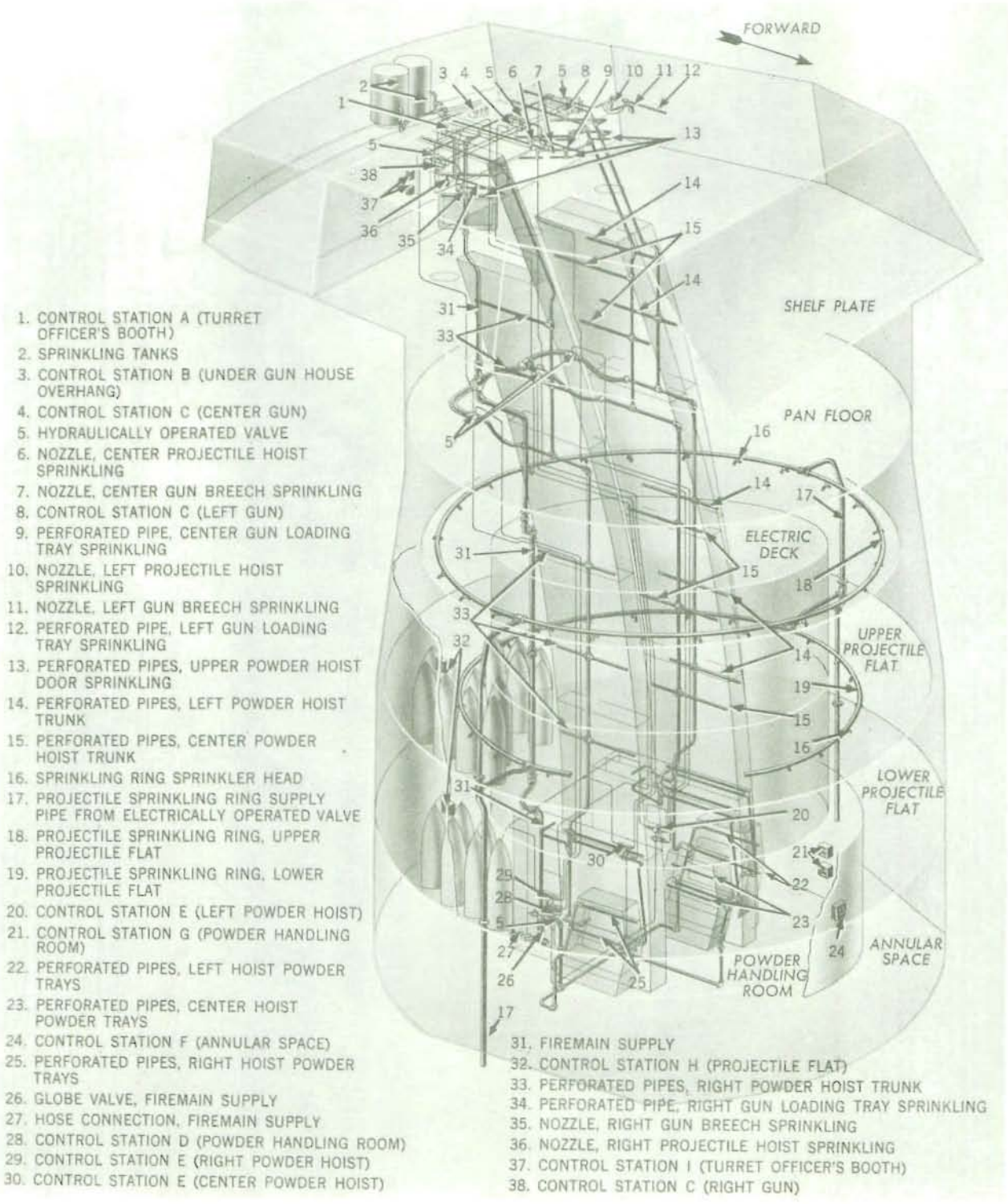


Figure 1-13. Turret Sprinkling System - General Arrangement

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Turret sprinkling control stations. Selective control of the turret sprinkling system is provided at both local and remote control stations. These are designated alphabetically, and consist of stations A to I inclusive, arranged as shown in the following table:

Control Station	Location	Manual Control Valve	Controls Sprinkling Of
A	Turret officer's booth	1	Powder hoists
		2	Gun rooms
B	Beneath the turret overhang	1	Powder hoists
		2	Gun rooms
		3	Annular space
C	Station C in each gun room	1	Gun room (local)
		2	Powder hoist (adjacent)
D	Powder handling room	1	Powder trays
E	Station E on each powder hoist trunk in powder handling room	1	Powder hoist (adjacent)
F	Annular space (powder handling room)	1	Annular space
G	Powder handling room	1	Projectile flats
		2	Annular space
H	Station H on each projectile flat	1	Projectile flats
		2	Projectile flats
		3	Projectile flats
I	Turret officer's booth	1	Annular space
		2	Projectile flats

Sprinkling system - electrical. An electrically operated valve system provides turret sprinkler control from a number of locations within the turret, from outside the turret on the overhang, or from related damage control stations. The system provides controlled sprinkling of the projectile stowage areas of each flat and the powder passing scuttles of the powder handling room. It is a separate system, separately controlled, and is not part of the mechanically and hydraulically operated system which provides sprinkling protection at each gun breech, loading tray, projectile hoist, and powder hoist trunk. The electrical sprinkling system (described in chapter 15) has sprinkling control of specific areas as indicated in figure 15-71.

Communications

The primary circuits which provide various types of communications within each turret, between turrets, and between the turrets and other ship stations are listed below. A brief description of each circuit follows the listing. Circuit extent and arrangements are shown in figures 1-14 and 1-15.

SYSTEM	CIRCUIT IDENTITY
Depression and train stop signal	DS
Intra-turret emergency alarm	RA
Train warning signal	TW
Turret announcing:	
Turret I	11 MC
Turret II	12 MC
Turret III	13 MC
Battle telephone	JA
Supplementary telephone	XJ
Sound-powered telephone and voice tube call bell	E
Ship's service telephone	J

Depression and train stop signal system (circuit DS). Circuit DS is an arrangement of a three-dial and three one-dial indicators located at the train operator's and gun-layers' stations respectively. The circuit is interconnected with six switches which are located as described on page 6-19 (chapter 6). Circuit DS opens the firing circuit of individual guns, and warns (by the indicator lights) when a gun's line of fire approaches the ship's superstructure.

Intra-turret emergency alarm system (circuit RA). Circuit RA is an arrangement of nine electrically operated sirens, strategically located throughout the turret, which are activated whenever serious danger exists or serious casualty has occurred. Control stations for the siren contact makers are located within the turret, on the various levels.

Train warning signal system (circuit TW). At times other than general quarters, the train warning signal system is used to warn ship's personnel on deck that the turret is about to train. It consists of a watertight warning bell, mounted on the exterior of the turret (under the turret overhang), which is energized by a normally open push-button within the turret officer's compartment.

Turret announcing system (circuits MC). The turret announcing system permits the turret officer to communicate with all principal stations within the turret. A transmitter control box within the turret officer's compartment provides communication with any or all stations, or a combination of stations. The system comprises an amplifier, 16 reproducers, and a portable microphone. Reproducers are of two types, one with a talk-back switch, and one without a talk-back switch.

Battle telephone system (circuits JA). The battle telephone system provides telephone connections between certain key personnel within the turret, and the ship's main battery plotting rooms. Push-to-talk button handsets and headsets with breastplate support and push-button controlled transmitters are used.

Supplementary telephone system (circuit XJ). The supplementary telephone system for the turret officer, comprises six local telephone circuits. Telephone equipment used is identical to that used for circuit JA. The circuits link the turret officer with the pointer's circuit (sight control station personnel, gun layers, and train operator), ammunition circuit (gun captains, projectile flats, powder handling room, and outside turret safety watch), subcaliber circuit, and the three powder hoist circuits which have connections with the gun captains.

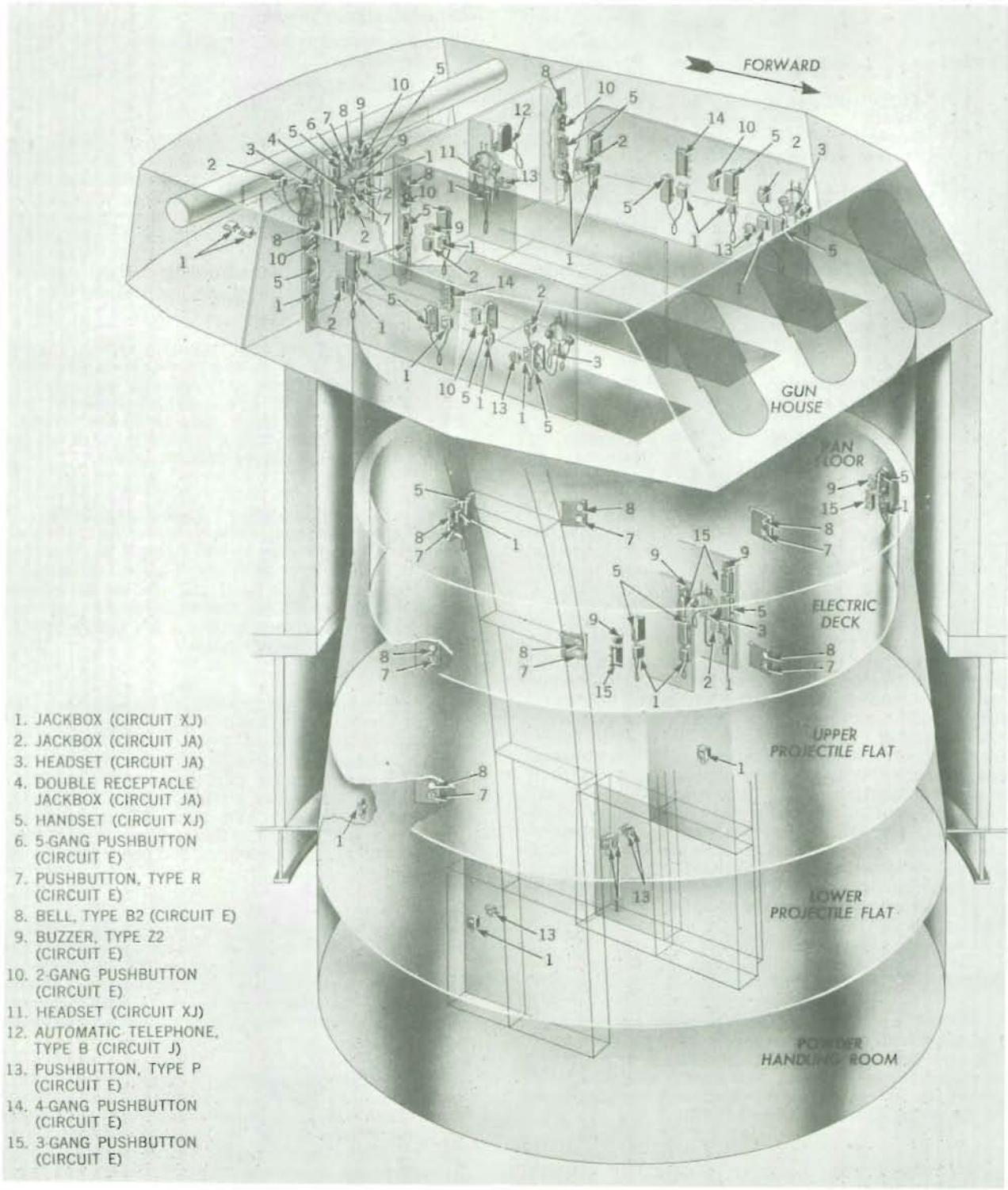

Figure 1-14. Turret General Communications System - General Arrangement

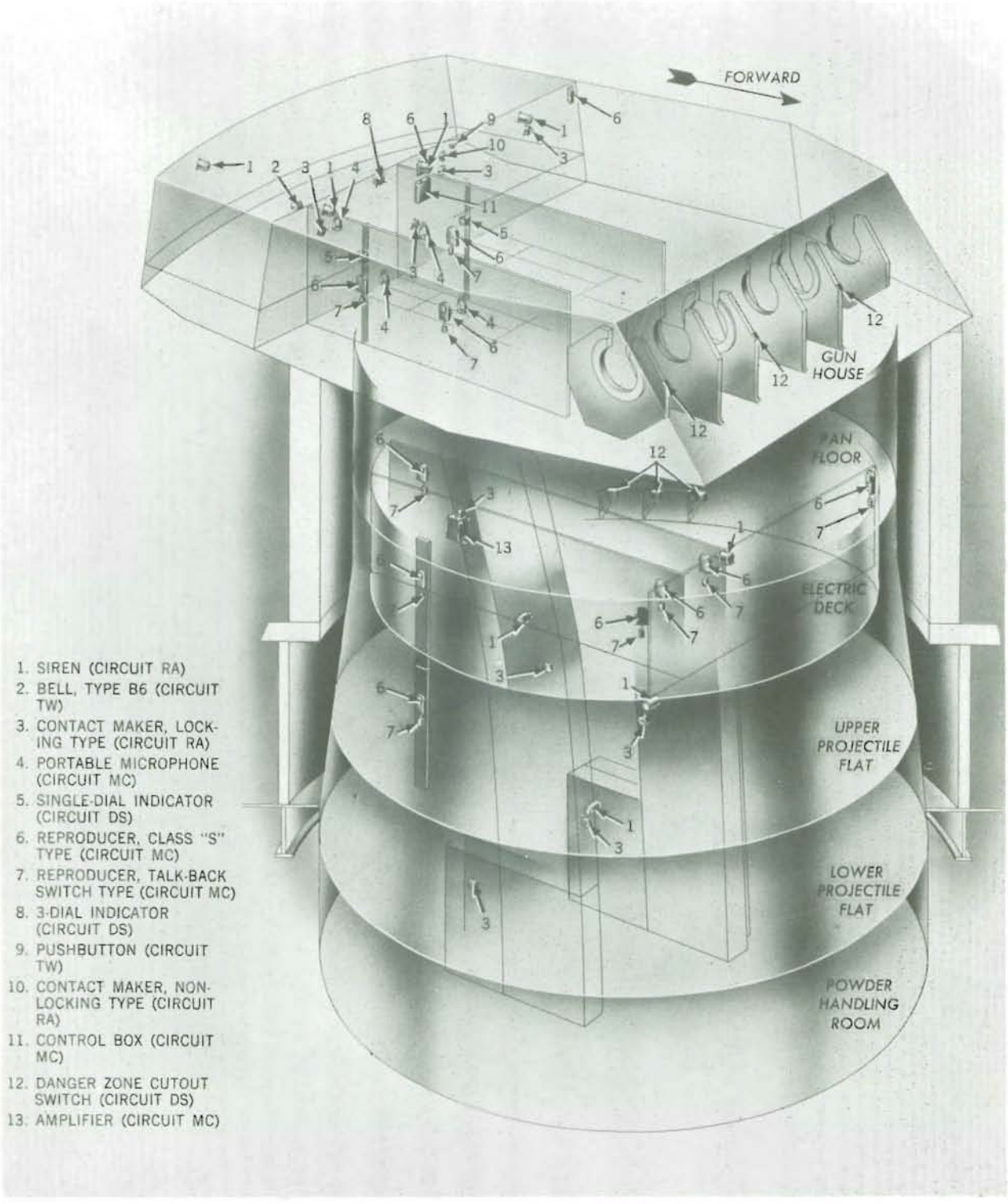

Figure 1-15. Turret Interior Communications System - General Arrangement

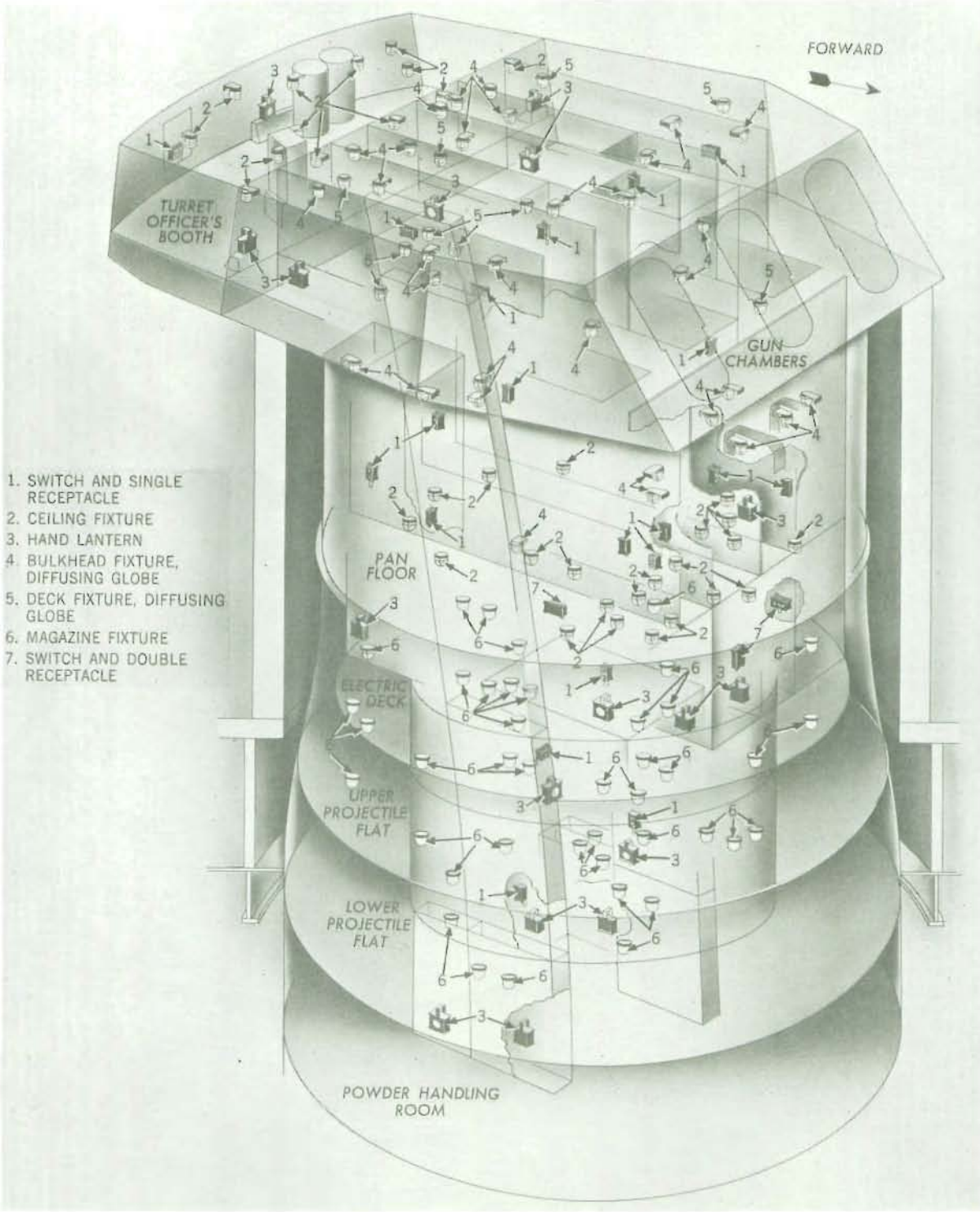

Figure 1-16. Turret Illumination - General Arrangement

Sound powered telephone and voice tube call bell system (circuit E). The sound powered telephone and voice tube call bell system comprises an audible call system which parallels most circuits of the turret officer's telephone system (XJ circuits) and most voice tubes. It includes bells and buzzers and associated push-buttons.

Ship's service telephone system (circuit J). The ship's service telephone system is a dial-type telephone system which connects the turret, through a central switchboard, to any similar dial telephone in the ship. Two telephones are located in the turret, one in the turret officer's compartment, and one in the electric deck space.

Illumination

Turret illumination in each turret comprises a general turret lighting system and a battle or instrument lighting system. In addition there is rangefinder de-icing equipment.

General turret illumination. The general turret lighting system comprises lighting fixtures, switch and receptacle units, hand lanterns, branch boxes, distribution boxes, and associated wiring (fig. 1-16). Normal and emergency power supply for the system is derived from the 120-volt, 60-cycle ship's service system through the automatic bus transfer panel. This equipment automatically switches from normal to emergency power (or vice versa) should there be failure in either power supply.

General illumination throughout the turret is provided by fixtures of the deck, bulkhead, or magazine type. Combination switch and receptacle units which provide an outlet source for trouble lights and various electrically operated portable devices are installed at convenient locations in each turret level. Hand lanterns, energized by self-contained dry-cell batteries, are located at convenient locations in the turret to provide emergency lighting.

Instrument illumination. The system that provides instrument illumination is a 6-volt circuit designated 16-inch Lighting Circuit Mk 3 Mod 0. This is a three division circuit (fig. 1-17) that controls lamp wells and reticle lamps which illuminate indicating dials and telescope crosslines. Two of these divisions illuminate instruments in the gun rooms and sight stations and the various reference marks, scales, and reticles of the rangefinder. The third division provides instrument lighting on the electric deck at gun layers' and train operator's stations.

The circuit is arranged to be supplied from a transformer or storage battery. Its components are two transformers, two storage batteries, two snap switches, six rheostats, branch boxes, and connection boxes.

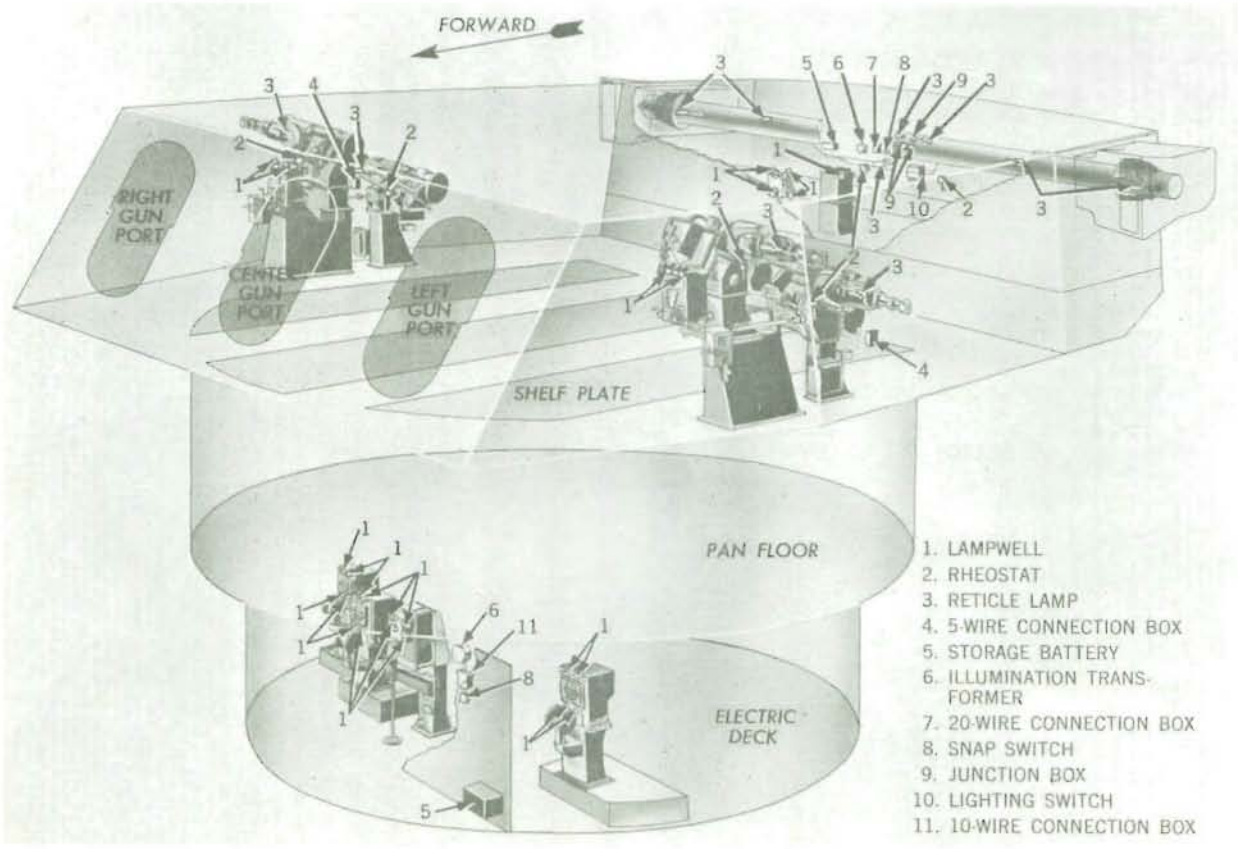

Figure 1-17. Turret Instrument Illumination - General Arrangement

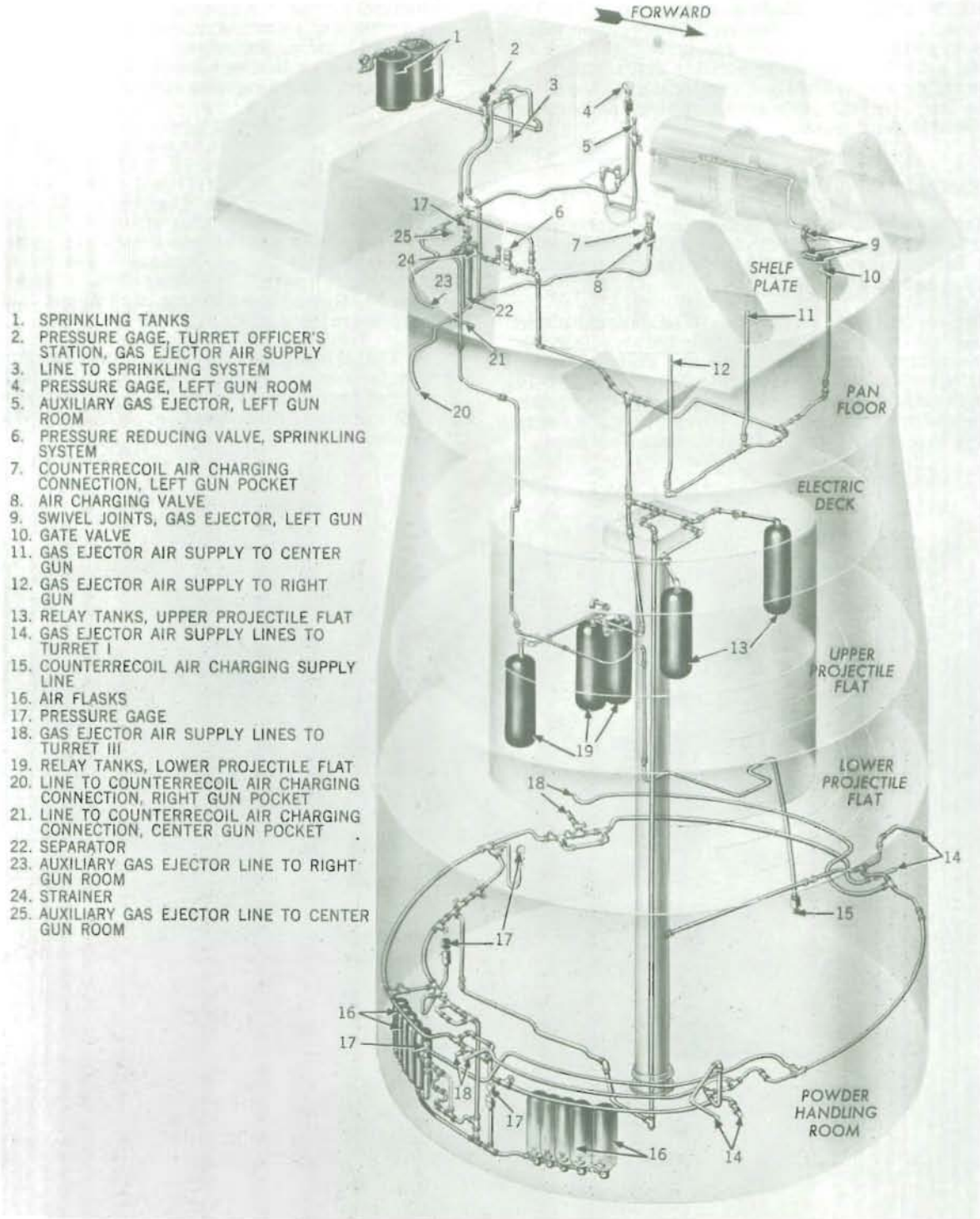

Figure 1-18. Gas Ejector and Counterrecoil Air Supply Pipe System. Turret II - General Arrangement

Rangefinder de-icing. Each rangefinder telescope is provided with de-icing mechanism which blows jets of heated air over the exposed window at each outer end of the rangefinder. Electrical components of this equipment are two rotary vane type electric motor driven blowers and two nichrome wire type heater elements. One blower is mounted on each end of the rangefinder tube. Power supply is 120-volt, single phase, 60-cycles, derived from the general lighting system.

Gas ejector supply

Air for the gas ejector supply is furnished by the ship's air compressors. The general arrangement of this system, together with the counterrecoil air supply replenishing pipe system is shown in figure 1-18.

The gas ejector supply pipe line enters the turret beneath the powder handling platform through a 2-inch pipe fitted with a swivel joint beneath the base casting. At this point a vertical 2-inch pipe extends upward through the exact center of the central column wiring tube. Within the wiring recess at the top of the central column the pipe is fitted with a 90 degree ell fitting which extends the pipe line horizontally rearward on the longitudinal centerline of the turret, to the exterior of the wiring recess. At this point the pipe line turns toward the left where, interconnected with three T fittings the pipe line extends to five relay tanks (two on the upper projectile flat, three on the lower projectile flat), and upward to a point below the center gun pocket. Here the pipe line has two branches, one leading rearward to the air supply connections for the auxiliary gas ejector and sprinkling system and the other leading forward to three 1-1/2-inch branch lines. These lead upward through the forward ends of the right, center, and left gun pockets where they terminate at 1-1/2-inch gate valves, which provide local cutoff of the gas ejector air supply. Connection of this supply to the gas ejector valve on the gun is described in chapter 3. Relay tanks each have a capacity of approximately 7.5 cubic feet.

The counterrecoil air supply replenishing pipe enters the turret through the foundation bulkhead into the annular powder handling space where it connects to a bank of air flasks. These are connected to a turret pipe system (by a portable pipe connection) which leads upward to a separator in the rear part of the center gun pocket.

The separator, which has three branch lines leading to air charging connections in the gun pockets, is provided with a pressure gage graduated from 0 to 3000 pounds per square inch. Gun pocket air charging connections are provided with similar pressure gages.

Chapter 2

TURRET OPERATION

INTRODUCTION

This chapter, a guide to turret operation, is arranged to be an aid in organizing the turret crew. Each station is separately described, and the equipment used and the duties of the station are defined. The duties are explained or identified with respect to the functional activities of equipment - a station or compartment - and with respect to methods of control of equipment and of the turret. In the instance of certain key stations, the duties include alternative activities concerning different methods of control or emergency or casualty operations.

It is not intended that ships' officers consider the descriptions of duties of turret personnel to be rigid or definitive. Variations therefrom are within the discretion of officers in charge, provided existing regulations are observed.

Station activities and turret control methods

Classes of operations. All station activities are associated with one of four functional classes of operations. These are:

Ammunition service to the guns
Gun operation
Gun laying
Controlling gun fire

Ammunition service to the guns from projectile flats or magazines is the same in all methods of turret operation.

Operation of the gun (breech mechanism, firing lock, and gas ejector) is the same in all methods of turret operation.

Gun laying (and turret train) is controlled either from a remote control station or from a local sight control station.

There are three basic types of fire control selections designated:

Primary
Secondary
Local

Primary control is turret control by a main battery director in combination with main battery plotting room equipment. It has two types of operation: "Automatic" and "Indicating." In "Automatic" control, the turret and its guns are automatically positioned by the receiver-regulators through signals received from plot. In "Indicating" control, the turret and its guns are positioned by the turret crew in follow-the-pointer operation. The firing station in both types of control is normally the stable vertical in either plotting room.

In secondary control, a turret acts as a controlling director, in combination with main battery plotting room equipment, to control either or both of the other turrets and their guns. This is an auxiliary method of director control, and has two types of operation: "Automatic" and "Indicating," which are identical to the similar types of primary control.

Local control is independent turret control, deriving target bearing and range locally. It is control in which the sight control stations, rangefinder, and auxiliary computer control the turret and gun positions. Guns are fired by designated local switch or switches.

Objectives. In all operations and in each method of control, the purpose of the turret design is to provide for rapid and accurate fire with safety. Speed and safety design features of the ammunition hoists, projectile rings, guns, and gun laying devices are dependent on crew teamwork and alertness, smart operation, and good maintenance. These personnel factors are best obtained by understanding the station equipment, the turret installations, and the crew arrangement. Each member of the crew must be drilled in his duties.

Firing cycle

The importance of teamwork in ammunition handling is shown in figure 2-1. In continuous fire, each of the turret's three guns is firing every 30 seconds, approximately. During this time interval many ammunition service actions and gun loading actions take place. Most of these actions depend upon completion of a prior action. The final action, gun firing, is dependent upon smooth coordination and rapid completion of all actions. Any lag or delay in these actions will stop or retard gun firing.

Personnel organization

The turret personnel organization is tabulated in figure 2-2. For 3-gun operation, a minimum crew of 77 men is required. Forty-six men are stationed below the electric deck and in the top of the powder hoist trunks to serve ammunition to the guns. Twelve others, stationed in the gun compartments, maintain gun operations. These 58 men are identically employed in all methods of turret control.

The remainder of the organization comprises three gun layers and a train operator on the electric deck, three men in each sight control station, and nine turret controlmen in the gun house. These 19 men have varying duties, depending on the method of turret control. All are engaged when the turret is operated in HAND under LOCAL control (except the three men in the stand-by sight control station). When the turret is operated in AUTOMATIC under PRIMARY control, one sight setter and the three gun layers (for automatic load operation only) are actively engaged. All others are at stand-by operation.

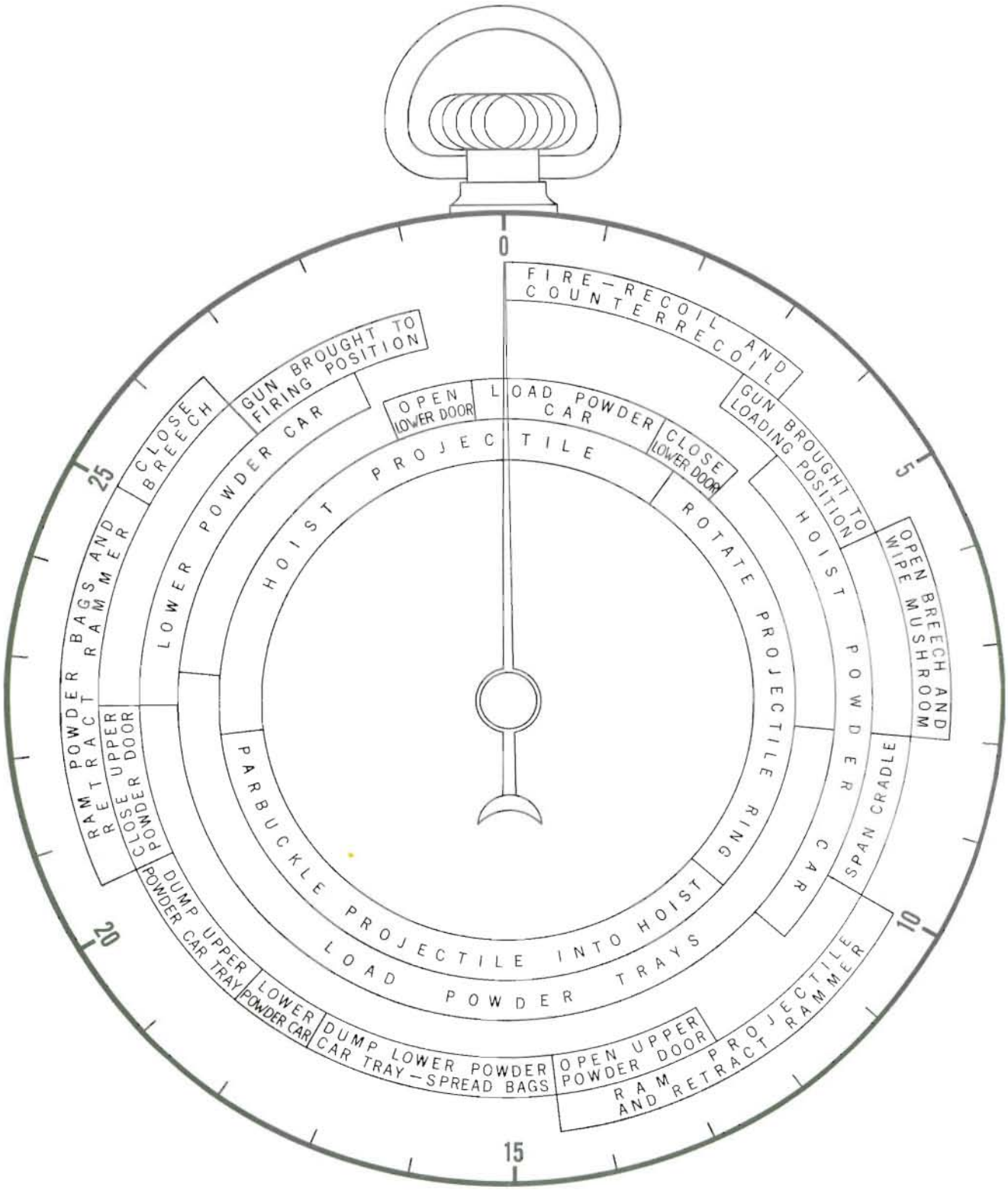

Figure 2-1. Firing Cycle Operations

CREW NAME	STATION	LOCATION
TURRET OFFICER	TURRET OFFICER'S BOOTH (RIGHT)	TURRET OFFICER'S COMPARTMENT
TURRET OFFICER'S TALKER	TURRET OFFICER'S BOOTH (RIGHT)	
TURRET CAPTAIN	TURRET OFFICER'S BOOTH (LEFT)	
COMPUTER OPERATOR	COMPUTER	
COMPUTER OPERATOR-TALKER: JW (RANGEFINDER OPERATOR TO COMPUTER)	COMPUTER	
RANGEFINDER OPERATOR-TALKER: JW	RANGEFINDER	
RANGEFINDER POINTER	RANGEFINDER	
RANGEFINDER TRAINER	RANGEFINDER	
TALKER: JE (COMPUTER TO SIGHT SETTERS)	COMPUTER	
POWDER HOIST OPERATOR, RIGHT	RIGHT HOIST CONTROL, TOP OF TRUNK	
POWDER HOIST OPERATOR, CENTER	CENTER HOIST CONTROL, TOP OF TRUNK	
POWDER HOIST OPERATOR, LEFT	LEFT HOIST CONTROL, TOP OF TRUNK	
SIGHT POINTER	SIGHT POINTER'S HANDWHEEL	RIGHT SIGHT STATION
SIGHT TRAINER	SIGHT TRAINER'S HANDWHEEL	
SIGHT SETTER	SIGHT SETTING INDICATOR	
SIGHT POINTER	SIGHT POINTER'S HANDWHEEL	LEFT SIGHT STATION
SIGHT TRAINER	SIGHT TRAINER'S HANDWHEEL	
SIGHT SETTER	SIGHT SETTING INDICATOR	
GUN CAPTAIN	LOADER'S PLATFORM	RIGHT GUN COMPARTMENT
CRADLE OPERATOR	PROJECTILE HOIST CRADLE	
RAMMER OPERATOR	RAMMER CONTROL	
PRIMERMAN	PRIMERMAN'S PLATFORM	
GUN CAPTAIN	LOADER'S PLATFORM	CENTER GUN COMPARTMENT
CRADLE OPERATOR	PROJECTILE HOIST CRADLE	
RAMMER OPERATOR	RAMMER CONTROL	
PRIMERMAN	PRIMERMAN'S PLATFORM	
GUN CAPTAIN	LOADER'S PLATFORM	LEFT GUN COMPARTMENT
CRADLE OPERATOR	PROJECTILE HOIST CRADLE	
RAMMER OPERATOR	RAMMER CONTROL	
PRIMERMAN	PRIMERMAN'S PLATFORM	
GUN LAYER	RIGHT ELEVATING CONTROL HANDWHEEL	ELECTRIC DECK
GUN LAYER	CENTER ELEVATING CONTROL HANDWHEEL	
GUN LAYER	LEFT ELEVATING CONTROL HANDWHEEL	
TRAIN OPERATOR	TRAIN CONTROL HANDWHEEL	

CREW NAME	STATION	LOCATION
PROJECTILE HOIST OPERATOR	RIGHT PROJECTILE HOIST CONTROL	UPPER PROJECTILE FLAT
PROJECTILE HOIST OPERATOR	CENTER PROJECTILE HOIST CONTROL	
PROJECTILE HOIST OPERATOR	LEFT PROJECTILE HOIST CONTROL	
PROJECTILE RING OPERATOR	PROJECTILE RING CONTROL	
SHELLMEN (2)	GYPSY HEAD ADJACENT TO RIGHT PROJECTILE HOIST	
SHELLMEN (2)	GYPSY HEAD ADJACENT TO CENTER PROJECTILE HOIST	
SHELLMEN (2)	GYPSY HEAD ADJACENT TO LEFT PROJECTILE HOIST	
SHELLMEN (3)	GYPSY HEAD IN FORWARD PART OF FLAT	
ELECTRICIAN	INNER MACHINERY SPACE	
PETTY OFFICER IN CHARGE (TALKER - XJ CIRCUIT)	PROJECTILE HANDLING SPACE	
PROJECTILE HOIST OPERATOR	RIGHT PROJECTILE HOIST CONTROL	LOWER PROJECTILE FLAT
PROJECTILE HOIST OPERATOR	CENTER PROJECTILE HOIST CONTROL	
PROJECTILE HOIST OPERATOR	LEFT PROJECTILE HOIST CONTROL	
PROJECTILE RING OPERATOR	PROJECTILE RING CONTROL	
SHELLMEN (2)	GYPSY HEAD ADJACENT TO RIGHT PROJECTILE HOIST	
SHELLMEN (2)	GYPSY HEAD ADJACENT TO CENTER PROJECTILE HOIST	
SHELLMEN (2)	GYPSY HEAD ADJACENT TO LEFT PROJECTILE HOIST	
SHELLMEN (2)	GYPSY HEAD ADJACENT TO LEFT PROJECTILE HOIST	
SHELLMEN (3)	GYPSY HEAD IN FORWARD PART OF FLAT	
ELECTRICIAN	INNER MACHINERY SPACE	
PETTY OFFICER IN CHARGE (TALKER - XJ CIRCUIT)	PROJECTILE HANDLING SPACE	
POWDER DOOR OPERATOR	RIGHT HOIST, BOTTOM OF TRUNK	POWDER HANDLING ROOM
POWDER DOOR OPERATOR	CENTER HOIST, BOTTOM OF TRUNK	
POWDER DOOR OPERATOR	LEFT HOIST, BOTTOM OF TRUNK	
FIRST POWDERMAN, RIGHT	RIGHT POWDER HOIST	
SECOND POWDERMAN, RIGHT	RIGHT POWDER HOIST	
THIRD POWDERMAN, RIGHT	MAGAZINE SCUTTLE	
FIRST POWDERMAN, CENTER	CENTER POWDER HOIST	
SECOND POWDERMAN, CENTER	CENTER POWDER HOIST	
THIRD POWDERMAN, CENTER	MAGAZINE SCUTTLE	
FIRST POWDERMAN, LEFT	LEFT POWDER HOIST	
SECOND POWDERMAN, LEFT	LEFT POWDER HOIST	
THIRD POWDERMAN, LEFT	MAGAZINE SCUTTLE	
PETTY OFFICER IN CHARGE (TALKER - XJ CIRCUIT)	POWDER HANDLING SPACE	

Figure 2-2. Turret Personnel Organization

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Crew stations

In normal turret operation (in all methods of control) crew stations are manned in all levels of the turret except the pan floor. All levels are isolated with all intercommunicating hatches closed and secured. This divides the manned spaces into compartments located on five levels with personnel arrangements as shown in figures 2-3 to 2-6. The upper and lower projectile handling flats are identically manned.

PERSONNEL DUTIES

Turret officer

Duties. The turret officer, as the supervisor of turret operations, directs the entire crew. He is responsible for organizing and training the operators of all stations for performance of their duties in all types of control. Turret operations as related to fire control are directed by the control officer except when battle damage has isolate the turret from all control stations. The turret transfer switchboard and other necessary control devices, for the different control methods, are set by the turret officer as directed by the control officer. His main duty is: general supervision of turret operation, coordinating and directing the work of the turret crew. He takes control, in the event of director control failure, to direct firing after shifting to local control.

In local control, the turret officer assumes full control of turret fire, designating the target and directing and coordinating all turret operations. He observes the fall-of-shot through the periscope and constantly gives spot correction orders to the computer operator.

Equipment used. The turret officer's control station and the equipment used by him both at the station and adjacent to it are shown in figures 2-7 and 2-8. The major piece of equipment is the turret officer's transfer switchboard. This has 16 rectangular panels arranged across its front with 21 rotary disc-type switches mounted in 14 panels (the remaining two panels serve miscellaneous purposes). The switches provide ON-OFF and transfer switching facilities for most of the turret fire control circuit. In local control, the turret officer uses his periscope to observe the target and fall-of-shot. He has a selective switch which is set either to include the director firing key in the firing circuit or to bypass it for local control of firing. This switch also connects the firing circuit either to the alternating current ship supply or to the local storage battery. When positioned to DIRECTOR, this switch also closes a circuit to light a "turret ready" light in plot and in the turret officers' panel. This panel also has indicating lights to show when the other two turrets are ready to fire plus a "plot ready" light. He has an indicator panel which indicates when the trainer is ready to fire, when the other turrets are ready, and when plot is ready. The indicator panel also provides the turret officer with individual firing key cutout and cut in switches. In addition the turret officer has at his disposal: a two-dial transfer signal indicator which indicates (from plot) whether transfer switches are to be set at FWD or at AFT; a three-dial danger sector indicator which indicates when the line of fire of any of the guns closely approaches ship's structure; a multiple turret train indicator which indicates turret train order, the actual angle of turret train, and the angle of train of the adjacent turret (except turret III). The turret officer also has: sprinkling system control valves for selective control of sprinkling of gun breeches, ammunition hoists, and projectile stowage spaces; various types of equipment for communications with personnel of the plotting rooms, control stations, and other ship's stations, and with personnel within the turret.

Turret captain

Duties. The turret captain, as the assistant supervisor of turret operations, helps to organize and train all turret personnel. He complies with the orders of the turret officer, assisting him in the setting of controls and in intraturret communications. The turret captain is the overseer of gun operations, directing and coordinating the work of the three gun captains. He takes over turret supervision in event of incapacity of the turret officer.

Immediately after all stations are manned, the turret captain (assisted by the gun captains) checks the electric gun-firing circuit by connecting a test lamp between the firing lock and the firing circuit lead at each gun. Individual firing keys, cut-in through the turret officers' indicator panel switches, are then closed on salvo circuit signal.

The turret captain observes the fall-of-shot through his periscope and gives spot corrections to the computer operator when directed by the turret officer.

Equipment used. The turret captain's control station and the equipment used by him are shown in figure 2-7. His equipment includes: the left periscope; an indicator which is identical to the turret officers except that it has no switches; an emergency alarm contact maker which, when held open, stills the alarm sirens; a train warning pushbutton which, when held closed, sounds the train warning bell; and elements of the sprinkling system, and interior communications equipment.

Computer operators

Duties. The computer operators (an operator and an operator-talker) are responsible for the operation of the auxiliary computer (fig. 2-30). They are at stand-by duty in primary and secondary control (unless the turret is acting as a director). They take over computation of the fire control problem, when turret control is switched to local. While in stand-by duty, if range can be received from the rangefinder operator, the operators compute the fire control problem as an exercise and check.

In local control, the computer operators compute sight angle and deflection. They introduce 13 manual inputs into the computer which, along with three electrical inputs, produce the required values. These values are indicated in the computer and are transmitted orally (via the computer operator-talker) to the sight setter.

Equipment used. The computer operators use the auxiliary computer and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

Talker

Duties. Stationed in the turret officer's compartment (fig. 2-3), the talker receives information (sight deflection and sight angle) from the computer operator. He orally transmits this information to the sight setters.

Equipment. The talker uses a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

Rangefinder operator (Turrets II and III only)

Duties. The rangefinder operator is responsible for the operation of the turret rangefinder (fig. 2-29). He is at stand-by duty in primary and secondary control (unless the turret is acting as a director). He supplies target range orally to the computer operators when turret control is switched to local and at other times as an exercise.

Equipment used. The rangefinder operator uses the rangefinder operator's handwheels, and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

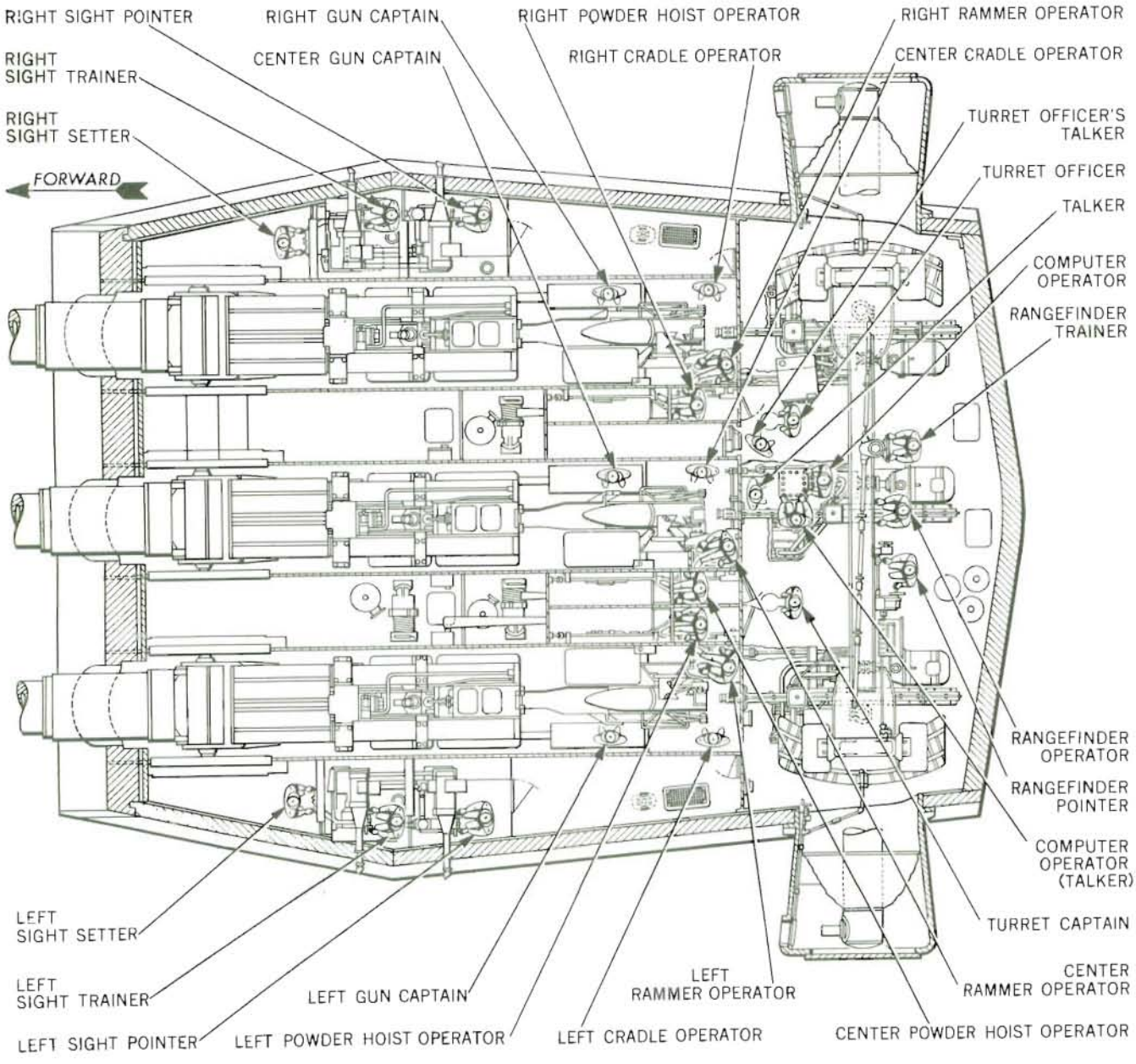

Figure 2-3. Turret Personnel Arrangement. Gun House Stations

Rangefinder pointer

Duties. The rangefinder pointer (fig. 2-3) is responsible for keeping the rangefinder lines of sight, in altitude or elevating and depressing motion (to follow the roll of the ship), on the target. He performs this duty whenever the rangefinder operator takes the target range.

Equipment used. The rangefinder pointer uses the rangefinder pointer's handwheels and an automatic elevating drive (stabilizer) which holds the rangefinder lines of sight horizontal.

Rangefinder trainer

Duties. The rangefinder trainer (fig. 2-3) is responsible for keeping the rangefinder lines of sight, in deflection or azimuth motion (to modify turret train movements), on the target. He performs this duty whenever the rangefinder operator takes the target range.

Equipment used. The rangefinder trainer uses the deflection handwheel and the deflection setting and indicator assembly.

Sight trainers (right and left)

Duties. The sight trainers (fig. 2-3) are at stand-by duty in primary and secondary control. One of them assumes control of turret train (in local control) when directed by the turret officer. They maintain communications with each other, with the sight pointers, and with the turret officer (through his talker). The sight trainer in control (fig. 2-13) is responsible for keeping the turret's vertical crosslines on the target. By turning his handwheels, the sight trainer offsets the hydraulic transmission A-end of the training gear to train the turret.

Equipment used. Each sight trainer uses: a telescope; handwheels; a telephone headset with breastplate-supported and pushbutton-controlled transmitters; and a foot-operated ready switch, which, when closed, illuminates TRAIN READY dials at the turret officer's, turret captain's, and sight station indicators.

Sight pointers (right and left)

Duties. The sight pointers (fig. 2-3) are at stand-by duty in primary and secondary control. When ordered by the turret officer, one of them turns his handwheels to keep the horizontal crossline on the target. By doing this, the sight pointer transmits gun elevation orders to the gun elevation indicator of each of the three gun layers. The sight pointers maintain communications with each other, with the sight trainers, and with the turret officer (through his talker).

Equipment used. The sight pointers use: the sight pointers' telescopes and handwheels; firing keys which are mounted on the handwheels; telephone headsets with breastplate-supported and pushbutton-controlled transmitters; and synchronizing clutches (for synchronizing the handwheels with the gun elevation indicators) and clutch indicators (which indicate the relative position of the opposite sight pointer's clutch).

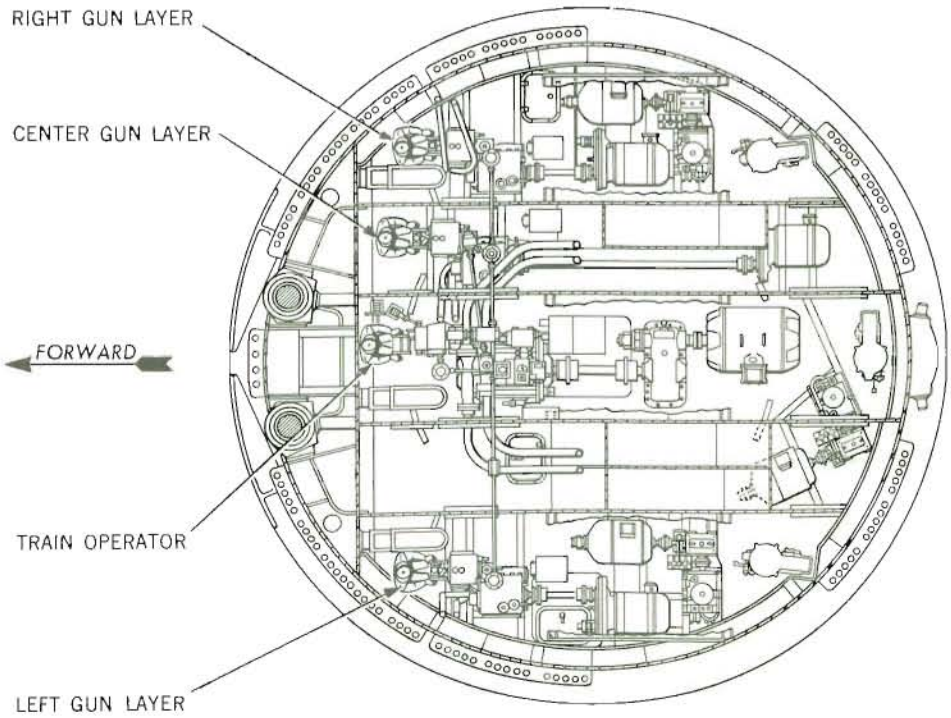

Figure 2-4. Turret Personnel Arrangement. Electric Deck Stations

Sight setters (right and left)

Duties. The two sight setters have identical duties. One of them (designated by the turret officer) performs these duties in all methods of turret control. They maintain communications with the computer operator and with the turret officer (through his talker). The sight setter selected (fig. 2-9) must clutch-engage his indicator with the sight angle cross-shaft system. He is then responsible for manually entering mechanical values that offset the lines of sight and correct gun orders. He operates the indicator hand cranks in response to electrically received dial-actuated orders (in primary control and secondary control) or according to data received by telephone (in local control, or in secondary control, when the turret acts as a director). These values are for offset depression of the lines of sight from parallelism with the guns (sight angle), azimuth offset of the lines of sight (sight deflection), and turret train offset for difference in target bearing at the director and the guns (parallax range). In performing these follow-the-pointer duties, he is entering corrections to the gun orders and off-setting the pointer and trainer lines of sight.

Equipment used. The sight setters use: the sight setters' indicators; telephone headsets with breastplate-supported and pushbutton-controlled transmitters; and synchronizing clutches (which provide for correct engagement of the sight angle cross-shaft system) and clutch indicators (which indicate the relative positions of both sight setters' clutches).

Gun captains

Duties. Each of the three gun captains is directly responsible for supervision of a gun. He directs the activities of his gun crew (fig. 2-31, primerman not shown) in all of their duties. He directs the starting of the projectile hoist power drive and has emergency stop control of gun laying for his gun.

The duties of the three gun captains are identical and include checking of the removal of tompions (or muzzle covers), releasing the slide securing pins, and releasing the gun locking device, and assists the turret captain when he checks the electric gunfiring circuit. He personally verifies the charges of the counterrecoil and recoil mechanisms. In addition to these duties, the right and left gun captains are responsible for releasing the turret centering pins.

During gun firing operations, the gun captain positions his ready switch at SAFE, opens the breech, verifies that the gun bore is clear and depresses the bore clear switch momentarily, closes the gas ejector valve, and wipes the mushroom clean of burning powder bag fragments. He indicates to his crew when they are to span the cradle and spanning tray, ram the projectile, prime the firing lock, and open the powder door. He indicates to the powder hoist operator when he is to dump the first powder car tray, lower the car, and dump the second powder car tray. He spreads the powder bags and indicates to his crew when they are to ram the powder bags, close the powder door, and raise the cradle. The gun captain closes the breech and, after

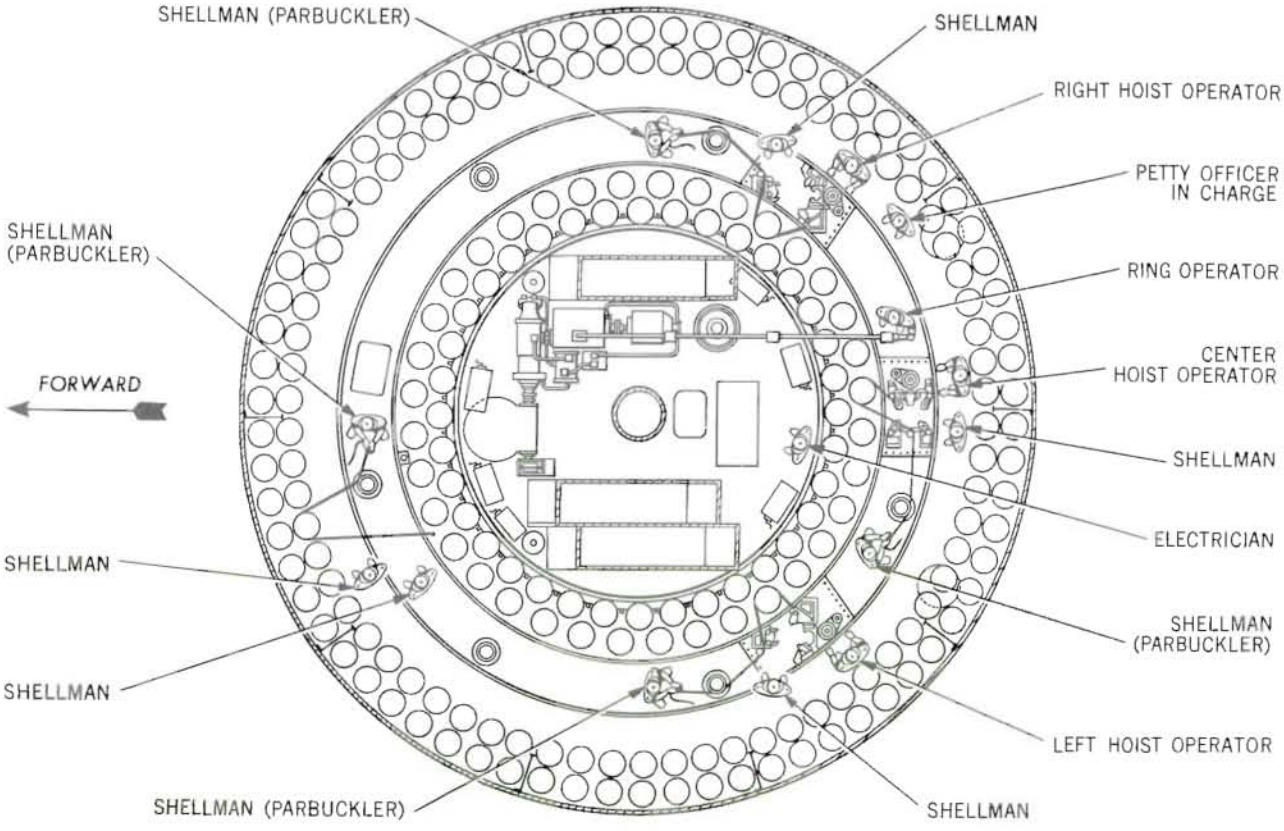

Figure 2-5. Turret Personnel Arrangement. Projectile Flat Station.

he and his crew are in safe positions, he positions his ready switch to READY. After the gun has fired and he returns the ready switch to its SAFE position, the gun captain verifies that the gun has returned to battery before beginning the next load operation.

The gun captain has facilities for communicating with the turret officer and with the powder hoist and projectile hoist operators.

After firing operations are completed, the gun captain and his crew help to clean and stow the gun units and unload the ammunition hoists.

Equipment used. Each gun captain uses push-to-talk button telephone handsets and the instrument panel at his station (fig. 2-10).

Cradle operator

Duties. Each of the three cradle operators has identical duties, all of which are performed under direct supervision of the gun captain.

The cradle operator (fig. 2-31) starts or stops the power drive. During gun firing operations, he spans the cradle and spanning tray, helps the gun captain spread the powder bags as they are dumped into the spanning tray, and raises the cradle after the gun is loaded and the rammer retracted. He performs these duties on indications by the gun captain.

When high capacity projectiles are fired, the cradle operator (acting as fuze setter) communicates with the secondary battery computer fuze follow-up operator and sets projectile fuzes as ordered.

After firing operations are completed, the cradle operator assists in cleaning and stowing the gun units. He sets the projectile hoist function control mechanism to lower projectiles in the hoist.

Equipment used. Each cradle operator uses a telephone headset with breastplate-supported and pushbutton-controlled transmitter, and the control devices at his station.

Rammer operator

Duties. Each of the three rammer operators has identical duties, all of which are performed under direct supervision of the gun captains.

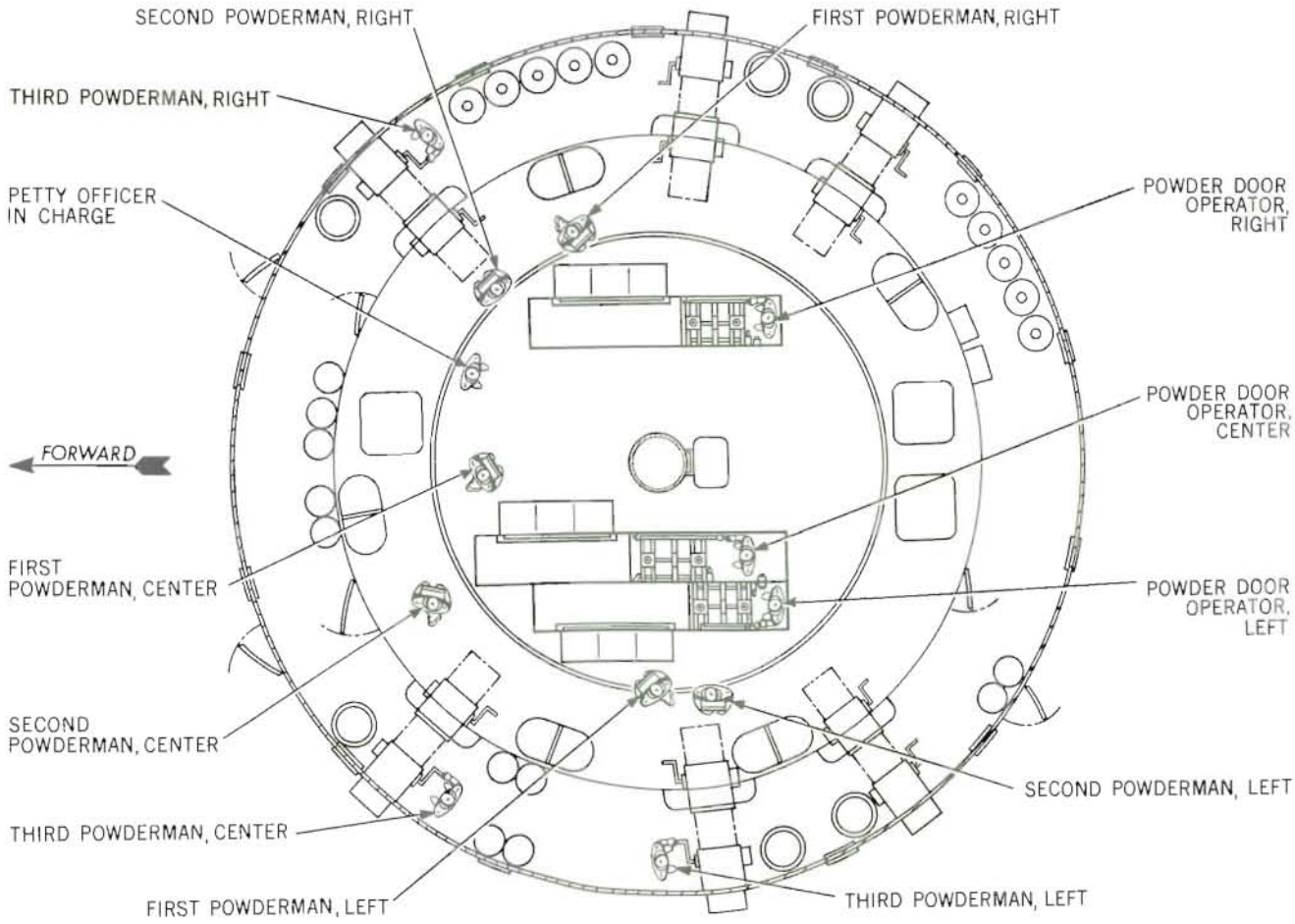

Figure 2-6. Turret Personnel Arrangement. Powder Handling Room Stations

During gun firing operations the rammer operator (fig. 2-31) operates the rammer to seat the projectile in the gun and to retract. He opens the powder door, operates the rammer to ram the powder bags into the gun and to retract, and closes the powder door. He performs these duties on indications by the gun captain.

After firing operations are completed, the rammer operator assists in cleaning and stowing the gun units.

Equipment used. Each rammer operator uses the control devices at his station.

Primermen

Duties. Each of the three primermen has identical duties all of which are performed under direct supervision of the gun captain.

During gun firing operations, the primerman (who is stationed on a platform below the shelf plate) inspects the primer seat and mushroom stem hole after each round is fired. He inserts a loaded primer into the firing lock.

Equipment. No equipment other than primers is used.

Powder hoist operators

Duties. Each of the three powder hoist operators has identical duties, some of which are performed on indications by the gun captain.

The powder hoist operator (fig. 2-32) has telephone communication with the turret officer (through his talker) and with the lower powder door operator. There is also a visual signal system between the lower powder door operator (fig. 2-11) and the hoist operator. Manually operated by the lower powder door operator, this system indicates to the hoist operator that he may hoist the car. A window in the bulkhead between the hoist operator and the gun room allows the operator to see signals made by the gun captain.

For the first load, "Control" orders the turret officers to "bring up powder." This order is relayed by the turret officers' talkers to the powder hoist operators. Until "Control" orders the turret officers to "cease fire" and to "return powder to magazine" the action is controlled by the hoist operators or gun captains.

The powder hoist operator's duties include starting or stopping the hoist power drive and operating it to hoist or lower the powder car when ordered to do so by the turret officer (through his talker). The hoist operator dumps the powder car trays at the car's two unloading stations when ordered to do so by the gun captain.

Equipment used. Each powder hoist operator uses the hoist and powder car control devices, and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

Gun layer

Duties. Each of the three gun layers is responsible for the operation and control of the elevating gear of his gun. He starts or stops the power drive and operates the devices (some of which are shown in fig. 2-12) by which the control method of gun elevation is selected.

The gun layer maintains communications with the turret officer (through his talker) who designates when the power drive is to be started or stopped, and the method of gun elevation control to be used. In starting or stopping operations the gun layer verifies that the tilting box is at neutral and the control selector lever is at HAND. With the gun in HAND control, he elevates the gun to correspond with the gun elevation order (shown on his indicator) before shifting to AUTO (automatic) control. In AUTO control the gun layer may bring the gun to its loading position from any angle of elevation by positioning the control selector lever at LOAD. He may return the gun to automatic control by positioning the control selector lever at AUTO. (Normally, the guns are brought to loading position and returned to AUTO control by the gun captain's ready switch). In AUTO control, the gun layer is at stand-by duty. He watches the indicator dials to check that gun position agrees with gun order. When ordered, he resumes HAND control of gun elevation.

When the elevating gear is operated in HAND control, the gun layer observes the gun order signal indicated by the pointers (dials) in the elevation indicator and compares that signal with the indicated position of the gun. If there is a "matching error" in the pointers, he operates his handwheels in a direction and at a speed calculated to "match pointers." The gun layer has a firing key that may be used to fire the guns (through switches on the turret officer's indicator panel) when directed by the turret officer.

Equipment used. The gun layer uses: pedestal mounted handwheels; a gun elevation indicator which is mounted on top of the handwheel pedestal; a firing key which is mounted on the handwheels; a control selector with a synchro power indicator light; gun elevation ready and gun ready indicator lights; a foot-operated ready switch which illuminates dials at the turret officer's, turret captain's, train operator's, gun captain's, and sight stations' indicators to indicate that the gun is ready; and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

Gun train operator

Duties. The train operator (fig. 2-33) is responsible for the operation and control of the turret training gear. He starts or stops the power drive and operates the devices by which the control method of gun train is selected.

The train operator maintains communications with the turret officer (through his talker) who designates when the power drive is to be started or stopped and the method of gun train control to be used. In starting or stopping operations the train operator verifies that the tilting box is at neutral

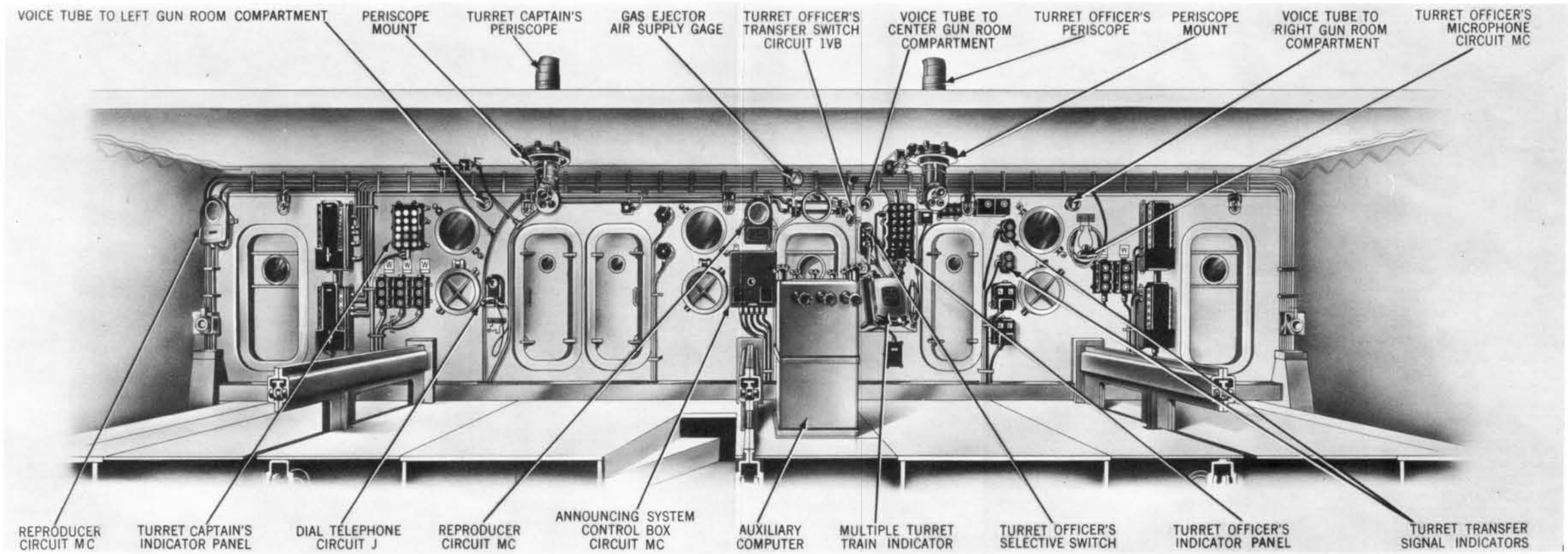

Figure 2-7. Turret Officer's Booth, Looking Forward

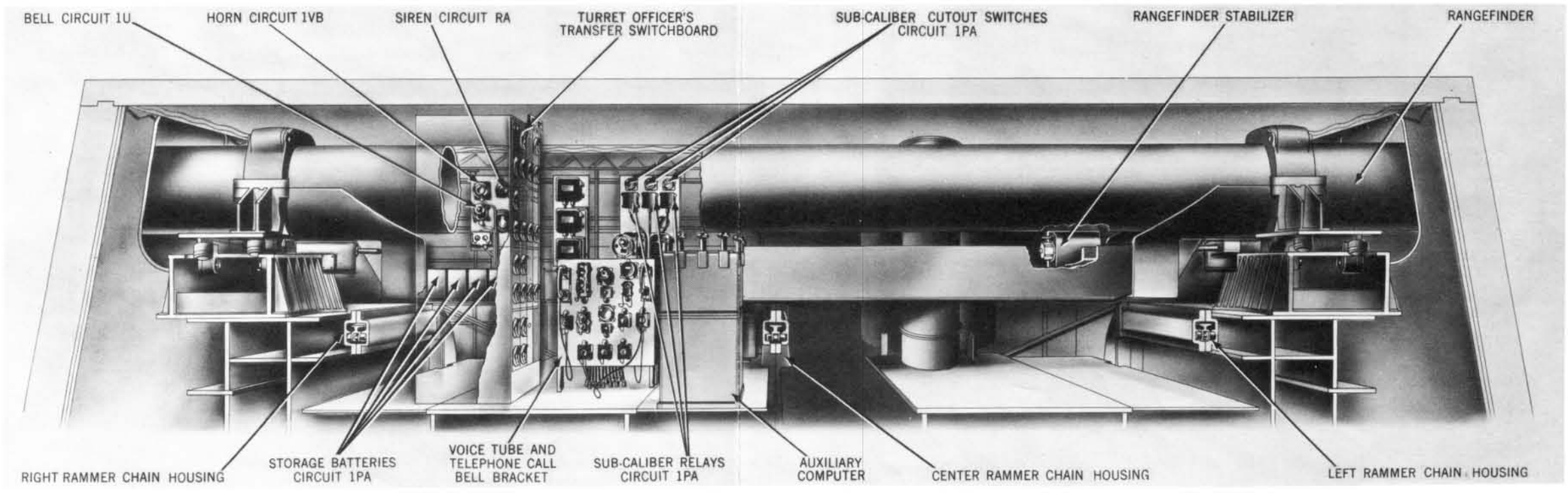

Figure 2-8. Turret Officer's Booth, Looking Aft

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(indicated by the neutral-start indicator light being lit) and that the control selector lever is at HAND. With the turret in HAND control, he trains the turret to correspond with the gun train order (shown on his indicator) before shifting to AUTO (automatic) control. In AUTO control, the train operator is at stand-by duty. He watches the indicator dials to check that turret position agrees with gun train order. When ordered, he resumes HAND control of gun train.

When the training gear is operated in HAND control, the train operator observes the train order signal indicated by the pointers (dials) in the train indicator and transmitter and compares that signal with the indicated position of the turret. If there is a "matching error" in the pointers, he operates his handwheels in a direction and at a speed calculated to "match pointers."

The train operator has a firing key that may be used to fire the guns (through switches on the turret officer's indicator panel) when directed by the turret officer.

The train operator also turns the parallax-range handcrank to match pointers on the range dials of his indicator and transmitter.

Equipment used. The train operator uses: pedestal mounted handwheels; a turret train indicator and transmitter which is mounted on top of the handwheel pedestal; a firing key which is mounted on the handwheels; a control selector with a synchro power indicator light; gun elevation and train ready indicator lights; a foot-operated ready switch which illuminates dials at the turret officer's, turret captain's, train operator's, and the sight station's indicators to indicate that turret train is ready; and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

Projectile hoist operators (each level)

Duties. Each projectile hoist may be filled and used to hoist projectiles from either the uppor or lower projectile flat. The hoist control stations and the hoist operator's duties are identical for each hoist on each level. The hoist operator is responsible for the operation of the projectile hoist and has emergency stop control of the hoist from the level on which he is stationed.

The projectile hoist operator performs his duties under direct supervision of the petty officer in charge. He operates the hoist control handle in accordance with the visual and audible signals and warnings of the dial indicators and gong.

Equipment used. The projectile hoist operator uses: the hoist control handle; the power drive stop button; the indicator dials and gong; and a turret alarm contact maker, circuit RA (center hoist only).

Projectile ring operator (each level)

Duties. Each projectile ring operator is a controlman for ammunition delivery to the shellmen. He is responsible for the operation of a projectile ring which he controls by manually rotating the hand lever (fig. 2-13). The ring operator's control stations on each level are identical.

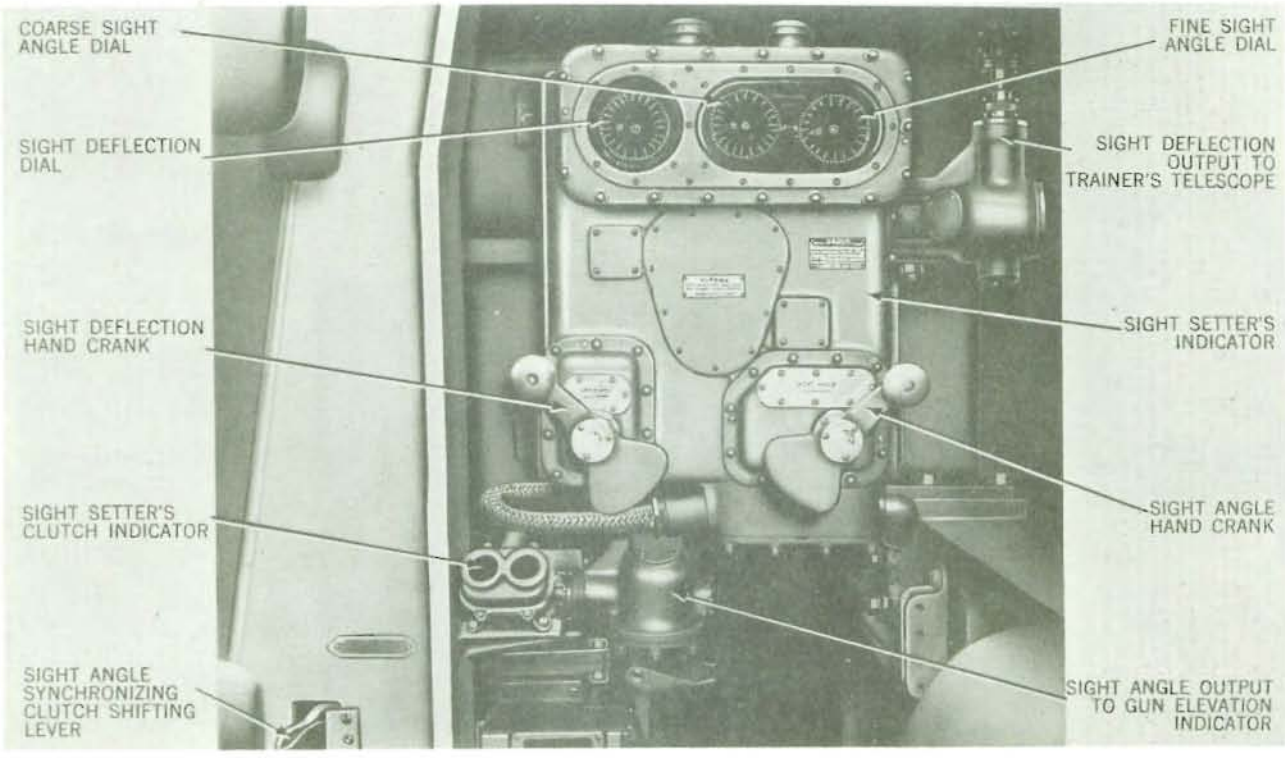


Figure 2-9. Sight Setter's Station, General Arrangement

The duties of the two ring operators are identical and include casting loose and securing the ring centering pins, and assisting the hoist operators and shellmen when directed to do so by the petty officer in charge.

The ring operator controls starting or stopping of the ring power drive. He controls speed and direction of ring rotation by the degree and direction of hand movement. When a ring station is reached (at the end of a rotation cycle) the projectile ring stops automatically with three projectiles in positions adjacent to each hoist loading aperture. Because he cannot observe parbuckling operations at all hoists, the ring operator must observe a three-dial indicator which, when illuminated, notifies him that the ring may be rotated in its next cycle.

Equipment used. The projectile ring operator uses: the control handlever; power drive start-stop pushbuttons; a three-dial indicator, circuit RP.

Shellmen (each level)

Duties. There are nine shellmen on each projectile flat and all are under direct supervision of the petty officer in charge. The duties and stations of shellmen are not rigidly defined; however they are usually divided into four teams comprising three two-man teams (next to each projectile hoist), and a three-man team in the forward part of the projectile flat. Each man in a team should be able to perform the duties of another team member.

The two-man teams at the projectile hoists act as hoist loaders and take projectiles from the rotating inner ring. The three-man team in the forward part of the projectile flat replenishes the projectile supply on the inner ring from the fixed stowage area. One man in each team acts as a parbuckler while the other team members unlock projectile lashing chains, apply the snubbing rope around the projectile to be moved (below its rotating band), and steady the projectile as it slides across the projectile flat floor plates.

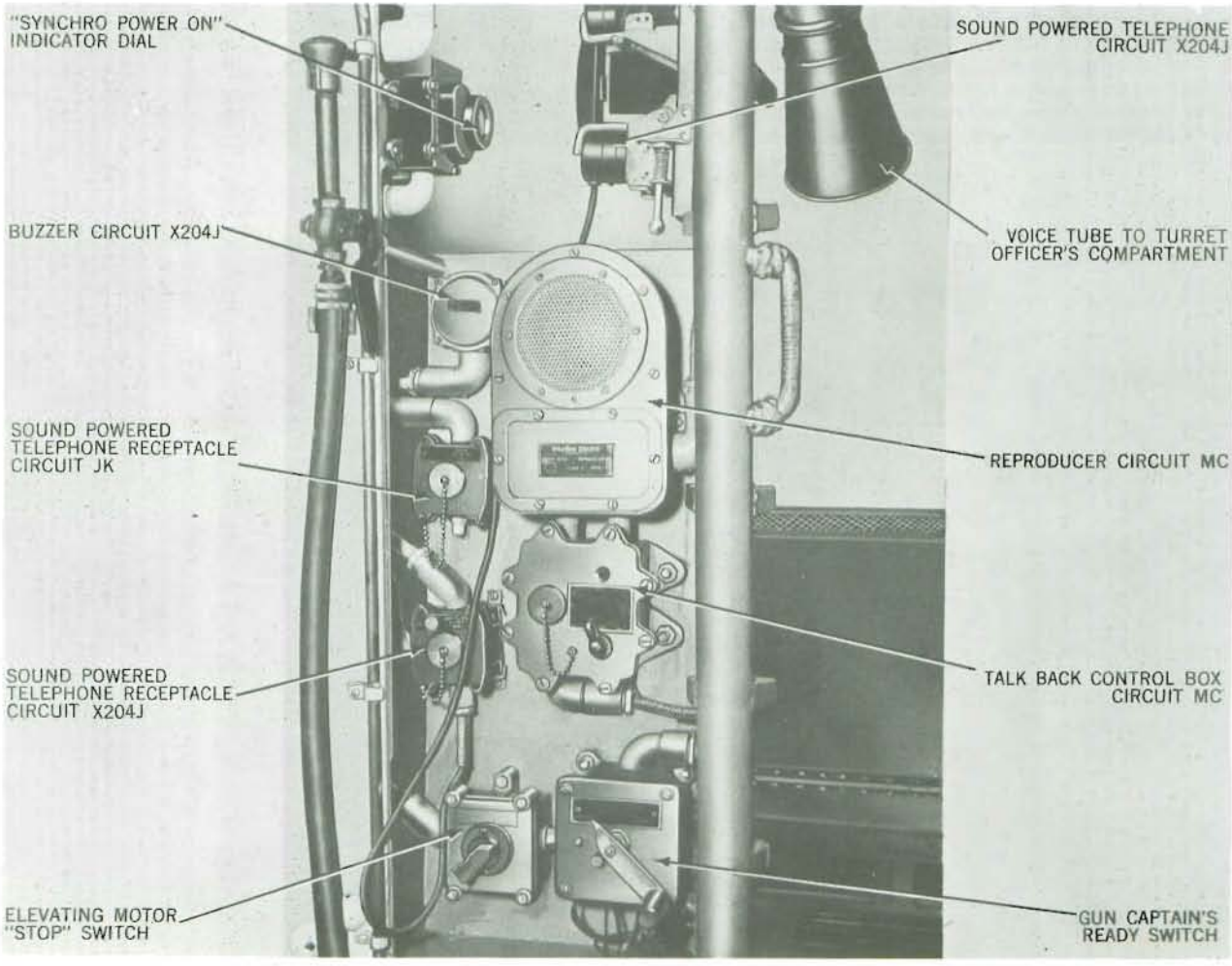


Figure 2-10. Gun Captain's Station, General Arrangement

Figure 2-11. Powder Hoist Lower Door Operator's Station, Manned

The shellman of a team employed as a parbuckler (fig. 2-36) is responsible for smoothly moving the projectiles onto the rotating ring or into the hoist. His parbuckling work consists of taking one or two turns of his snubbing rope around a gypsy head and applying hand pull to the rope to move a projectile.

The shellmen (or projectile hoist operators) close contact makers at each projectile hoist operator's station to illuminate dial indicators at the ring operator's station. This notifies the ring operator that he may rotate the ring.

Equipment used. The shellmen use: the snubbing ropes and gypsy heads in the projectile handling space of each flat; and the contact makers for the projectile ring ready lights, circuit RP.

Electrician (each level)

Duties. The electrician in the machinery space of each projectile flat performs a number of miscellaneous duties. He is primarily concerned with the turret power drive electric controllers, supply panels, and other electrical equipment in the machinery space. During operation, he acts as a roving trouble-shooter. He makes circuit continuity checks, replaces fuses and indicator lamps, and repairs and replaces electrical elements in instances of malfunction or failure. His roving battle station includes servicing of all turret electircal installations.

Equipment used. The electrician uses tools and accessories of his electrical test and service maintenance outfits.

Petty officer in charge (projectile handling deck, each level)

Duties. The petty officer in charge of each projectile flat performs a number of duties, the most important of which is supervision of safe projectile transfer. Under the turret officer, he organizes his crew of shellmen, hoist operators, and ring operator and trains the men to be skillful in operating their equipment when serving the projectile hoists. If service to a hoist lags he assists that team or directs a member of another team (replenishing team) to assist.

The petty officer in charge has telephone communication with the turret officer (through his talker) and reports to him any equipment malfunction or casualty resulting in ammunition service lag.

If any fire hazard is indicated or occurs, he operates sprinkling controls.

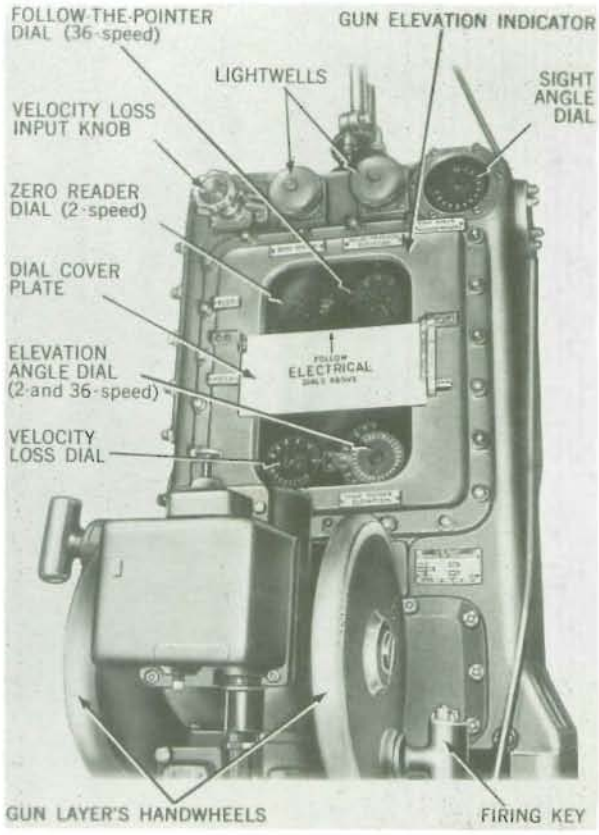


Figure 2-12. Gun Layer's Station, General Arrangement

Equipment used. The petty officer in charge (projectile handling deck) uses: communications units located in the projectile flat; the controls of sprinkling station H; and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

Lower powder door operators

Duties. A member of the powder handling room crew, each of the three lower powder door operators (fig. 2-11) has identical duties. Primarily these are to open and close the loading doors at the lower end of the powder hoist trunk. He has emergency stop control of the hoist power drive and telephone and visual communications with the hoist operator.

When the powder hoist is operated to serve powder to the gun, the powder door operator manually opens the lower doors after operating his foot pedal to unlatch them (when the car is at the loading station). He closes the doors when ordered to do so by the powder passers. He manually positions his indicator switch lever vertically when the car is loaded and the doors are closed.

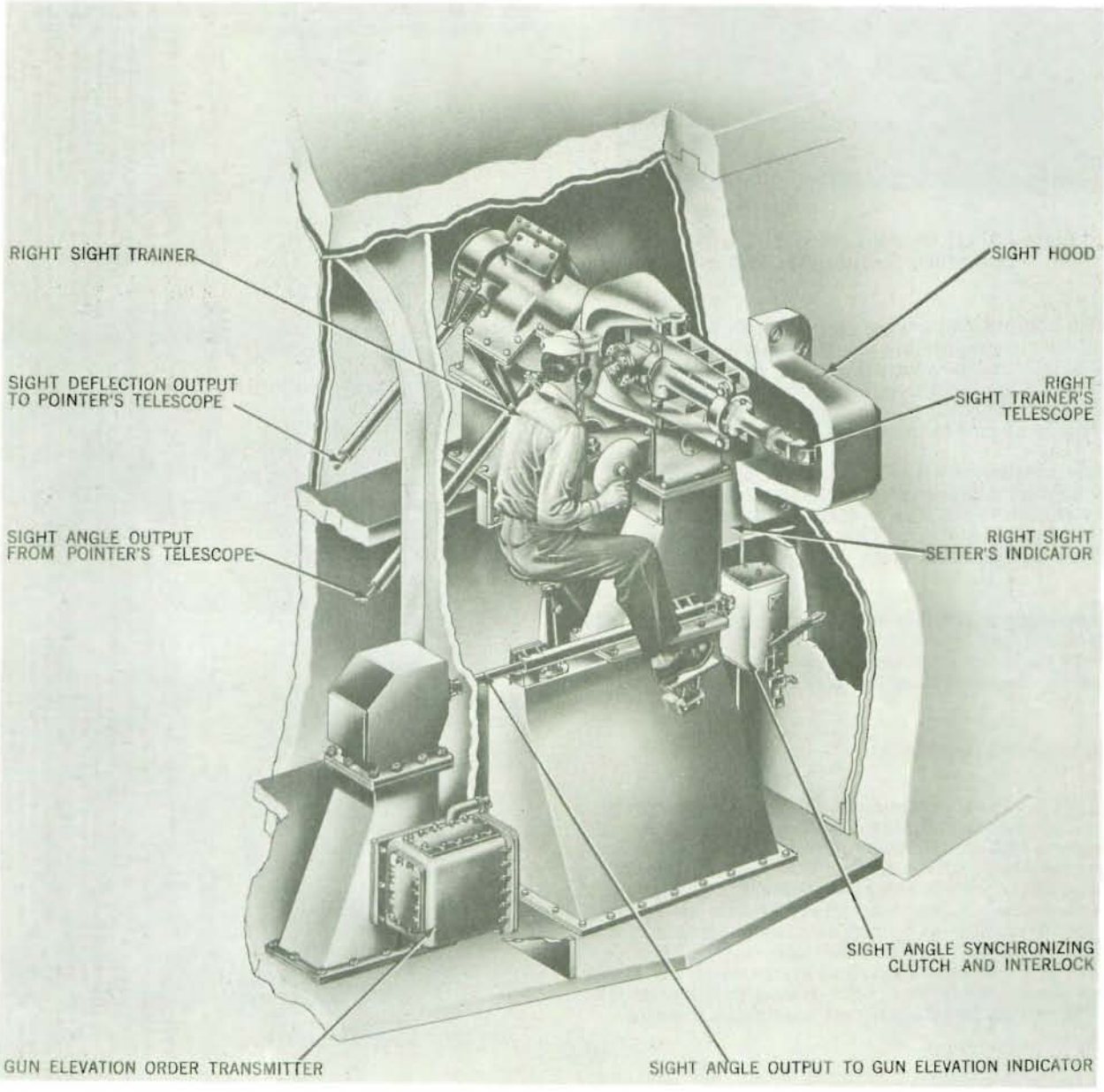


Figure 2-13. Right Sight Trainer's Station, Manned Right Side View

This causes the HOIST light to be illuminated at the hoist operator's station.

Equipment used. The powder door operator uses: the door operating and control devices, and indicator controls at his station; and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

Powdermen (powder passers)

Duties. The nine powdermen in the powder handling room crew are divided into three three-man teams, each team comprising first, second, and third powdermen. The teams have identical duties; however the duties of individual team members differ.

All powdermen perform their various duties under supervision of the petty officer in charge of the powder handling room. Team members designated first and second powderman are responsible for removing powder bags from the handling room scuttles, placing the bags (with the red colored ignition ends toward the rear) in the powder hoist trunk loading trays, and loading the powder car. The team member designated third powderman is stationed in the annular powder handling space and is responsible for passing the powder bags from the magazine scuttle to the handling room scuttle.

During powder service operations the first powderman of a team rotates the handling room scuttle (fig. 2-39) and removes the powder bag. He carries the bag to the loading tray of the powder hoist he is assigned to. In this time interval the second powderman rotates the same scuttle, removes the bag, and places it in the same loading tray. Each powderman repeats this procedure three times to place a total of six bags in the two levels of the loading tray. When the powder car is lowered and the lower doors are opened, the first and second powdermen roll the six bags into the car (fig. 2-35) and notify the door operator to close the doors.

Each time that the powder handling room scuttle is emptied, the third powderman of a team rotates the magazine scuttle (fig. 2-38) and passes a powder bag into the handling room scuttle. He then turns a mechanical indicator device to notify the magazine crew to fill the magazine scuttle. He repeatedly rotates and empties the magazine scuttle and passes powder bags to the handling room scuttle while there is a demand for powder.

Equipment used. The powdermen use: first and second powdermen use the handling room scuttle and hoist loading tray; the third powderman uses the magazine scuttle and mechanical indicator. Water filled tanks for powder submergence are adjacent to all personnel in the event that a powder bag breaks in transit.

Petty officer in charge (powder handling room)

Duties. The petty officer in charge of the powder handling room has a number of duties, the most important of which is supervision of safe powder transfer to the powder cars. Under the turret officer, he organizes the powder room crew, and trains the men to be alert, careful, and skillful in their various duties. He directs their movements to prevent traffic confusion, orienting the three hoist crews so that they move between the scuttles and loading trays without interference. If the service to a hoist lags, he assists that crew.

The importance of his duty as traffic director and coordinator is best appreciated by referring to figure 2-1 and noting the comparatively short interval in which the powder trays must be loaded.

He and his crew must be alert to prevent transfer of loose powder or a torn powder bag. This would result in powder being spilled during hoisting or gun loading operations and subsequent delay in the firing cycle. If powder spills during the handling room transfer operation, he directs the crew in the handling of the spilled powder so that hoist service can be safely resumed.

If any fire hazard is indicated or occurs, he must operate one or both of his sprinkling controls.

The petty officer in charge has telephone communication with the turret officer (through his talker).

Equipment used. The petty officer in charge (powder handling room) uses: communications units located in the projectile flat; the controls of sprinkling stations D and E; and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

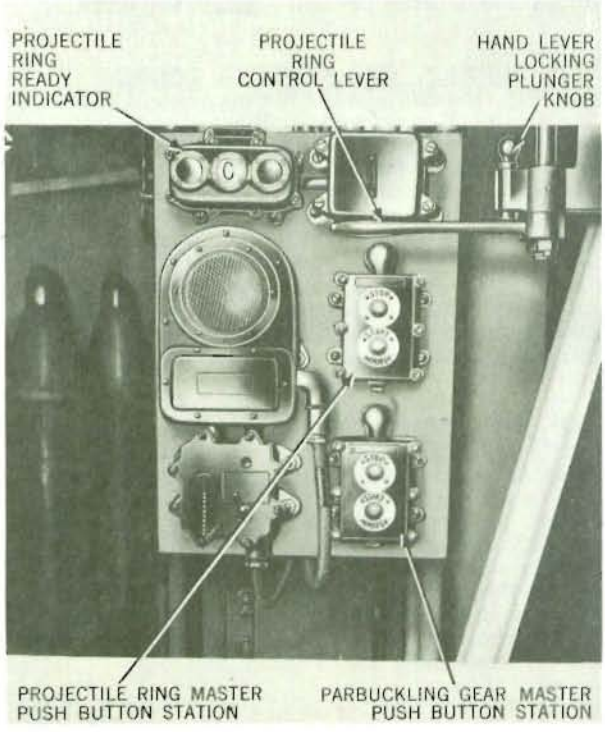


Figure 2-14. Projectile Ring and Parbuckling Gear Control Station

PREPARATION FOR OPERATION

After stations are manned, a considerable number of manually performed operations are required to cast loose, start the power drives, and fill the ammunition hoists of a secured turret. These activities not only require time, but many of them depend on other time-consuming features of the equipment that delay firing until system temperatures and pressures can build up. It is important that necessary preparations be coordinated by dividing duties among the crew and establishing a duty-sequence for each man. Design arrangements for access, turret exterior operations, work priority, and locations of controls must be considered by the turret officer.

Manning stations

Personnel access to the turret is through three doors: the center door in the bottom of the gun house overhang and the two doors in the turret foundation at the powder handling room level. The right door in the bottom of the gun house overhang is used as an emergency escape hatch and should be closed and secured at all other times.

The turret crew may be routed through the three doors by any of several alternatives, but the recommended routes are based on secured left and right gun-pit hatches. This requires all stations below the electric deck to be manned through the turret foundation doors, while the gun house and electric deck personnel use the door in the bottom of the gun house overhang.

Starting operations

Three classes of manually performed operations are involved in starting turret operations. These are:

Auxiliary service operations
Casting loose
Establishing communications

Auxiliary service operations. All auxiliary service operations are starting activities within the turret and are "first" duties for the crew. Location arrangements and crew assignments for accomplishing them as follows:

LIGHTING. Mounted on the gun house transverse bulkhead, two adjacent to each the right and left hand sides (fig. 2-7), are four 12-circuit distribution boxes. Switches on the boxes (normally operated by the turret officer and turret captain) provide selective control for closing all lighting and portable electrical equipment circuits within the gun house compartments, the gun pockets, and the pan floor spaces.

Two 12 circuit and two 6-circuit distribution boxes are mounted in the left box girder above the pan floor between the left and center gun pockets. Switches on the boxes (operated by designated electric deck personnel) provide selective control of lighting and receptacle circuits in the powder handling room.

Two 12-circuit distribution boxes are mounted in the left box girder above the electric deck between the left and center gun pockets. Switches on the boxes (operated by designated electric deck personnel) provide selective control of lighting and receptacle circuits in the electric deck spaces.

Two 12-circuit distribution boxes are mounted on the circular bulkhead in the machinery space of each projectile flat. Switches on the boxes (operated by the electrician stationed in that space) provide selective control of lighting and receptacle circuits in the respective projectile flat.

INSTRUMENT ILLUMINATION. A snap switch mounted in the center of the gun house rear plate (in the turret officer's compartment) provides control of illumination of instrument dials and sight crosslines for certain equipment in the gun house and electric deck spaces. It has four positions labeled: OFF (2 positions), BATTERY, and ILLUM. TRANS. The switch is usually positioned at ILLUM. TRANS. which steps-down the 110-volt, 60-cycle, ship's service supply to the 6-volt current required for instrument illumination. When the switch is positioned at BATTERY the 6-volt current for instrument illumination is supplied by storage batteries. Rheostats in the circuit at the various equipment provide dimming control for each circuit.

VENTILATION. Mounted on the gun house transverse bulkhead, two adjacent to the right and three adjacent to the left-hand side (fig. 2-7), are five ventilation pushbutton controls. There is an additional pushbutton control in each gun room. Each pushbutton is plainly marked with the designation of the fan set it controls. The pushbuttons (operated by the turret officer, turret captain, and gun captains) provide high and low speed, and stop control. Air exhaust is automatically regulated to maintain the desired pressure within the turret.

AIR SUPPLY, GAS EJECTOR SYSTEM. Ordinarily, the gas ejector air supply will always be open and under pressure. Either the turret officer or the turret captain may observe the pressure gage at their station to check system pressure. Additional gas ejector system gages are located in the gun rooms and are checked by the gun captains. Should system pressure not be indicated at the gages, it is necessary to check and open the valves of the six gas ejector storage tanks located on both projectile flats, and to check the system piping. This is done by designated men on the respective levels, as directed by the turret officer or turret captain.

AIR TO SPRINKLING TANKS. In ordinary turret drill operations, sprinkling tanks are filled with water at all times, but are not under air pressure. In preparing for battle conditions or target practice, air pressure is placed on the water in the tanks as follows. The turret officer opens a valve in the air supply line to the sprinkling tanks and then sets the air control cock to vent. After water appears at the overflow, the cock is kept at vent until both tanks are free of air. The air control cock is then set to supply air to the tanks.

HEATING. A total of 15 heaters, located in the turret officer's compartment, the two sight control stations, and the electric deck control stations, provide heat for turret personnel.

Four distribution boxes, each equipped with an ON-OFF snap switch, control the power supply of all heaters. Each heater is provided with an adjacently mounted ON-OFF snap switch.

Casting loose. Casting loose operations consist of opening covers, such as the sight hood shutters, periscope hood covers, rangefinder optic shutters, and muzzle covers; and of releasing the various securing devices on the gun, slide, turret, and projectile rings.

Opening sight hood shutters. The right and left sight pointers and sight trainers are each provided with a telescope within a sight port and enclosed by a sight hood assembly. Mounted on the gun house side armor plate, all sight hoods are similarly arranged with a bullet-proof steel door. This door slides horizontally to open or close and is operated by a double screw and link operating mechanism which secures it in either position. The mechanism has an operating handwheel within the side armor at the sight port.

Personnel designated by the turret officer open the periscope hood covers which are reached from the exterior top of the gun house. The covers are secured closed by a wing nut, and after being swung open are secured open by another wing nut.

The rangefinder pointer and trainer are each provided with an optic within a sight port and enclosed by a sight hood assembly. Mounted on the gun house side armor plate, both sight hoods are similarly arranged with a door similar to that of the sight hood assemblies. This door slides horizontally to open or close and is operated by a shaft and screw mechanism which secures it in either position. The mechanism has an operating handcrank within the side armor at the sight port.

Tompions, muzzle covers. Personnel designated by the turret officer remove the tompions or muzzle covers. Removing a tompion requires that the tompion clamping bolt be loosened with a proper wrench and the tompion then lifted out.

Releasing turret centering pins. Two turret centering pins are provided, one in each wing gun room in the rear outboard corner. An operating wrench for each pin is mounted on the transverse bulkhead adjacent to the pin which is usually released by the gun captain or one of his crew (fig. 2-15). The wrench is used to turn the screw bolt of the centering pin, a clockwise motion screwing the bolt into and raising the centering pin from the tapered centering hole in the upper barbette. The turning motion is indicated on a nameplate secured to the top of the deck plate mounted in the gun room floor plate. Travel distance of the pin is 4.25 inches.

Releasing slide securing pins. When directed by the turret officer, the gun captains or their crew release the slide securing pins (fig. 2-16).

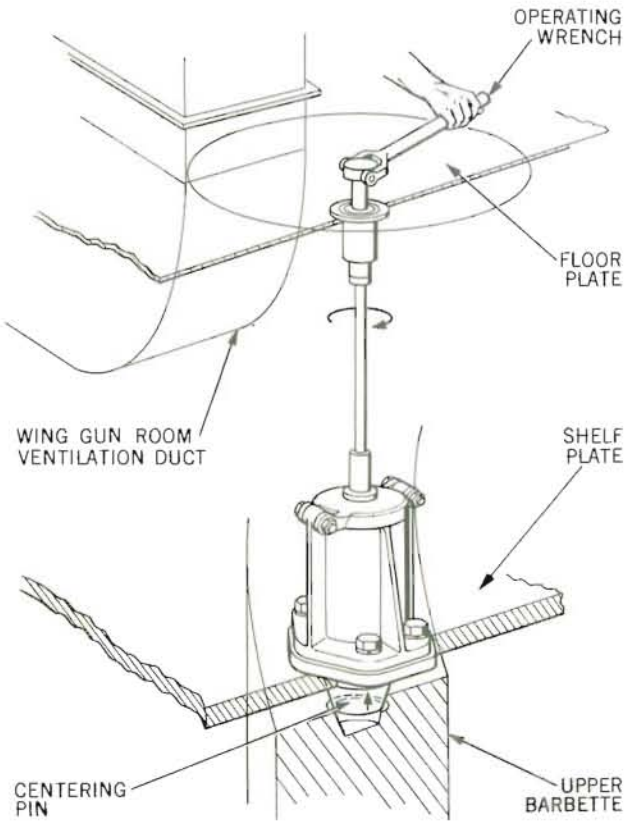


Figure 2-15. Releasing Turret-Centering Pin

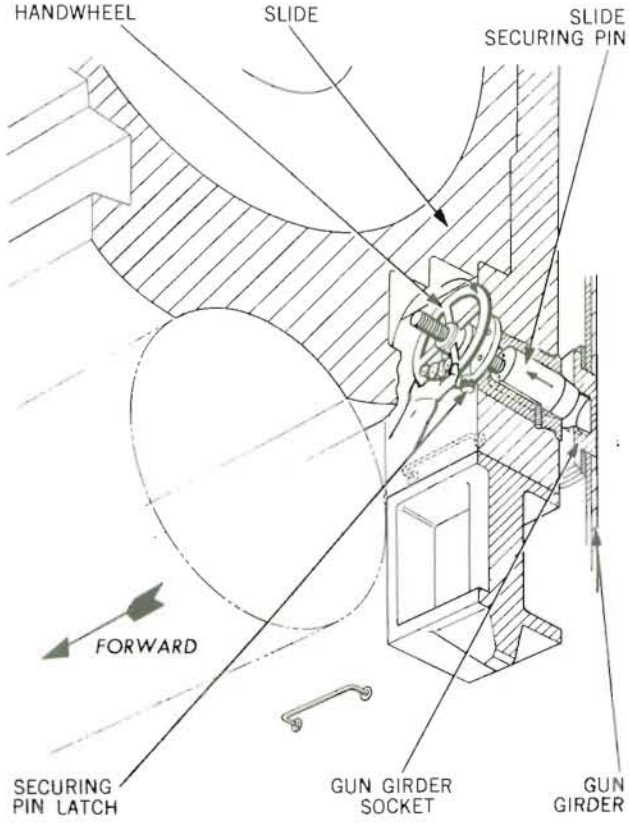


Figure 2-16. Releasing Slide-Securing Device

These are similar hand-operated screw-type mechanisms mounted on the opposite side of each slide to the loader's platform bracket. By turning the respective handwheel clockwise and holding the securing pin latch down, the pin is withdrawn from its socket in the gun girder.

Releasing gun locking device. Each gun is provided with a gun locking device which secures the gun and yoke assembly to the slide assembly. When directed by the turret officer, the gun captains or their crew release the device by loosening the knurled locknut and pivoting the threaded safety link and nut up to the stowed position (fig. 2-17). The nut is then turned clockwise and tightened until the device is secured in the stowed position.

Releasing projectile ring pins. Each projectile ring is provided with two retractable screw-type centering pins, which fit into sockets in the projectile flat recess. A special socket wrench is stowed in a clip at each pin station. A member of the projectile flat crew, designated by the petty officer in charge, retracts the ring pins using the special wrench (fig. 2-18) and turning in a clockwise direction.

Establishing communications. Simultaneously with the preceding starting activities and during performance of certain of the ordnance equipment control setting operations described below, it is imperative that communications be established throughout the turret. None of the mechanisms should be operated until control members of the crew have received reports that the casting-loose operations and inspections have been completed and that the gun pits, slides, projectile rings, and other hazardous areas are clear of personnel, tools, accessories, and supplies. "Ready" reports should be coordinated by clearing them through the turret captain.

Communications employed in this phase of the starting operations (and subsequently) are the public address and telephone systems. A minimum of 27 crew members must be equipped with telephone

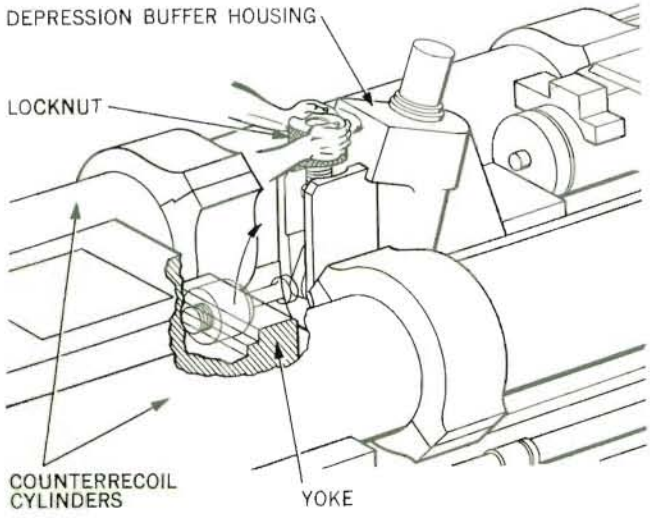


Figure 2-17. Releasing Gun Locking Device

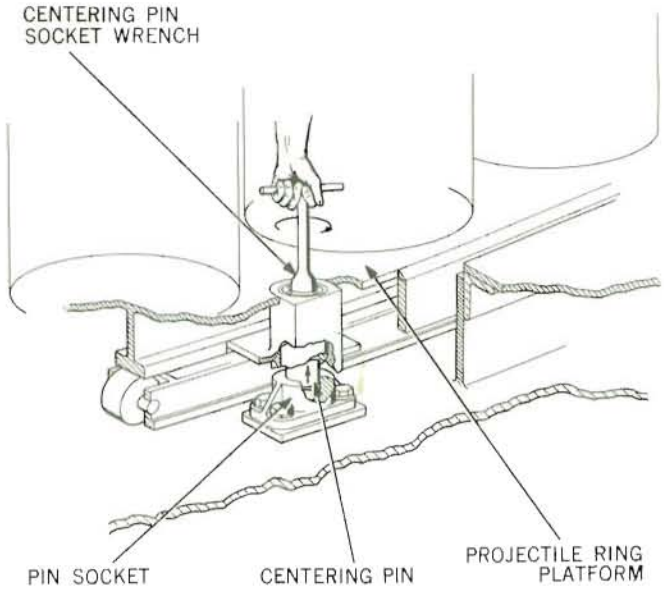


Figure 2-18. Releasing Projectile Ring Centering Pin

headset receivers and talk-back microphones. These 27 crew members are: the turret officer, turret captain, rangefinder operator, computer operator, talker, sight station personnel (6), gun layers and train operator (4), gun captains (3), powder hoist operators and door operators (6), and the petty officers in charge on the projectile decks and powder handling room (3).

Ordnance equipment preparations and starting operations.

Starting operations, described in the following paragraphs, include safety checks, operating precautions, and operating tests as well as the turning on of turret primary power, starting drives, and setting controls.

Safety checks, operating precautions, and tests. Personnel must be fully cognizant of the necessary operating precautions and safety checks. All ordnance assemblies require periodic maintenance and inspection. When preparing for operation and before starting any of the electric motors, it is necessary to verify that: proper lubrication has been performed; hydraulic fluid and oil levels, and high and low air pressures, are adequate and available; the equipment has been cast loose; and all personnel are clear. These and many other detailed precautions, tests, and checks are noted in other chapters and should be performed by the personnel directly controlling the various assemblies or by personnel designated by the turret officer.

Energizing main power circuit. A manual bus transfer panel, in the machinery space of the upper projectile flat, provides two external switches for controlling normal and alternate power for major electrical installations in the turret. Power from the bus transfer panel is transferred to five circuit

breaker power panels in compartment and electric deck ventilating systems; and the turret heating system. Each panel cut-off switch is normally turned to the ON position. A mechanical indicator plate above the operating handle in a small circular window indicates when power is on or off.

Located in the projectile flat machinery spaces are 17 motor controllers which control starting and stopping of power drive motors. On the upper projectile flat are three elevating gear motor controllers, three powder hoist motor controllers, one projectile ring motor controller, and one parbuckling gear motor controller. On the lower projectile flat are the training gear motor controller, three rammer motor controllers, three projectile hoist motor controllers, one projectile ring motor controller and one parbuckling gear motor controller. Each controller is equipped with a main line disconnect circuit breaker or switch, interconnected with the door so that the door can be opened only after the handle has been positioned at OFF. The ON or OFF position of the handle is indicated by a name plate on the controller cabinet. Ordinarily the handle is left in the ON position.

Starting drives. The following paragraphs contain the necessary instructions for starting the drive units for all power-driven ordnance assemblies within the turret.

Starting elevating gears. The master pushbutton switch for each elevating gear motor controller is located adjacent to the respective gun layer's station. It is a watertight unit with two pushbuttons, one labeled START-EMERG and the other STOP. The starting circuit contains two series connected neutral start interlock switches which prevent starting the elevating gear motor unless the A-end tilting box and the servo control valve are at neutral. In addition the control selector lever must be placed in the HAND position before the elevating motor is started.

If the elevating motor does not start when the START-EMERG button is pressed, either the handwheels or the tilting box are not in their neutral positions. Rotate the handwheels in both directions, counting the turns between limits, and position the handwheels at neutral midway between these limits. To position the tilting box at neutral operate the neutral return device hand-lever on top of the A-end control case. Tilting box neutral position is mechanically indicated by a pointer.

After the elevating gear motor is started, allow it to run until the hydraulic fluid is at normal operating temperature. Verify that the power-off control valve is energized and that the lubricating system is pumping oil. Operate the elevating gear in HAND to both limits of gun movement.

To switch control from HAND to AUTO verify: that the synchro power indicating light in the control selector is lighted and that the gun captain's switch is positioned at READY. Rotate the handwheels until gun elevation matches gun elevation order, as shown on the gun elevation indicator. When these match, place the control selector lever in the AUTO position.

Starting training gear. The master pushbutton switch for the training gear motor controller is located adjacent to the train operator's station. It is a watertight unit with two pushbuttons, one labelled START-EMERG and the other STOP. There is a neutral start indicator light assembly connected to the adjacent master switch. The starting circuit contains two series connected neutral start interlock switches which prevent starting the training gear motor unless the A-end tilting box and the servo pilot valve are at neutral. This condition is indicated by illumination of the neutral start indicator light. The control selector lever must be placed in the HAND position before the training gear motor is started.

If there is no illumination in the neutral start indicator, either the handwheels or the tilting box are not in their neutral positions. Rotate the handwheels in both directions, counting the turns between limits, and position the handwheels at neutral midway between these limits. The tilting box neutral position is mechanically indicated by a pointer on top of the A-end case. To position the tilting box at neutral operate the neutral return hand pump located near the train operator's station.

After the training gear motor is started, by pressing the START-EMERG button, allow it to run until the hydraulic fluid is at normal operating temperature. Verify that the power-off solenoid is energized and that the brakes are released. Operate the training gear in HAND to both train limit stops.

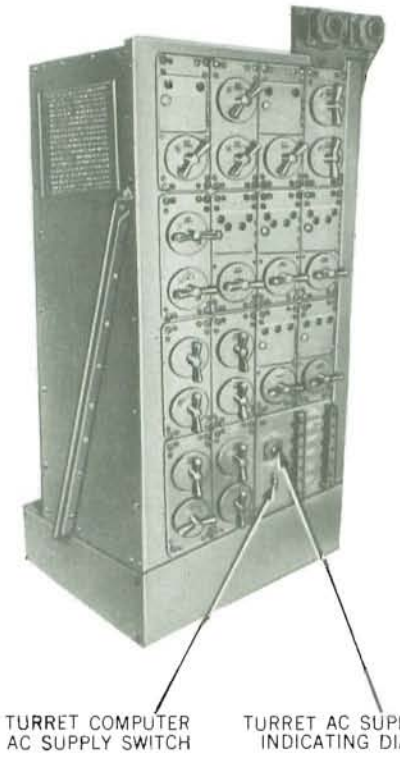
To switch control from HAND to AUTO, verify that the synchro power indicating light in the control selector is lighted. Operate the handwheels until the turret position matches gun train order, as shown on the train indicator. When these match, place the control selector lever in the AUTO position.

To switch to local control (in HAND) by either the left or right sight trainer, the train operator: disengages his handwheels by positioning the clutch lever on the left side of his handwheel pedestal at neutral; engages the handwheels of the selected sight trainer by positioning the clutch lever (located on the overhead at his station) at LEFT or RIGHT.

Starting rammers. The master pushbutton switch for each rammer motor controller is located at the rear of each gun room at the respective rammer operator's station. It is a watertight unit with two pushbuttons, one labeled START-EMERG and the other STOP. The starting circuit contains a neutral start interlock switch which prevents starting the rammer motor unless the A-end tilting box is at neutral. To start the motor, the rammer operator presses the START-EMERG pushbutton.

Starting projectile hoists. The master pushbutton switch for each projectile hoist motor controller is located at the rear of each gun room adjacent to the respective cradle operator's station. It is a watertight unit with two pushbuttons, one labeled START-EMERG and the other STOP. The starting circuit contains a neutral start interlock switch which prevents starting the projectile hoist motor unless the hoist control handle is placed at neutral. To start the motor, the projectile hoist operator presses the START-EMERG pushbutton.

Starting powder hoists. The master pushbutton switch for each powder hoist motor controller is located at the hoist operator's station.



SWITCH NUMBER AND NAME

	1 TRAIN INDICATOR		2 TURRET I MULTIPLE TURRET TRAIN INDICATOR
3 TRAIN TRANSMITTER	4 GUN TRAIN RECEIVER–REGULATOR	5 TURRET COMPUTER TRAIN RECEIVER	6 TURRET II MULTIPLE TURRET TRAIN INDICATOR
7 ELEVATION INDICATOR SELECTOR			
8 ELEVATION RECEIVER–REGULATOR SELECTOR	9 LEFT GUN INDICATOR AND RECEIVER–REGULATOR	10 CENTER GUN INDICATOR AND RECEIVER–REGULATOR	11 RIGHT GUN INDICATOR AND RECEIVER–REGULATOR
12 ELEVATION TRANSMITTER SELECTOR	13 SIGHT ANGLE TRANSFER		
14 ELEVATION TRANSMITTER TRANSFER	15 SIGHT DEFLECTION TRANSFER	16 LEFT SIGHT SETTER'S INDICATOR	17 RIGHT SIGHT SETTER'S INDICATOR
18 RANGE TRANSMITTER	19 PARALLAX RANGE RECEIVER		
20 IC CIRCUIT TRANSFER	21 OWN SHIP'S COURSE AND OWN SHIP'S SPEED		

Figure 2-19. Turret Officer's Transfer Switchboard, Turret II, General Arrangement

It is a watertight unit with two pushbuttons, one labeled START-EMERG and the other STOP. The starting circuit contains a neutral start interlock switch which prevents starting when the pump yoke is offset from the neutral position. To start the motor the hoist operator places the hoist control lever at neutral and presses the START-EMERG button.

Starting projectile rings. The master pushbutton switch for each projectile ring motor is located at the center projectile hoist at respective upper and lower projectile flats. It is a watertight unit with two pushbuttons, one labeled START-EMERG and the other STOP. The starting circuit contains a neutral start interlock switch which prevents starting when the pump yoke is offset from neutral position. To start the motor, the ring operator places the hand control lever at neutral and presses the START-EMERG button.

Starting parbuckling gears. The master pushbutton switch for each parbuckling gear motor is located at the center projectile hoist at respective upper and lower projectile flats. It is a watertight unit with two pushbuttons, one labeled START-EMERG and the other STOP. To start the motor, the parbuckler presses the START-EMERG pushbutton.

Setting controls; energizing the control circuit. Two classes or groups of controls must be closed when starting turret operations. These are the ordnance equipment controls and the turret officer's controls described below.

Ordnance equipment control setting. The automatic elevating and training gear receiver-regulator (AUTO) control devices are not placed in operation by the power drive starting operations (page 2-17). These control devices are energized by setting certain turret officer controls.

Turret officer controls. All fire control signals and communications transmitted to the gun layers and train operator, the elevation and train receiver-regulators, the personnel of both sight stations, the computer, and personnel in the gun rooms (acting as fuze setters) are routed through controls set by the turret officer. They are electric switching controls compactly arranged in the turret officer's transfer switchboard (fig. 2-7). Switchboards for turrets I, II, and III are virtually identical. Panel details of the switchboard for turret II are shown in figure 2-19.

Primary control. The 21 transfer switches on the switchboard panel are set as follows for primary control.

Switch Number	Switch Position
1	PLOT FWD
2	FWD
3	PLOT FWD
4	PLOT FWD
5	TURRET 2
6	FWD
7	PLOT FWD
8	PLOT FWD
9	AUTO AND IND
10	AUTO AND IND
11	AUTO AND IND
12	OFF
13	FWD
14	OFF
15	FWD
16	SIGHT ANGLE AND DEF
17	SIGHT ANGLE AND DEF
18	FWD
19	FWD
20	PLOT FWD
21	FWD

All transfer switches that may be positioned at at either FWD (PLOT FWD) or AFT (PLOT AFT) must be positioned similarly (all at FWD or all at AFT). There is a two-dial indicator (dials marked F and A) which shows the selected FWD or AFT position for transfer switches through which control circuits are actuated from either plotting room.

In addition to the transfer switches, the turret officer also operates the turret officer's selective switch, mounted on the transverse bulkhead at his station. This switch assembly consists of a pair of rotary switches. Controlled by a pointer type knob, the upper switch has three positions, labeled DIRECTOR - OFF - LOCAL. The lower switch, controlled by a pointer-handle, also has three positions, labeled AC SUPPLY - OFF - BATTERY. By rotating these switches, the turret officer selects local or remote firing, and the source of power to energize the firing circuit. Battery power can be used only for local turret firing.

Secondary control. The transfer switches are set as follows for secondary control.

Switch Number	Switch Position
1	OFF
2	LOCAL
3	OWN TUR COMP
4	OFF
5	OFF
6	LOCAL
7	TURRET II
8	TURRET II
9	IND
10	IND
11	IND
12	TURRET II
13	
14	OFF
15	
16	OFF or SIGHT ANGLE AND DEF
17	OFF or SIGHT ANGLE AND DEF
18	
19	
20	OFF
21	

The switches are set as above for turret II when it acts as a director in secondary control, and the switches in turrets I and III are set as follows.

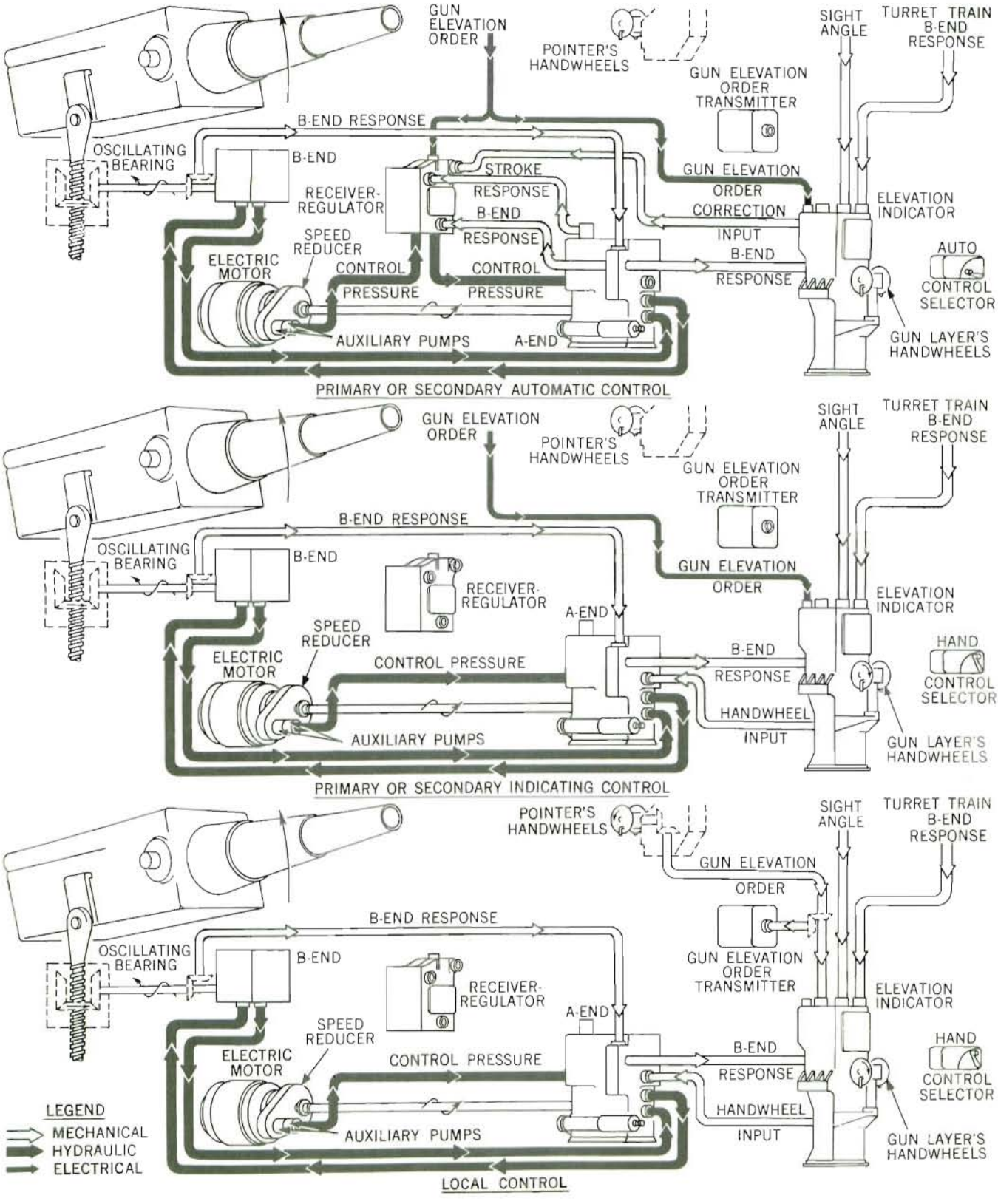


Figure 2-20. Elevating Gears and Controls, Functional Diagrams

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Switch Number	Switch Position
1	TURRET II
2	LOCAL
3	TURRET II
4	TURRET II
5	TURRET II
6	LOCAL
7	TURRET II
8	TURRET II
9	AUTO or IND
10	AUTO or IND
11	AUTO or IND
12	TURRET II
13	
14	OFF
15	
16	SIGHT ANGLE AND DEF
17	SIGHT ANGLE AND DEF
18	
19	
20	OFF
21	

Local fire control. The transfer switches are set the same for local fire control as they are set when the turret acts as a director in secondary control.

FIRING OPERATIONS

First round

In preparing for the first round, the turret officer designates which projectile flat will serve the hoists and whether armor piercing or high capacity projectiles will be used. The hoist operators on the designated flat clutch engage their hoist control handles and the petty officer in charge, or a crew member, starts the parbuckling gear and projectile ring drive.

Serving hoists. When the preceding operations are completed, the shell men and parbucklers on the designated flat begin serving the projectile hoists. The powder handling room crew begin serving the powder hoists.

A shell man and parbuckler work as a team to parbuckle projectiles into the hoist aperture. The shell man puts the hook on the end of the parbuckler's snubbing rope into a convenient hole or eye on the projectile flat provided for the purpose. He steadies and guides the projectile as it moves. The parbuckler operates the snubbing rope, looping the free end of the rope twice around a gypsy head and pulling it tight enough to move the projectile into the hoist aperture. Spring-loaded shutters at the hoist aperture retain the projectile in the hoist after it is placed within it. The projectile ring operator operates his handlever every three rounds (each hoist) to position the projectile ring so that the shell men teams may reach the projectiles in rotating stowage.

Three powdermen work as a team to load each powder hoist. Two men operate the powder handling room scuttles, carry powder bags to the hoist loading trays, and load the powder cars. The third powderman of each team operates a magazine scuttle. The first and second powdermen must each make three trips to load six powder bags into the loading trays. When the trays are loaded they stand by, waiting for the door operator to open the hoist lower doors so that they can roll the bags into the powder car. After this is done the powdermen load the trays in preparation for the next round.

Filling hoists. After a projectile is parbuckled into the projectile hoist, the hoist control handle is positioned at HOIST (and held there until the TOP OF STROKE indicator is illuminated at the hoist operator's station) and the projectile is automatically lifted to the next higher level. The next projectile can be parbuckled into the hoist as soon as the loading level is clear. The hoist rack is then lowered by positioning the hoist control handle at LOWER. As successive projectiles are parbuckled into the hoist, the manipulation of the hoist control handle is repeated as above until a projectile is lifted into (and latched in) the cradle.

After the powder bags have been rolled into the powder car and the hoist lower doors are closed, the control lever is positioned at HOIST and the powder car with six bags is hoisted to the upper unloading station.

Breech opening. The gun captain opens the breech, wipes the mushroom, and looks through the bore to make sure that there are no gases or burning remnants from the preceding round left in the gun or breech. He then announces "bore clear," depresses the bore clear switch momentarily, and trips the gas ejector valve. For the first load, the gun captain must manually disengage the salvo latch.

Priming. As soon as "bore clear" is announced, the primerman inserts a live primer into the firing lock.

Cradle opening. After a projectile has been lifted into (and latched in) the cradle and the bore clear switch has been depressed, the cradle operator depresses the foot pedal (unlatching the cradle) and positions the cradle control valve handle at LOWER CRADLE. The cradle then rotates to lower and to enter the spanning tray into the open gun breech. The cradle cannot be lowered until the bore clear switch has been depressed because of the cradle interlock portion of Ready Light Circuit 1R.

Projectile ramming. After the cradle assembly is spanned (containing a projectile), the rammer hand lever is moved toward RAM and the projectile is rammed into and seated in the gun. The hand lever is then moved toward WITHDRAW. The upper powder door is opened simultaneously with these ram and withdraw movements.

Powder transfer. After the rammer has been withdrawn, the powder car hoisted, and the hoist upper door opened, the hoist operator dumps the lower car tray. The upper powder door cannot be opened, because of the powder door interlock portion of Ready Light Circuit 1R, until the rammer has been withdrawn after projectile ramming. The three powder bags roll down the open door (which forms a shelf between the powder hoist trunk and the spanning tray) and are guided into the spanning tray by the gun captain and cradle operator. These men spread the bags (two forward and one aft) to make a space wide enough for the three bags still

in the powder car. These remaining bags are then dumped by the hoist operator (who has lowered the powder car) and are guided into position in the spanning tray to be rammed into the gun's powder chamber.

Powder ramming. After all six powder bags have been transferred to the spanning tray, the rammer hand lever is moved toward RAM and the bags are rammed into the gun's powder chamber. The handlever is then moved toward WITHDRAW. The upper powder door is closed simultaneously with these ram and withdraw movements. As soon as the rammer is fully withdrawn and the upper powder door is closed, the cradle control valve handle is positioned at RAISE CRADLE. The cradle then raises and retracts from the gun. The gun captain then closes the breech and positions his ready switch at READY.

Firing. When the breech is closed and the gun captain's ready switch is positioned at READY, the firing circuit closed within the turret, and the turret officer's selective switch turned to DIRECTOR, the gun can be fired electrically by remote control. During recoil and counterrecoil, the salvo latch is tripped automatically and the breech can be opened. The preceding loading procedure is repeated for the second and subsequent rounds.

Gun laying, firing

Turret control methods of gun laying and firing include primary or secondary automatic control, primary or secondary indicating control, and local control. Each method is described in following paragraphs.

Automatic control. In primary or secondary automatic control, gun laying and firing are accomplished entirely by remote control. Electrical signals (gun orders) to lay the guns in elevation and train the turret are relayed from either of the plotting rooms (forward or aft), or from another turret (acting as a director) and pass through the turret officer's transfer switchboard to the elevation and train receiver-regulators. The transfer to automatic control is completed when each gun layer and the train operator positions the lever of his control selector at AUTO.

Inputs to the elevating gear and to the training gear in the various methods of control are shown in figures 2-20 and 2-21.

Sight deflection and sight angle orders are relayed through the turret officer's transfer switchboard to the sight setter's indicator. The sight setter matches the sight angle order by hand and transmits this order mechanically to the sights and the gun elevation indicators (as a factor in correcting for gun erosion). The sight setter also matches the sight deflection order by hand and transmits this order mechanically to the sights.

Parallax range orders are relayed through the turret officer's transfer switchboard to the turret train indicator and transmitter. The train operator matches the parallax range order by hand and transmits this order mechanically to the indicator and transmitter and to the train receiver-regulator.

Corrections for roller path inclination, velocity loss, and gun erosion are combined in a differential gearing in the elevation indicator. These corrections are mechanically transmitted through a shaft to each elevation receiver-regulator from the respective elevation indicator.

Train response is mechanically transmitted from the right B-end (training gear) to the turret train indicator and transmitter, and to all elevation indicators (to correct for roller path inclination). Train response is mechanically transmitted from the train indicator and transmitter to the train receiver-regulator.

Gun elevation (B-end) response is mechanically transmitted from the B-end (elevating gear) to the respective elevation indicator and receiver-regulator.

Stroke response (elevation and train) is mechanically transmitted from elevating and training gear A-end control boxes to the respective elevation and train receiver-regulators.

Indicating control (primary). In primary (indicating) control, gun laying is accomplished locally. Gun firing is accomplished either by remote control or from a designated local station. Electrical signals (gun orders) to lay the guns in elevation and train the turret are relayed from either the forward or aft plotting room and pass through the turret officer's transfer switchboard to the gun elevation indicator and turret train indicator and transmitter. The gun layers and train operator observe their indicator dials and manipulate their handwheels to follow-the-pointer and directly control gun elevation and turret train. Each gun layer and the train operator positions the lever of his control selector at HAND.

Sight deflection and sight angle orders are relayed through the turret officer's transfer switchboard to the sight setter's indicator, and from this instrument to the elevation indicator and sights as in automatic control.

Parallax range orders are relayed through the turret officer's transfer switchboard to the turret train indicator and transmitter. The train operator matches the parallax range order by hand and transmits this order mechanically to the indicator and transmitter.

Roller path inclination, velocity loss, and gun erosion corrections are combined in a differential gearing in the elevation indicator.

Train response is mechanically transmitted from the right B-end (training gear) to the turret train indicator and transmitter, and to all of the elevation indicators (to correct for roller path inclination).

Gun elevation (B-end) response is mechanically transmitted from the B-end (elevating gear) to the respective elevation indicator.

Indicating control (secondary). In secondary (indicating) control, gun laying is accomplished locally. Gun firing is accomplished either by remote control or from a designated local station. Electrical signals (gun orders) to lay the guns in elevation and train the turret are relayed from another turret (acting as a director) and pass through the turret officer's transfer switchboard to the gun elevation indicator and turret train indicator and transmitter.

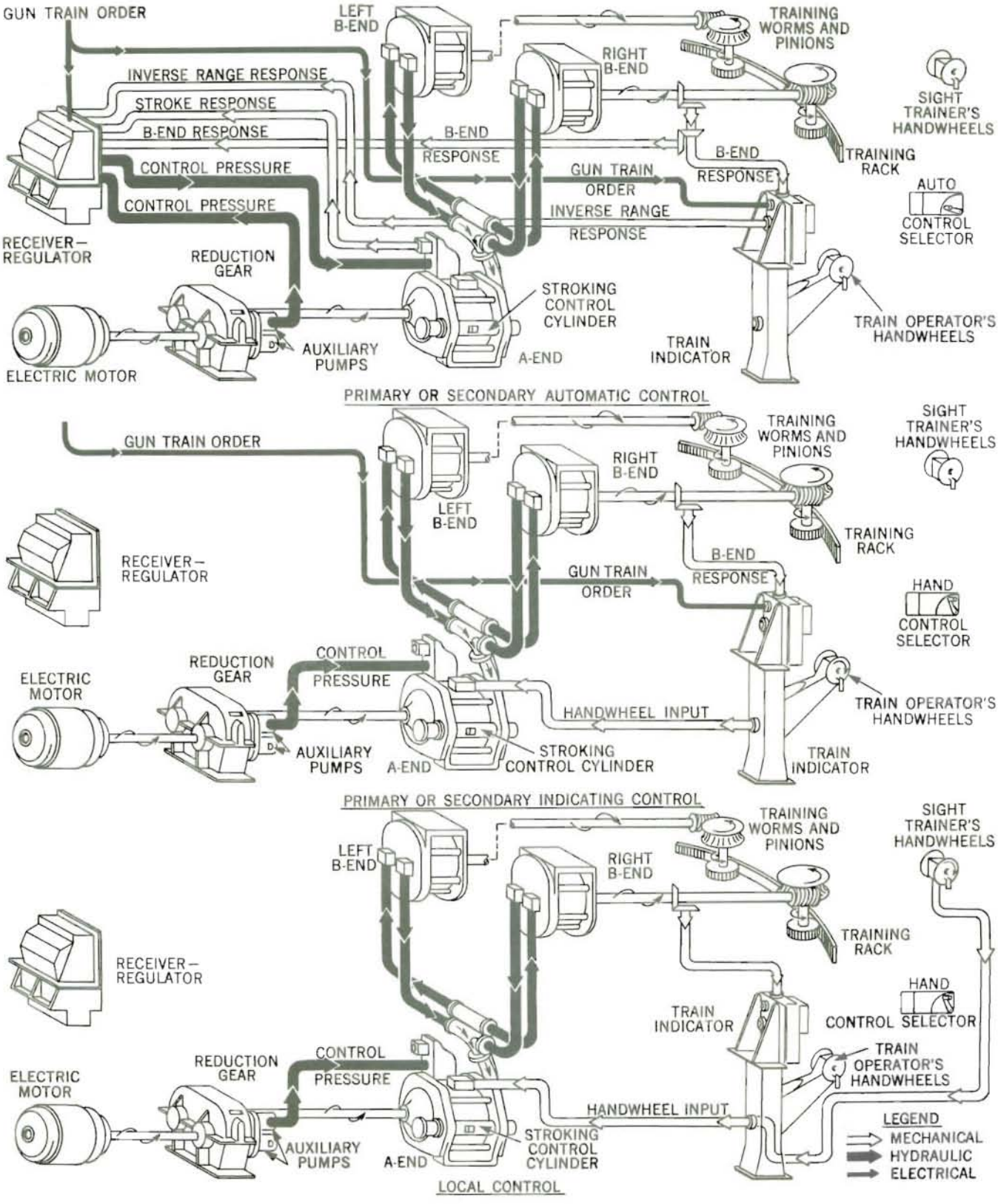


Figure 2-21. Training Gears and Controls. Functional Diagrams

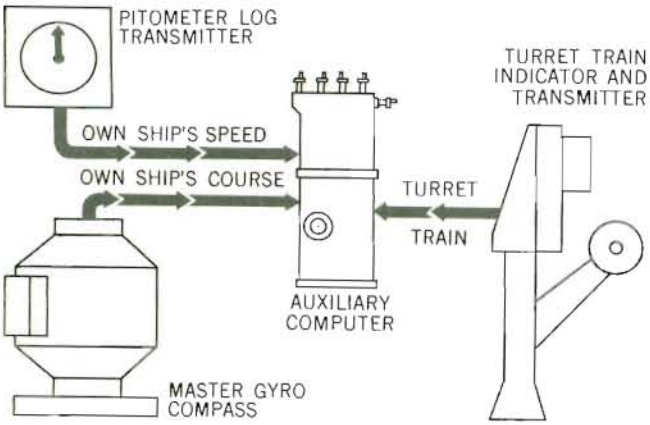


Figure 2-22. Auxiliary Computer Operation, Automatic Inputs

The gun layers and train operator observe their indicator dials and manipulate their handwheels to follow-the-pointer and directly control gun elevation and turret train. Each gun layer and the train operator positions the lever of his control selector at HAND.

Sight deflection and sight angle orders are relayed through the turret officer's transfer switchboard to the sight setter's indicator and from this instrument to the elevation indicator and sights as in automatic control.

Parallax range orders are relayed through the turret officer's transfer switchboard to the turret train indicator and transmitter. The train operator matches the parallax range order by hand and transmits this order mechanically to the indicator and transmitter.

Roller path inclination, velocity loss, and gun erosion corrections are combined in a differential gearing in the elevation indicator.

Train response is mechanically transmitted from the right B-end (training gear) to the turret train indicator and transmitter, and to all of the elevation indicators (to correct for roller path inclination).

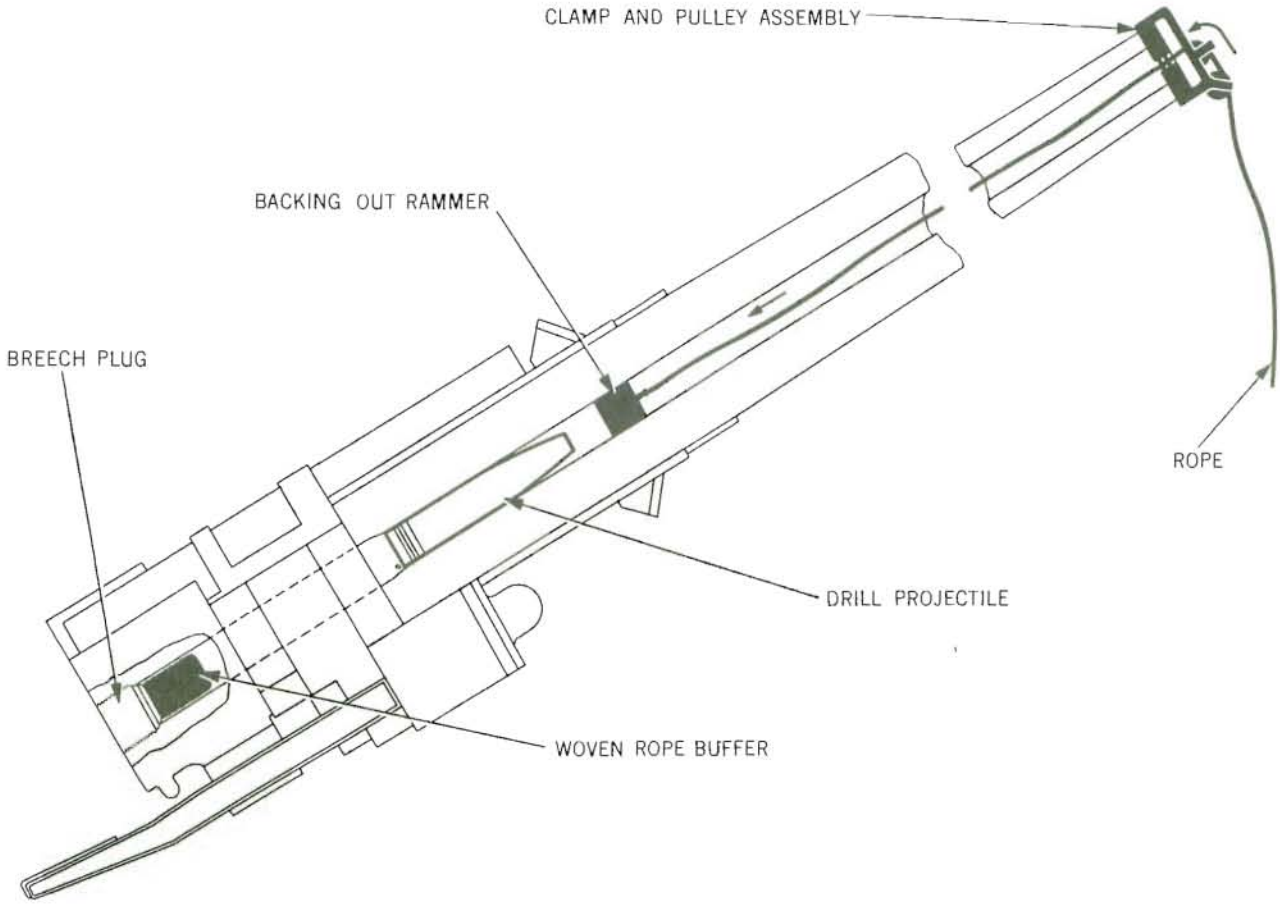


Figure 2-23. Use of Backing Out Rammer

Gun elevation response is mechanically transmitted from the B-end (elevating gear) to the respective elevation indicator.

Indicating control (local). In indicating control (local control), gun laying is accomplished locally and gun firing is accomplished by designated local switch or switches. Mechanical signals (gun orders) to lay the guns in elevation are transmitted through shafting from a sight pointer's handwheels to the elevation indicators. The gun layers manipulate their handwheels to follow-the-pointer and control gun elevation. Mechanical signals to train the turret are transmitted through shafting directly from either sight trainer's handwheels to the training gear A-end. The turret officer's transfer switchboard is set as described on page 2-3 for local control. Each gun layer and the train operator positions the lever of his control selector at HAND.

Target range and the fire control problem are computed by the turret rangefinder and auxiliary computer respectively. Sight deflection and sight angle orders are orally transmitted from the computer to the sight setter's indicator. The sight setter adds these values to his instrument by hand and transmits the sight orders to the pointer's and trainer's sights.

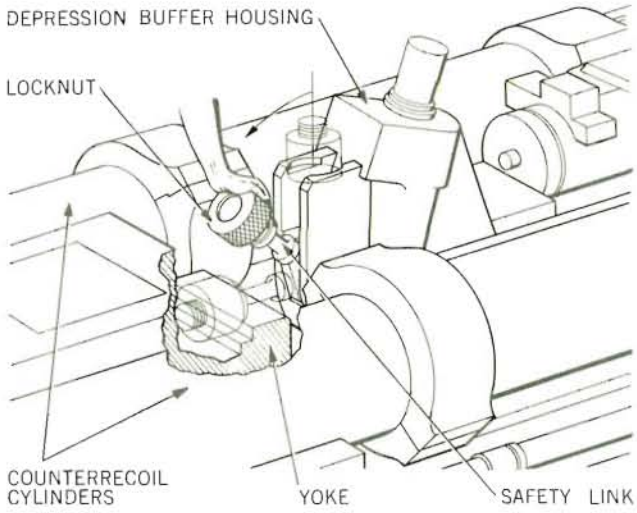


Figure 2-24. Securing Gun-Locking Device

Loading

The gun can be brought to its loading position of five degrees elevation while in either automatic or hand control as selected by positioning the control selector lever at AUTO or HAND, respectively.

Automatic control. Automatic (loading) control is control action by the elevation receiver-regulator which moves the gun automatically from any angle of elevation to the loading position. This action occurs either when the control selector lever is positioned from AUTO to LOAD or when the gun captain's ready switch is turned to SAFE (provided synchro power is available, as indicated by an illuminated dial marked SYNCHRO POWER ON at the gun layer's station).

Hand control. Hand (loading) control is control action initiated by the gun layer who turns his handwheels to move the gun to the loading position. He does this when the gun captain's ready switch is turned to SAFE, in which position a dial marked LOAD is illuminated at the gun layer's station.

Sighting

Sight setting. The sight setter sets the sights by turning his hand cranks to match dials in the sight setter's indicator. The hand cranks set the sights by mechanically transmitting sight angle and sight deflection orders to shift the lines-of-sight of the sight pointer's and sight trainer's telescope. The indicator also supplies sight angle to the gun elevation indicators where it is used as one of the factors for computing erosion correction (for transmission to the receiver-regulator, AUTO control).

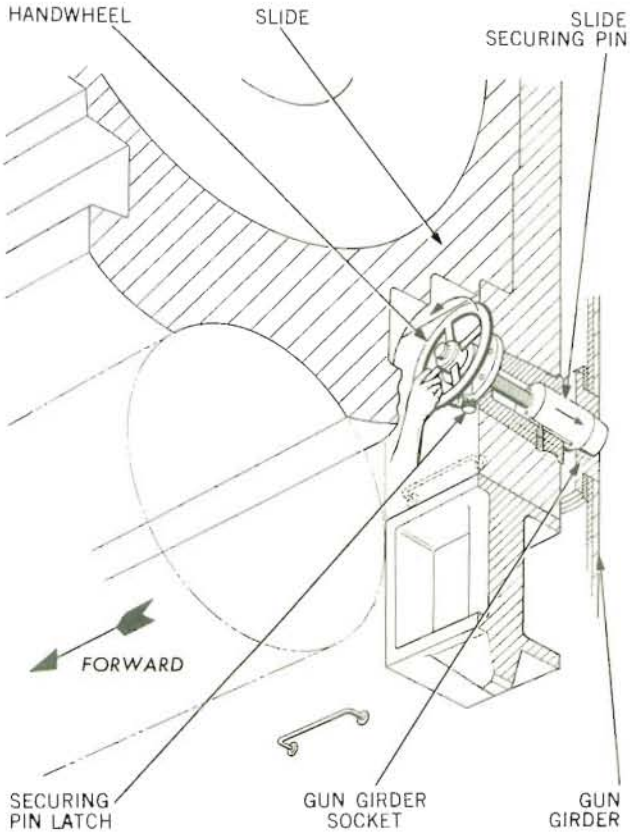


Figure 2-25. Securing Slide Securing Device

Pointer's sight operation. The sight pointer (in local control or when the turret is used as a director in secondary control) lays his horizontal crossline on the target by turning his handwheels, thereby developing gun elevation order. This value is transmitted to the gun elevation indicators and the gun layers turn their handwheels to lay the gun by matching dials.

Trainer's sight operation. The sight trainer (in local control or when the turret is used as a director in secondary control) lays his vertical crossline on the target by turning his handwheels, thereby training the turret to the proper position.

Range estimating

Computing data. The turret computer is used by the computer operator in local control to solve the fire control problem.

Three electrical synchro inputs are received in the computer (fig. 2-22). These are own ship's speed and own ship's course, received from the ship's gyro compass and Pitometer log via the plotting room; and turret train, received from the local turret train indicator and transmitter.

Thirteen inputs are manually introduced. These are: projectile, initial velocity, target angle, wind angle, wind speed, true target bearing, own ship's speed, deflection correction, present range, range correction (shot), time, target speed, and turret train follow-up. Three of these hand inputs are identical to the electrical inputs - true target bearing (when own ship's course electrical does not function), turret train follow-up, and own ship's speed. The first two are for emergency use when the corresponding electrical input or the respective follow-up is inoperative. The electrical input for own ship's speed operates a dial but does not set the mechanism. Setting must be done by hand.

The outputs of the computer are sight deflection and sight angle, indicated on dials or counters at the computer and transmitted by telephone to the sight setters.

GUN CASUALTY OPERATION

Misfire operation

Misfires are usually caused by a break in the electrical firing circuit, the weakest portion of which is the primer. To avoid misfires, handle primers carefully to prevent damage of the electrical contact within the primer.

In the event of a misfire a series of operations must be performed by the gun captain (with assistance from his gun crew) to correct the malfunction quickly and resume normal fire. Teamwork is necessary because of the number of operations, the urgency, and the work involved.

The normal procedure is quickly performed, but it requires a number of control, unloading, and loading actions. These actions interrupt gun laying, extract the misfired primer, and load a new primer, as described in the next paragraph.

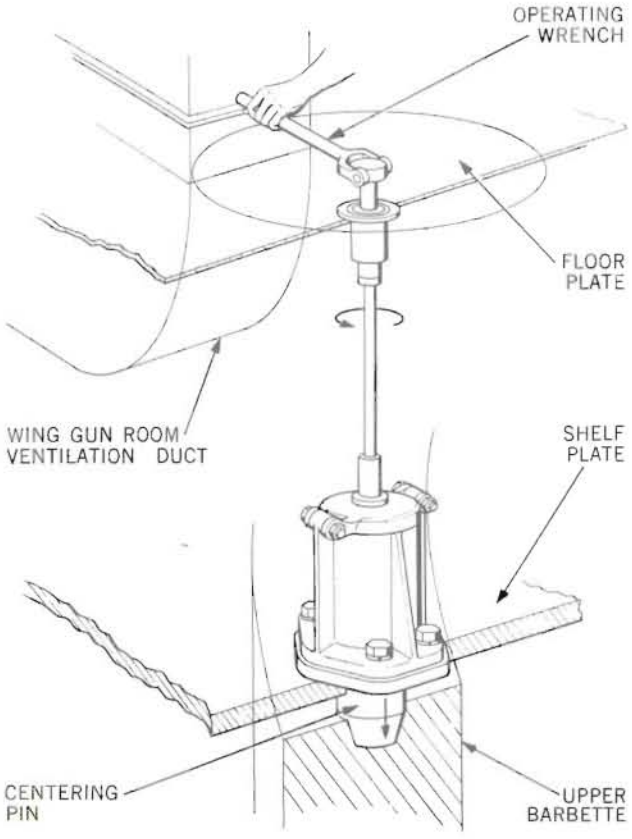


Figure 2-26. Securing Turret Centering Pin

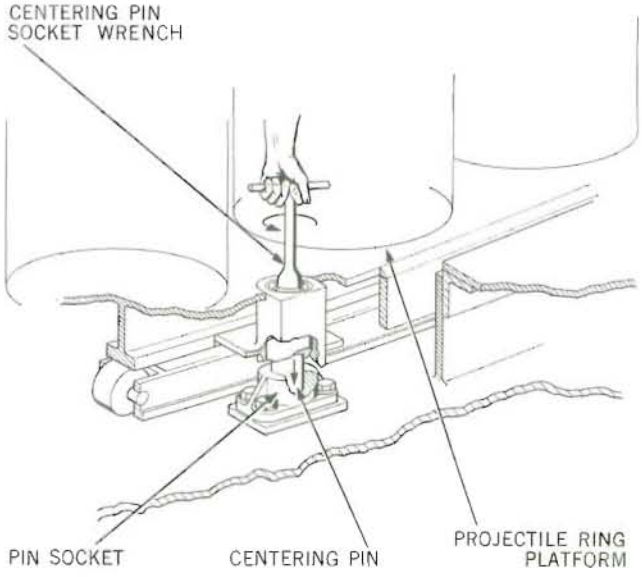


Figure 2-27. Securing Projectile Ring Centering Pin

Suggested operating procedure for misfire correction. When misfire occurs, the malfunction is corrected as follows:

The gun captain immediately positions his ready switch lever to SAFE, after pulling the PULL TO RELEASE button on the switch to release the lever lock (fig. 15-22). This action opens the respective gun firing circuit, and either automatically brings the gun to its five degrees loading position or notifies the gun layer (by indicator light) to do so.

The gun captain notifies the turret officer of the misfire and receives permission to extract the misfired primer from the firing lock. This action may be done without opening the breech* (see NAVORD INSTR. 5100.1 as quoted) or removing the firing lock (unlatch the wedge retracting lever and rotate it rearward independently of the breech operating lever).

The gun captain inserts a new primer into the firing lock (using the re-priming tool) and rotates the wedge retracting lever to close the firing lock wedge.

The gun captain then notifies the turret officer that the gun is reprimed and awaits orders from the turret officer to position his ready switch to READY. The turret officer must check to see that the firing circuit is open.

The gun captain positions his ready switch to READY upon orders from the turret officer, and gun laying and normal firing may be resumed.

If the firing malfunction persists after the above procedure, it may be necessary to resort to percussion firing until the electrician can check the firing circuit.

*NAVORD INSTRUCTIONS 5100.1, Safety Precautions, III - 26:

"The possibility of a serious accident due to opening the breech of a gun too soon in the case of a hangfire demands the constant exercise of the utmost prudence and caution. A hangfire must be assumed to exist when:

(1) An unsuccessful attempt has been made to fire the gun.

(2) A charge remains in a bag gun, with the possibility of ignition by an undetected ember from the previous round.

(a) The following procedure shall be followed in the cases noted above:

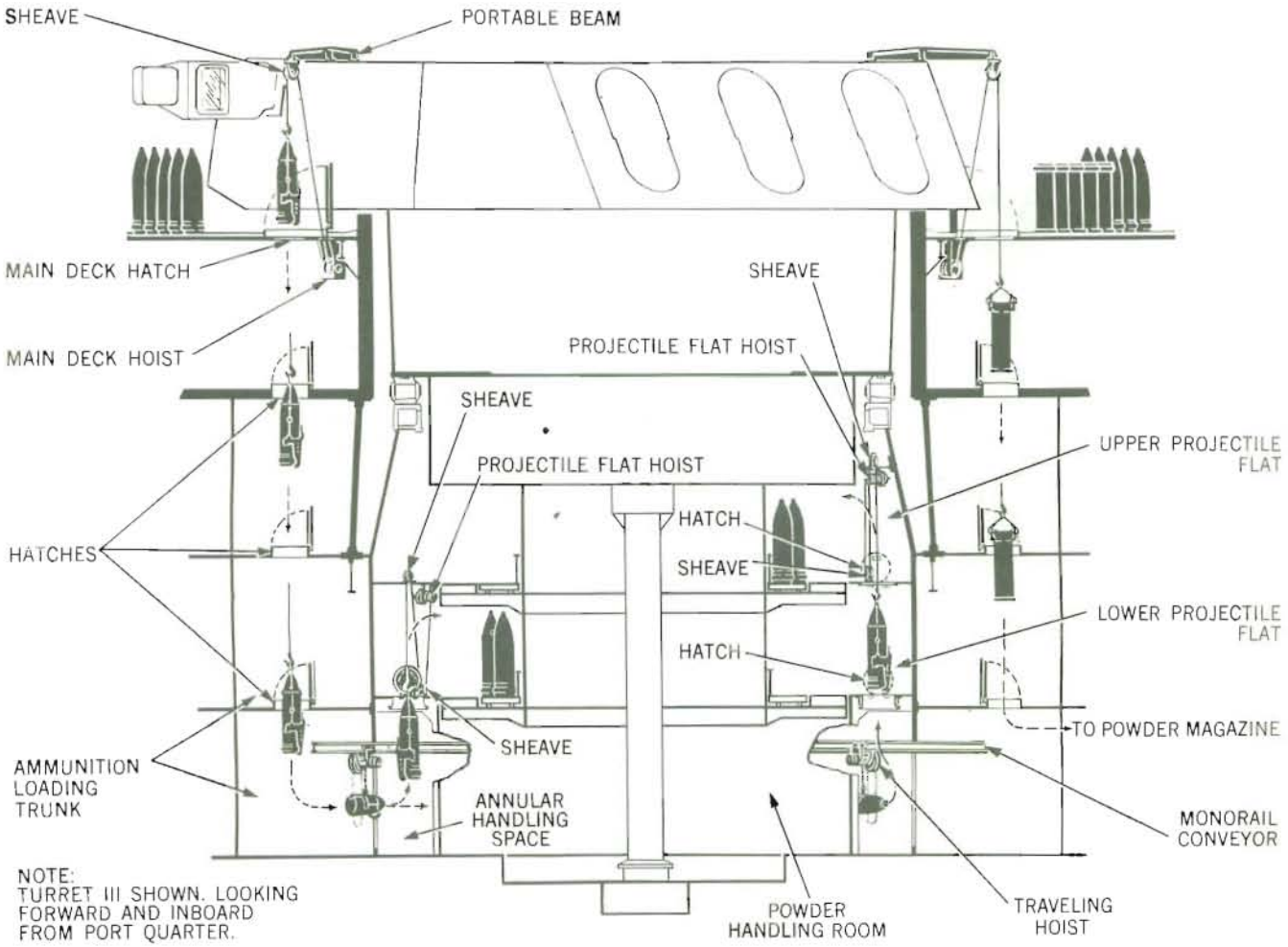


Figure 2-28. Ammunition Stowage into the Turret

(1) Keep the gun pointed and trained in a safe direction.

(2) Keep the breech mechanism fully closed.

(3) Continue attempts to fire, if desired, repriming bag guns provided such efforts do not involve any movement tending to open the breech.

(b) If the gun is not fired under the above conditions:

(1) Open the firing key and break the firing circuit elsewhere.

(2) Unhook the firing lanyard, if detachable.

(3) Remove the primer from the lock of a bag gun, using the primer tools supplied for this purpose, taking care to avoid danger from recoil or blowback. For this purpose, or for shifting primers, do not leave the firing lock open longer than necessary.

(4) Do not open the breech for 30 minutes (10 minutes for field and landing guns on shore) after the last attempt to fire. This, at the discretion of the commanding officer, is not obligatory in time of action; nor is it obligatory or advisable with a hot gun if an instruction of the Bureau of Ordnance to prevent a projectile "cook-off" recommends earlier opening of the breech when the gun cannot otherwise be cleared by firing it.

Figure 2-29. Rangefinder Stations, Manned

(c) The crew shall never leave a loaded gun until the precautions in (a) and (b) (1) to (3) above have been carried out.

(d) Ammunition removed from a loaded gun shall be disposed of in accordance with current instructions of the Bureau of Ordnance."

Manual projectile extraction

A backing-out rammer outfit consisting of a ram, a rope, a clamp and pulley assembly, and a woven rope buffer is used to remove drill projectiles from the gun. The buffer is placed in the powder chamber (to protect the mushroom when the projectile breaks loose and falls back) and the breech is closed. The ram with rope attached, and the clamp and pulley assembly are installed with the rope led through the pulleys. While the ram is held at the muzzle end of the gun, the gun is elevated as shown (fig. 2-23). The ram is dropped on the projectile and raised by the rope and pulleys. This operation is repeated until the projectile is unseated and falls back against the buffer. See "Backing-out precautions," chapter 3.

SECURING OPERATIONS

At conclusion of firing operations, many duties must be performed to stow and secure the ordnance assemblies, auxiliary equipment, and turret stations. The work includes conventional gun cleaning and preservation as defined by the Ordnance Manual, inspections and system replenishing services, closing down power units, shifting controls, and securing operations. These activities are generally the reverse of the casting-loose and starting preparations described previously in this chapter. They are duty assignments that include all members of the turret organization.

This work comprises three general classes of activities:

Stopping equipment
Conditioning for stowing
Securing

Stopping equipment

All power-driven ordnance equipments are stopped by depressing master pushbutton stop control switches.

The electric control systems of the elevating and training gears are stopped by opening signal circuits and supply switches of the turret officer's transfer switchboard and selective switch.

Ventilating units designated by the turret officer are stopped by depressing master pushbutton stop control switches.

Heaters are cut off by opening supply switches adjacent to each unit.

The power-supply manual disconnect switches of all Ordnance controllers are opened, and supply switches are opened at all power equipment panels except the miscellaneous equipment panel.

Certain of these operations are deferred when the "Cease fire" order is received, in order to unload the hoists, to condition units for stowing, or to move them to securing positions.

Hoist unloading operations. The power drives of the hoists must be in operation to move ammunition from the projectile cradle and powder car to the projectile flats and powder handling room.

At "Cease fire" the gun captain directs the cradle operator to position the function control and shut-off valve handle at LOWER PROJECTILES.

WARNING

If powder has been exposed in the gun chamber, no projectiles are to be lowered until the pow- has been returned to the powder car and the powder car returned to the bottom of its hoistway. The only flame-proofing within the projectile hoists is provided by the projectiles in it.

The hoist operator then positions the hoist control handle at HOIST and the hoist rack is lifted until the TOP OF STROKE indicator is illuminated at the hoist operator's station. This action lifts the projectile above the cradle projectile latch.

Figure 2-30. Computer Operator's Station, Manned

The cradle operator must move the latch back to permit downward passage of the projectile when the hoist operator positions the hoist control handle at LOWER (after the LATCH CLEAR indicator is illuminated). When this occurs the projectile is lowered from the cradle to the next lower stage, and the projectile flat crew parbuckles the projectile at their level from the hoist. As successive projectiles are parbuckled from the hoist, the use of the hoist control handle is repeated as above until the hoist tube is empty.

At "Cease fire," the power hoist operator lowers his loaded powder car to the hoist loading station in the powder handling room. The lower door operator dumps the car trays to roll the powder bags into the loading trays. The first and second powdermen carry the bags from the loading trays to a powder handling room scuttle. They rotate the scuttle each time they place a bag in it to return all bags to the magazine via the magazine scuttle which is operated by the third powderman.

WARNING

A loaded powder car must not be unloaded nor the lower powder door opened until all exposed powder in the handling room has been returned through the scuttles to the magazines. Unload and return powder to the magazine from one car before opening the lower door of another hoist.

Conditioning for stowing

Preparations for stowing the equipment consist of cleaning and inspecting all assemblies, performing "After Operation" lubrication as prescribed by the lubrication charts, and servicing counterrecoil bottles and hydraulic system tanks to replenish depleted air and fluid volumes.

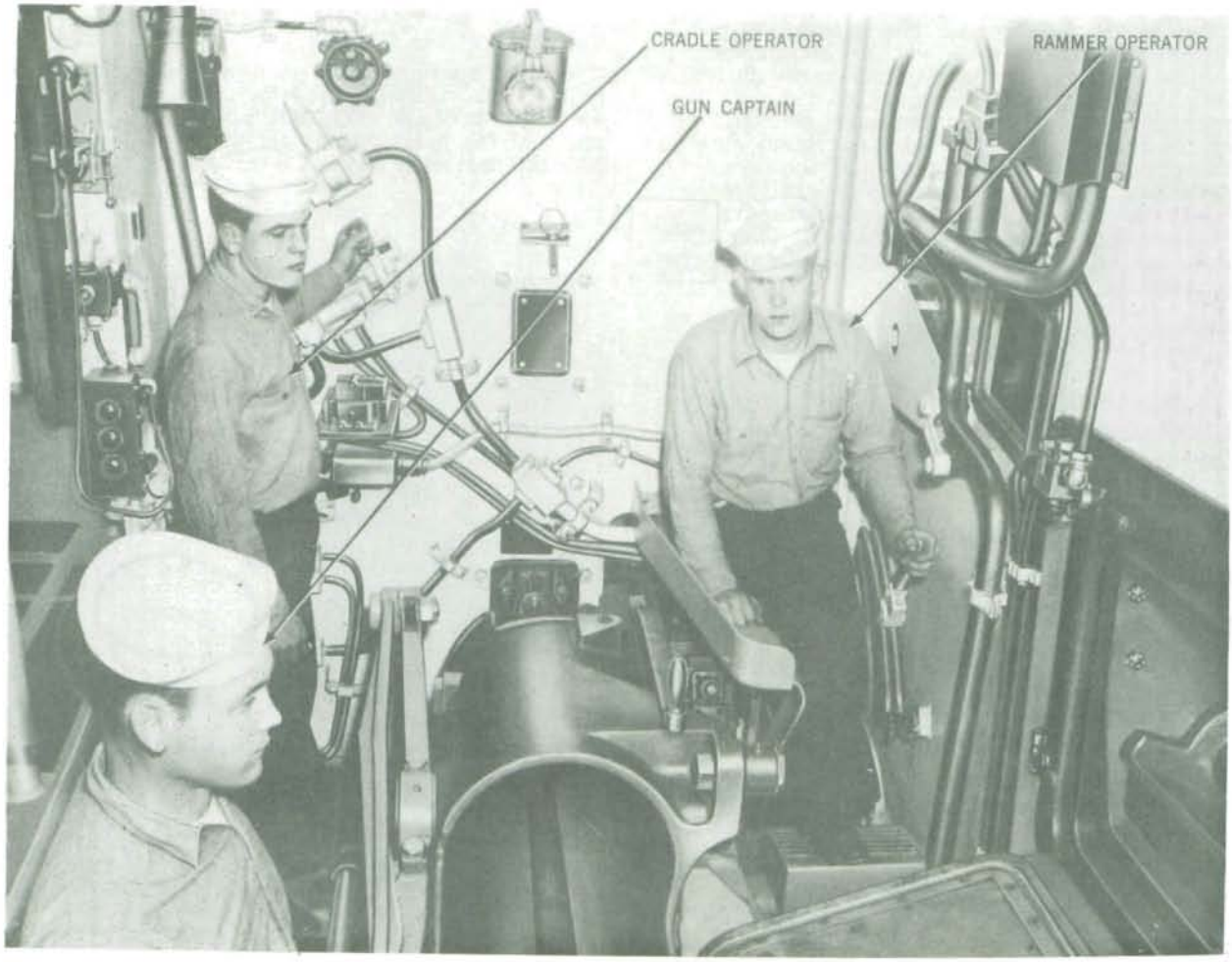


Figure 2-31. Right Gun Chamber Stations, Manned

Lamp replacements. The inspection work must include complete check-off of all ready-lights, light-well illumination, and other battle illumination, replacing all defective lamps.

Cable check. Cable loops of the firing circuit at the gun breeches and firing keys, and all other wiring exposed to chafing and twisting action must be examined for kinks, insulation breaks, or other defects.

Securing

The principal securing operations are illustrated and are described in the following paragraphs.

Securing the guns. The gun locking device is connected (fig. 2-24) with the threaded safety link and locknut lowered to the locked position in the yoke recess. The nut is then tightened until the device is secured in the locked position. After cleaning, bore gage tests, and preservation treatment, the tompion or muzzle cover is installed and the breech is closed.

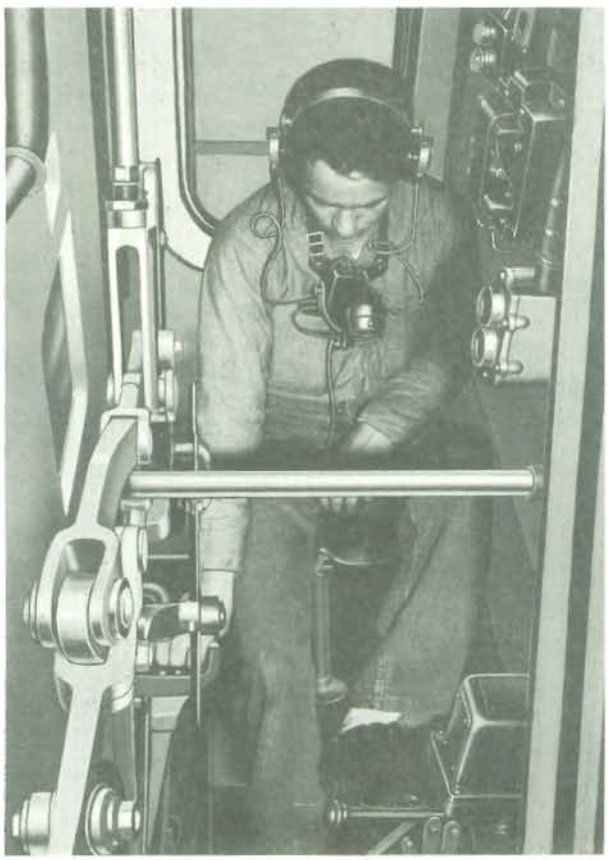


Figure 2-32. Powder Hoist Operator's Station, Manned

Figure 2-33. Gun Train Operator's Station, Manned, Left Side View

Securing the slides. Slides are secured by elevating the gun to zero degrees elevation in order to align the securing pin with its gun girder socket (fig. 2-25). By turning the respective handwheel counterclockwise and holding the securing pin latch down, the pin is run into its socket.

Securing the hoists. Each ammunition hoist must be stowed empty. Projectile hoists are to be stowed with racks fully lowered and control handles at neutral. Function control and shut-off valve handles are to be positioned at HOIST PROJECTILES. Powder hoists are to be stowed with the car fully lowered and all doors closed.

Securing the elevating gear. The elevating gear is locked against backlash action and seaway stress when the slide securing pin is in secured position. Controls are secured when the gun layer stops handwheel rotation at neutral position and the control selector lever is at HAND position. The drive motor is then stopped.

Securing the training gear. The training gear is secured by training the turret slowly until the two centering pins align with their holes in the upper barbette. This position is zero degrees train for turrets I and II, and 180 degrees train for turret III. Both pins must be run out until each is tight (fig. 2-26). This operation is essential to prevent seaway stress in the roller carriage, "brinelling" in the roller track, and backlash chatter in the pinions and training rack.

Controls are secured when the train operator stops handwheel rotation at neutral position (indicated by the neutral-start indicator light being illuminated) and the control selector lever is at HAND position. The drive motor is then stopped.

Securing the projectile rings. The projectile rings are secured by operating each ring from its "Cease fire" position in repetive power drive cycles until the centering pins and sockets align. The pins are then run out until each is tight (fig. 2-27).

All projectile lashings are inspected to verify secured position of each toggle link. Lashings of expended ammunition should be tied to the coaming.

Each projectile ring control hand lever is secured at STOP detent position and the drive motor is then stopped.

Securing the parbuckling gear. The two parbuckling gear assemblies are stopped, and the snubbing ropes are neatly coiled and hung in convenient locations in the projectile flats.

Securing the sights. The turret optics should be positioned with offsets removed when securing. The sight setter handcranks should be at 2000 minutes sight angle, 500 miles deflection. The rangefinder should be positioned at zero degrees elevation and azimuth, and the periscopes at zero degrees azimuth.

The rangefinder is secured by operating the handcrank mechanism to close the hood door and making sure that it latches shut.

Each periscope is secured by seating the azimuth movement plunger and releasing the cover from its open position, moving it to its closed position, and running the wing nut tight.

Sight telescopes are secured, after wiping sight objectives with lens paper, by operating the sight hood door mechanism to close the door tightly.

Securing the turret officer's controls. The turret officer's transfer switches, selective switch, and firing key switches are positioned as follows when securing:

Transfer switches: All switches having an OFF position to be positioned at OFF, all other switches at their primary control position.

Selective switch: Pointer knob and pointer handle at OFF with the stop secured.

Firing key switches: All switches at OFF position.

Securing the sprinkling system. The air pressure control valve to the sprinkling tanks is closed. The system air pressure is relieved.

The firemain cut-off valve in the powder handling room is closed.

Securing the ventilating system. Ventilating fan sets are stopped as designated by the turret officer.

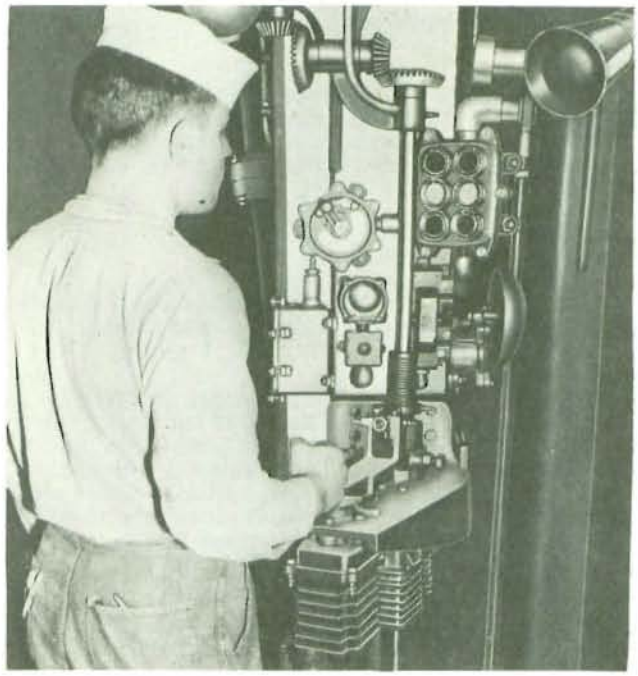


Figure 2-34. Projectile Hoist Operator's Station, Manned

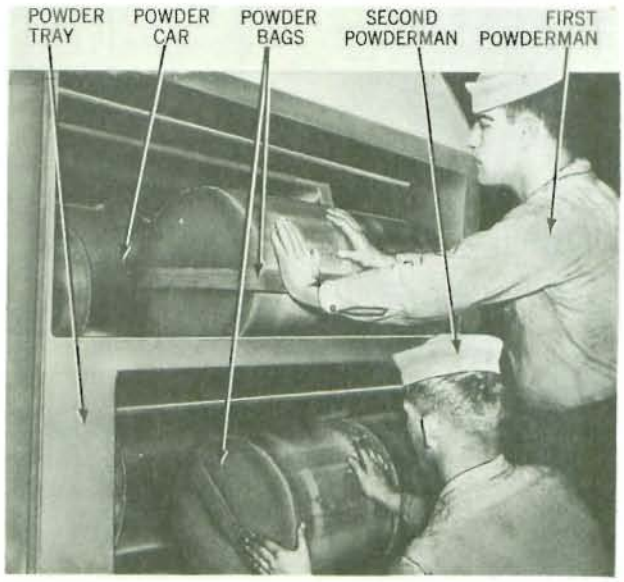


Figure 2-35. First and Second Powdermen Loading Powder Car

STOWING AMMUNITION

Ship and turret design arrangements permit two separate routes to be utilized for moving ammunition from the main deck outside the turret to stowed positions in the magazines and projectile flats. A separate stowage route is located on each side of the turret as shown in figure 2-28. The routes (or ammunition loading trunks) are formed by hatch openings in each deck, each opening being located directly below the main deck hatch.

Stowage procedure

Ship and turret arrangements for ammunition stowage handling are similar for both routes (port and starboard). Each route comprises an ammunition trunk outside of the turret, extending from the main deck to the magazine level. At the bottom of each trunk are overhead trolley conveyor arrangements that lead to, and travel around, the annular handling space between the powder handling room and the powder magazines. There are hatches inside the turret, leading upward from the annular handling space between the powder handling room and the powder magazines. There are hatches inside the turret, leading upward from the annular handling space to the projectile flats.

The ammunition loading trunks are accessible only after the turrets have been trained to predetermined angles. These angles of train are: turret I, 266 degrees; turret II, 230 degrees; and turret III, 193 degrees. After the turrets are trained to these positions, portable beams are bolted to the tops of the gun house structures. Each portable beam suspends a sheave and hoisting hook directly over a trunk.

Structural arrangements for the ammunition stowage handling routes are the trunks and annular handling space. In addition, there are hatch arrangements within the turret for projectile stowage handling. These latter arrangements consist of two round hatches in each projectile flat. Each hatch is fitted with a hinged cover that fits flush with the floor plates when closed. These hatches, located in the rear part of each fixed stowage ring, are arranged in pairs with a hatch in the upper flat aligned directly above a hatch in the lower flat. Both hatches in a pair are aligned directly above the annular handling space of the magazine level. Projectiles may be stowed on the normally closed hatch covers.

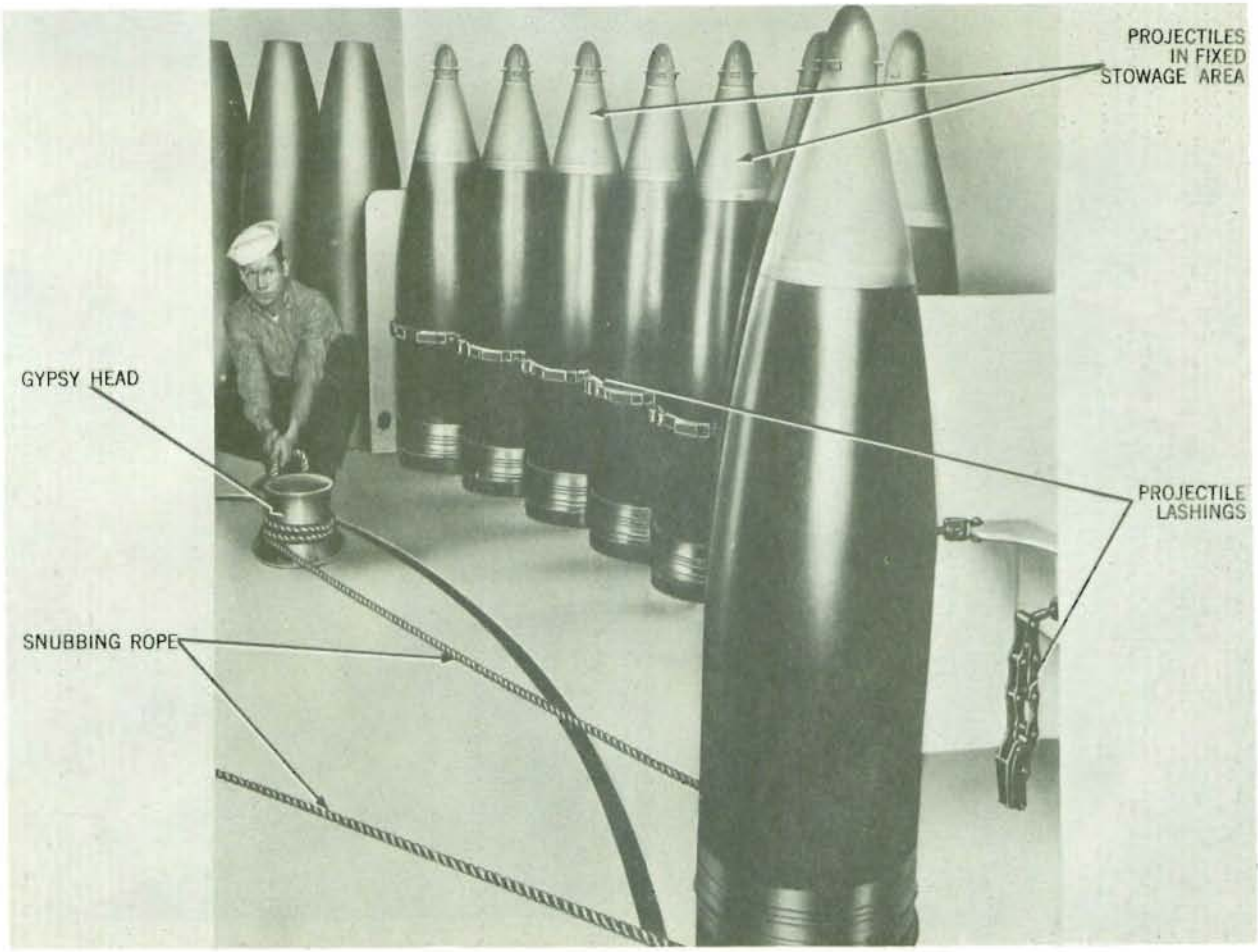


Figure 2-36. Shellman Parbuckling Projectile

Each stowage route is provided with hoist equipment which includes a main deck hoist, a projectile flat hoist, and the monorail conveyor traveling hoist at the magazine level. The main deck hoist is electric-motor-driven with remote start-stop controls located at the main deck hatch. The hoist motor rotates a drum and is mounted on a foundation weldment that is secured to the underside of the main deck. A wire rope with swiveling hook is led upward from the hoist drum through the sheave in the outer end of the portable beam. This hoist is used for stowing projectiles and powder into the turret.

The projectile flat hoist is electric-motor-driven with remote start-stop controls located on the turret foundation bulkhead adjacent to the round projectile flat hatch. Mounted on the projectile flat overhead, the hoist is adjacent to and above the round hatch opening in the floor below the hoist. The hoisting chain is lead downward from the hoist through a sheave that is secured to the floor alongside of the round opening. From the floor sheave, the chain is lead upward to a second sheave that is secured to the overhead directly over the center of the round hatch opening in the projectile flat floor. This hoist is used only for transferring projectiles from the magazine level to the upper and lower flats.

The monorail conveyor traveling hoist at the bottom of the ammunition trunk is an overhead trolley with a manually operated chain hoist. This hoist is used to transfer projectiles from the main deck hoist to the projectile flat hoist. The hoist is also used in transferring powder or stowing powder in the magazines.

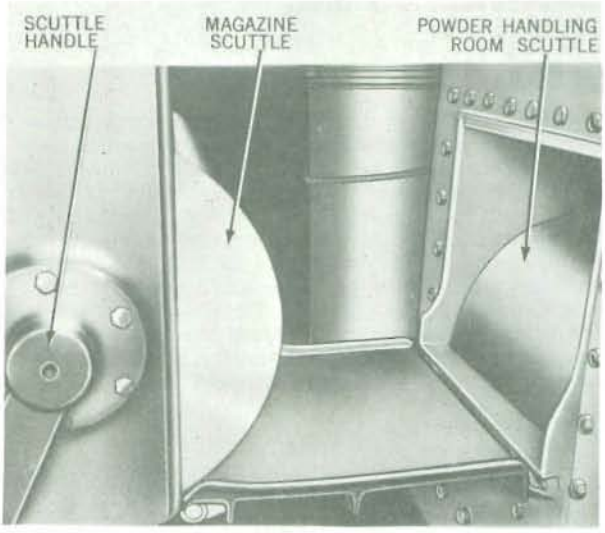


Figure 2-38. Magazine and Powder Handling Room Scuttles. Powder Handling Space

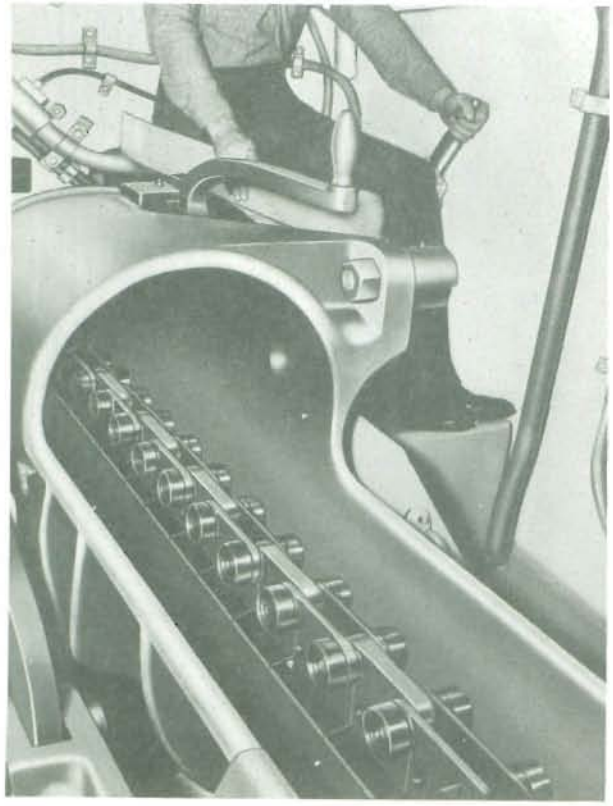


Figure 2-37. Rammer Operator's Station, Manned

Figure 2-39. Powder Handling Room Scuttle, Manned. Powder Handling Room

Projectiles are handled by a projectile carrier which is a projectile holding yoke and base stirrup with a wire rope sling and becket. A two-position carrying design, the carrier is used to carry projectiles in the horizontal position as well as vertical. It is removed from each projectile after the projectile is delivered in a vertical position at the bottom of the trunk. A similar carrier is then installed on the projectile, and the first carrier is hoisted empty to the main deck. Projectiles are transported in a horizontal position through the annular handling space, by the second carrier and the overhead trolley-conveyor, to a position beneath the projectile flat hatches. Projectiles are hoisted in a vertical position through these hatches to the projectile flats. Stowing of projectiles on the inner and outer rings is performed by parbuckling.

After the projectile has been hoisted to either projectile flat, it must be secured in position on either the fixed outer ring or the rotating inner ring. Projectiles are secured by special chain lashings. The outer row of projectiles on the outer ring fit into notches in a flange, and are chained to the flange. The inner row of projectiles are secured similarly. All securing chains are equipped with pelican-type fasteners, which permit rapid and separate unlashing of the projectiles.

Powder tanks are handled by a powder tank carrier, which is two short lengths of wire rope joined by a steel ring and equipped with a spring-loaded latch fitting on each end. The hook of the main deck hoistsfits through this ring when the carrier is latched to the upper powder tank flanges. It is a one-position carrying design used to carry powder tanks in a vertical position through the ammunition loading trunks or annular handling space.

After the powder tank has been hoisted into a magazine, it must be secured in position. Powder tanks are secured by stacking them horizontally in bins (between the magazine floor and overhead). The tanks are held in position by their flanged and grooved ends (which are interlocked), and by vertically placed portable battens (which prevent the stacked tanks from shifting). Stacking of tanks in the topmost rows is facilitated by powder handling cars (gravity actuated) within the magazine. These cars hoist powder bags singly, thereby enabling the stowage crew to empty a powder tank, stack it in position, and then fill it by hoisting the bags.

Chapter 3

GUN ASSEMBLIES

16-inch Gun Mark 7 Mod 0

16-inch Breech Mechanism Mark 4 Mod 0

Firing Lock Mark 14 Mod 5

16-inch Gas Ejector Mark 5 Mod 0

16-inch Yoke Mark 5 Mod 0

GENERAL DESCRIPTION

The 16-inch, 50-caliber gun assemblies (fig. 3-1) of each turret are right, center, and left installations. Each gun assembly consists of a 16-inch Gun Mk 7 Mod 0, a 16-inch Breech Mechanism Mk 4 Mod 0, a Firing Lock Mk 14 Mod 5, a 16-inch Gas Ejector Mk 5 Mod 0, and a 16-inch Yoke Mk 5 Mod 0. The right and center gun assemblies are identical right-hand arrangements. The left gun differs in that the air-line piping to the reduction valve is located at the left side of the breech together with the closing valve. The tripping levers for releasing the holding-down linkage of the breech and for operating the closing valve are also located at the left side of the breech.

The gun (fig. 3-2) is a lightweight type, mounted in an individual slide, with its own elevating gear. The gun is chambered for a bag charge and is equipped with a carrier-type breech mechanism.

The breech mechanism (figs. 3-3 and 3-4) is of conventional design with closure of the breech by a breech plug and obturator unit assembly.

A SALVO ~~clavo~~ latch prevents opening of the gun breech, in the case of an unnoticed misfire or hangfire when the guns are fired in salvo. The salvo latch is automatic and positive in action.

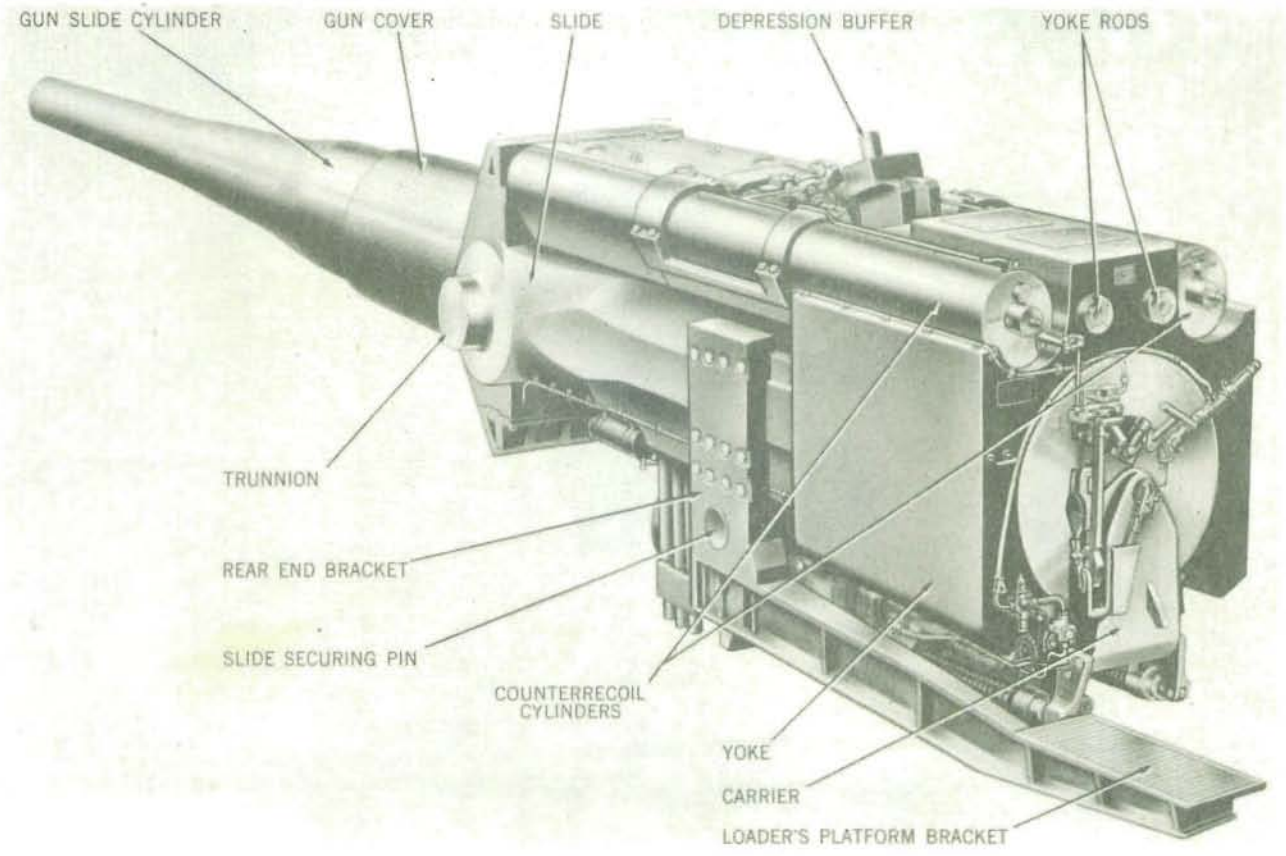


Figure 3-1. 16-inch Gun Mk 7 Mod 0 and 16-inch Slide Mk 6 Mod 0 (Operating Lever Safety Ratchet Mechanism Assembly Not Shown; See Figure 3-3)

The firing lock is a hand-primed wedge type with provision for either electric or percussion firing of the primer when the breech is completely closed.

The gas ejector is an automatic, low-pressure air porting system which clears the bore when the breech is opened after a round has fired. The system also provides air for the breech closing cylinders.

Yoke. The gun yoke is a large counterbalancing unit, mounted on the gun shoulder, that provides integral lug seats for the recoil cylinder piston rod and the counterrecoil cylinder yoke rods.

Components

Each gun assembly comprises the following principal units and subassemblies:

Gun
Breech mechanism
  Screw box liner
  Breech plug and obturator unit
  Operating mechanism
  Firing mechanism
Salvo latch
Firing lock
Gas ejector

Assembly arrangements

Each of the right, center, and left gun assemblies consists of the above components and each is mounted in a separate gun slide (ch. 4). The three gun slides are pivoted horizontally on trunnions whose axes are in the same straight line. The common trunnion axis is above the shelf plate and forward of the turret transverse centerline. (See data, page 3-3.)

Each gun and slide assembly is located in its own turret subdivision. This provides separate gun room compartments that are isolated (by bulkheads and hatches) from adjacent guns, the turret officer's booth, the sight stations, the electric deck below the gun pits, and the powder hoist trunks.

Assembly differences

The gun assemblies are virtually identical in arrangement. The design of the left gun differs in that the holding down linkage trip lever and the

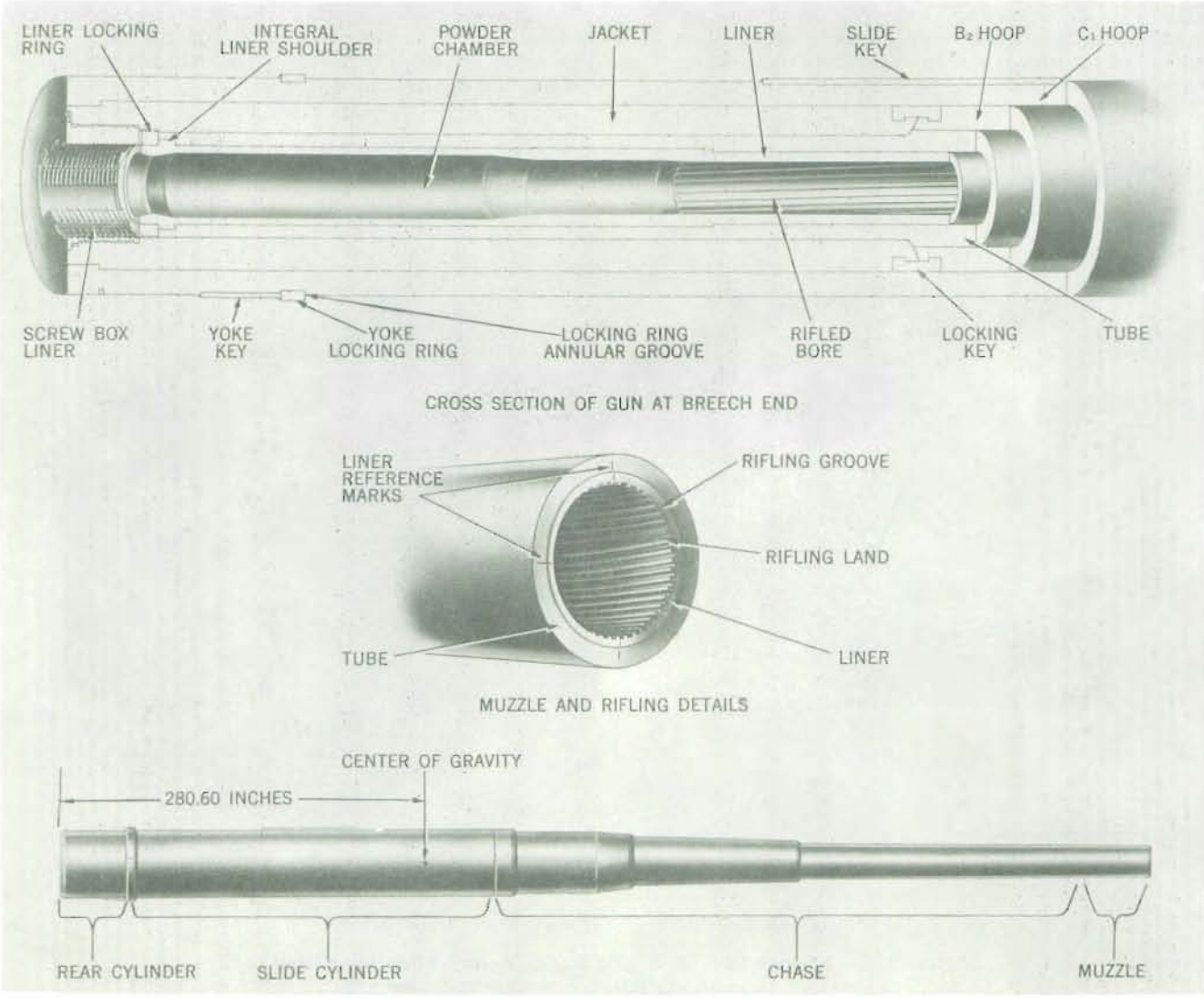


Figure 3-2. 16-inch Gun Mk 7 Mod 0, General Arrangement, Details and Profile

closing valve and the reduction valve. The elevating screw of the left gun attaches to a bracket at the right side of the gun slide. Otherwise, the left gun assembly is identical to the right and center assemblies.

Data

Weight and dimensions of the gun assemblies, the positions of the guns in the turrets, and other gun data are tabulated below. The data are the same for all turret installations.

Turret position

Bore axes, center	Turret centerline
Bore axes (right and left guns) from centerline, inches	122
Gun trunnion axis (above the plane of axes of roller path rollers), inches	198
Gun trunnion axis (forward of turret transverse centerline), inches	132

Gun dimensions

Over-all length (muzzle to breech), inches	816.0
Maximum diameter slide cylinder, inches	49.0
Maximum width of yoke, inches	66.0
Maximum height of yoke, inches	95.25

Weights

Gun, with screw box liner, lb	239,156
Gun, with recoiling parts, lb	292,000
Yoke weight, lb	38,500

Ammunition

16-inch AP Projectile	Mk 8, Mod 0
Weight, pounds	2700
Length, inches	72
Radius of ogive (windshield), cal	9 (144 in.)
16-inch, HC Projectile	Mk 13 Mod 0
Weight, pounds	1900
Length, inches	64
Radius of ogive, cal	9 (144 in.)
Powder charge (service)	
Number of bags	6
Total weight of charge, lb	650

Ballistics

Muzzle velocity, 16-inch AP Projectile Mk 8 Mod 0, fps	2425

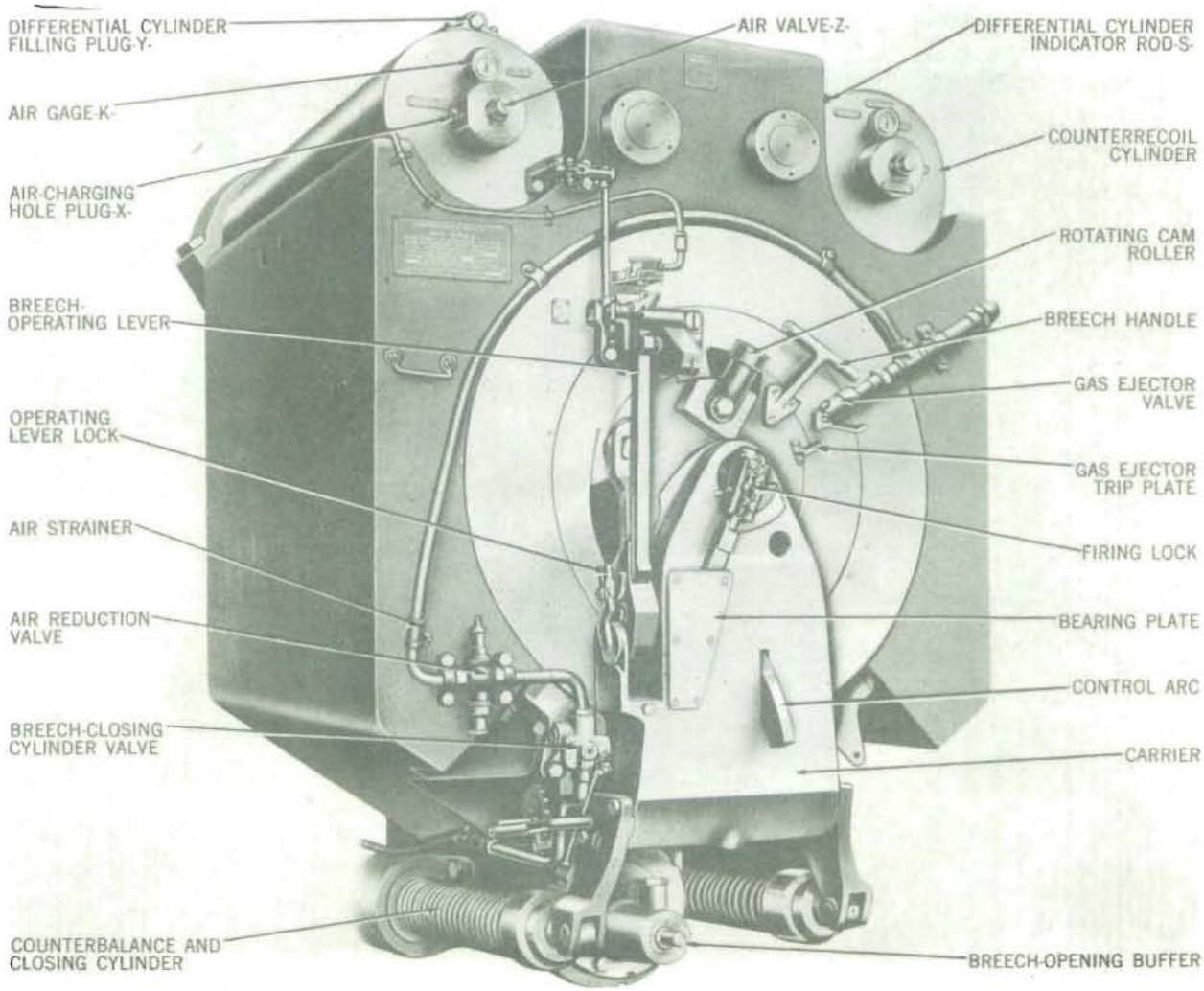


Figure 3-3. 16-inch Breech Mechanism Mk 4 Mod 0 - Breech Closed

Muzzle velocity, 16-inch HC Projectile 13 Mk 13 Mod 0, fps 2690
Range, 16-inch AP Projectile Mk 8 Mod 0, yd 40,185
Range, 16-inch HC Projectile Mk 13 Mod 0, yd 41,622
Rate of fire, rounds per minute 2
Range table, 16-inch AP Projectile Mk 8 Mod 0 . . . . . OP 1457
Range table, 16-inch AP Projectile Mk 13 Mod 0 . . . . . OP 1100

DETAIL DESCRIPTION

Gun

Type. The built-up type gun consists of the following forged steel components:

Components. The gun comprises a liner, tube, jacket, hoops, locking rings, a liner locking ring, and a yoke ring.

Design features. The liner, tube, jacket, and hoops are tube-shaped cylinders. They are assembled by heating and expanding each piece before slipping it into position over the tube. The pieces that are united end-to-end over the tube are held together by the locking rings. The liner is inserted into the tube, jacket, and hoop assembly from the breech end until its shoulder engages the breech end of the tube. A tight, single unit is formed when the heat-expanded components cool and shrink. The liner is locked in the tube by the liner locking ring, which threads into the jacket and is screwed up tight against the liner shoulder and tube. The liner lock-

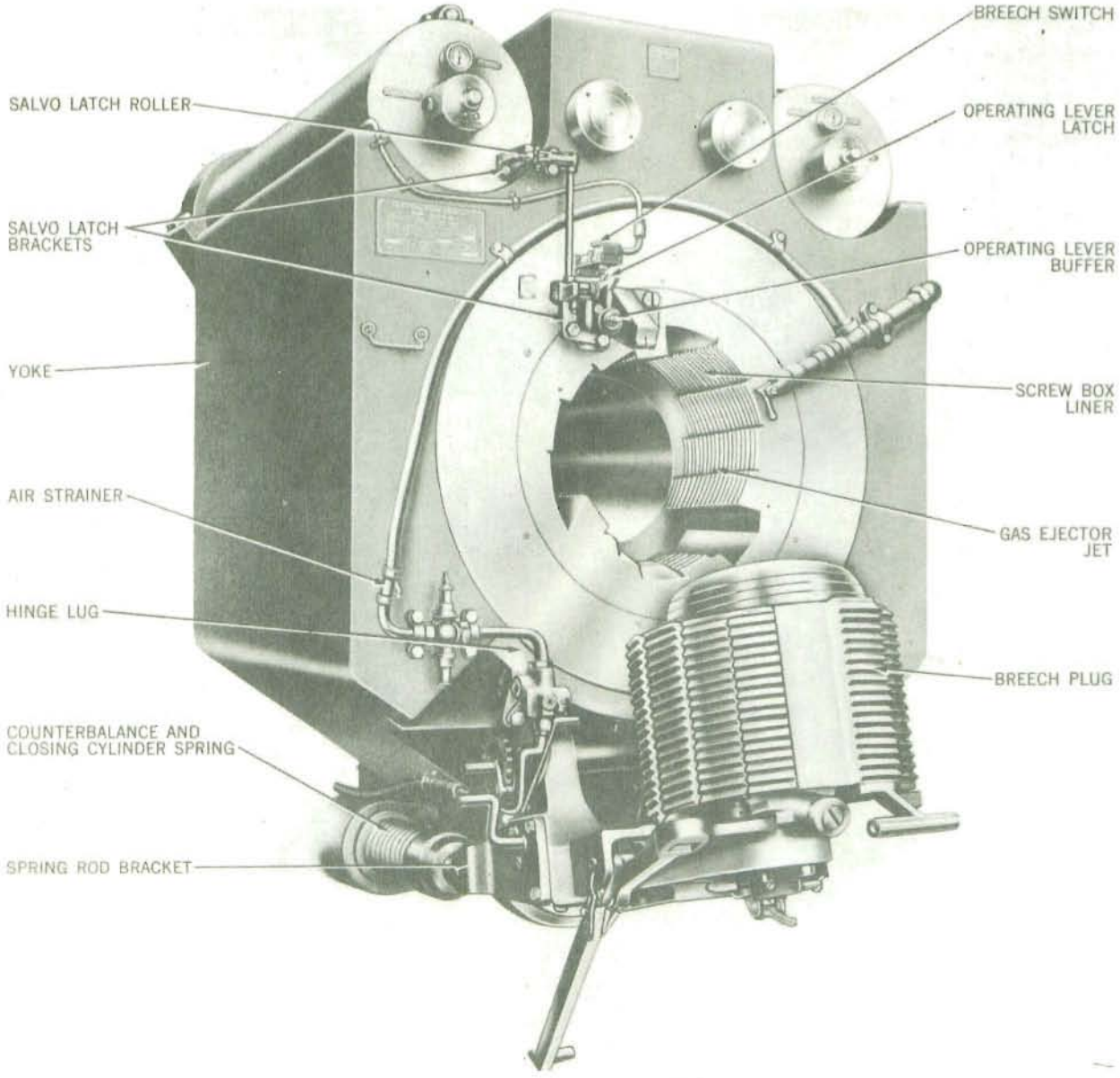


Figure 3-4. 16 inch Breech Mechanism Mk 4 Mod 0 - Breech Open (Operating Lever Safety Ratchet Mechanism Assembly Not Shown; See Figure 3-3)

ing ring prevents expansion of the gun liner toward the screw box liner when the gun is fired. Seated in the annular groove of the gun shoulder, the two-piece yoke ring attaches the yoke to the gun. The gun profile (fig. 3-2) is a straight slide cylinder 337.0 inches from the breech shoulder with a stepped and tapered chase to a straight muzzle cylinder. The gun profile, slide cylinder, and yoke are designed to facilitate gun removal from the slide and turret (through the gun port) without dismantling the turret.

Ballistic data tabulation. Gun data are tabulated below:

Length of gun, inches	816.00
Outside diameters:	
Rear cylinder, inches	49.00
Slide cylinder, inches	23.00
Muzzle, inches	23.50
Liner at muzzle, inches	18.46
Liner at rear, inches	22.10
Slide cylinder length, inches	337.00
Bore diameter, inches	16.00
Bore length, inches	800.00
Powder chamber:	
Choke diameter, inches	17.50
Bore diameter, inches	18.35
Length, inches	1105.82
Volume, cubic inches	27,000
Rifling:	
Grooves	96
Length, inches	682.46
Length of plating, inches	690.00
Depth of grooves, inches	0.15
Twist	Uniform, right hand, one turn in 25 calibers
Weight (with screw box liner), pounds	239,156
Center of gravity, from breech, inches	280.6

Breech mechanism

Type. The breech mechanism (fig. 3-5) is of the rotating plug and swinging carrier type. Screw box liner and breech plug are segmented with stepped screw threads.

Design variations. The design is the same for the right and center guns of each turret. The left gun differs in the location of the levers for releasing the holding-down linkage and operating the closing valve.

Components. Each breech mechanism comprises the following principal units and subassemblies:

- Screw box liner
- Breech plug
- Obturator unit
- Carrier
  - Carrier hinge lug and bearings
  - Carrier holding-down latch
- Breech opening buffer
- Counterbalance and closing cylinder
  - Reducing valves
  - Control valve
  - Air strainer
- Breech operating mechanism
  - Operating lever
  - Operating lever safety ratchet mechanism assembly
  - Rotating cams
- Firing mechanism
- Salvo latch
- Breech switch
- Firing lock
- Gas ejector

Screw box liner. The screw box liner is an adapter, made of nickel steel, threaded into the breech end of the gun. It provides an internal stepped thread to receive the breech plug. The liner has an outside diameter of 31.2 inches with right-hand buttress-type male threads, 0.50-inch pitch, for seating in the breech end of the gun. It is locked in position by the lower rotating cam and control arc and two lock screws. The rotating cam and control arc fits into a matching recess in the liner and gun. The internal surface of the screw box liner is divided into 15 sectors of 24 degrees each. These form three symmetrical groups, 120 degrees each, of five stepped sectors; the radius of each sector in each group decreases clockwise. The first sector is the largest radius and is blank. The succeeding four sectors are with buttress-type female threads, with 0.90-inch pitch. The breech plug locks with 24 degrees rotation of the plug after the threads engage. There are clearance cuts, of varying radii, in the blank and threaded sectors of the liner. These cuts provide clearance for the entering and withdrawing movements of the plug. An annular groove near the breech end of the screw box liner forms an annular air duct space between the liner and the gun. The space is part of the gas ejector system and is sealed with a plastic compound to prevent loss of air. Three holes are drilled from the air duct space through the screw box liner. These holes are fitted with nozzles to direct gas ejector air forward and toward the center of the gun bore. The face of the screw box liner is drilled and tapped so that the holder for a 16-inch Boresight MK 2MOD 0 may be mounted.

Breech plug. With the obturator unit (fig 3-6) mounted on its forward face, the breech plug is mounted to rotate on the carrier spindle. The plug is arranged with stepped, threaded sectors that engage with the screw box liner and close the breech of the gun. The surface of the plug is machined and is divided into three symmetrical groups, 120 degrees each, of five 24 degree sectors. Each group has four stepped screw thread sectors and a blank sector, decreasing in radii clockwise. These groups mate with similar groups of stepped screw thread sectors and blank sectors in the screw box liner, and close the breech by 24 degrees rotation. The buttress-type threads are right hand with 0.90-inch pitch. The breech plug is bored through, from front to rear, to receive the carrier spindle. The plug bore, at its forward part, forms a bearing surface for the carrier spindle. At its rear part, the plug bore is threaded with 0.90-inch pitch, square threads. These threads mate with similar threads that form the outer surface of the plug adjusting nut (figs. 3-5 and 3-6). This nut is an adapter that is threaded on the carrier spindle. It is used to compensate for movement of the gun hoop and hinge lug; it is fully described under "adjustments". The bearing portion of the plug bore is lubricated from an oil hole in the upper blank sec-

tor; the threaded portion is lubricated from an oil hole in the plug face. The face of the plug is drilled to receive the plug ball pin (figs. 3-6 and 3-12) and the breech handle (fig. 3-3), and is provided with slots for dovetail assembly of the rotating cam rollers.

Obturator unit. The obturator unit (fig. 3-6) is assembled in the breech plug and carrier; it consists of a mushroom, gas check pad, and two steel split rings. This unit prevents the escape of gases from the breech of the gun when it is fired. The mushroom is a nickel steel forging, machined to a mushroom and stem appearance. It covers the inner forward face of the breech plug, with its stem extending rearward through the plug and carrier. Between the mushroom head and breech plug are the gas check pad and two split rings. The gas check pad is composed of alternate vulcanized layers of oil-resistant rubber and fiber-glass cloth previously coated with an adhesive. The pads fit the forward face of the plug. One split ring is at the rear of the pad, the other is at the forward side; both rings serve as a protection for the gas check pad. The mushroom is keyed to the carrier and held tightly against the pad by a split nut and compressed spring. The mushroom stem, to the rear of the split nut, has a bayonet-type joint to which the firing lock is attached, and it is made to receive the primer seat bushing. A hole is bored from the primer seat bushing through the mushroom face. This hole provides for igniting the gun charge when the firing lock mechanism detonates the primer. When the gun is fired, the gas check pad is distended by the force of the gases of combustion. This distention seals the gun breech and prevents escape of the gases. Directions for checking the thickness of the gas check pad are given in the Instructions section of this chapter, page 3-20. Directions for lubrication of the pad are given in the chapter on Lubrication.

Carrier. The carrier (figs. 3-5 and 3-6) is a steel casting with an integral spindle at its upper part on which the breech plug is pivoted. The carrier is mounted on the hinge lug, which is bolted to the gun shoulder. The breech plug is mounted to rotate on the carrier, which also provides a fulcrum point for the operating lever to rotate the plug. The firing lock operating bar, the firing mechanism, and spring rod brackets of the counterbalance assembly are all mounted on the carrier. The integral hollow spindle of the carrier, fitted with a bronze bushing at its forward end, forms the plug bearing.

Carrier hinge lug and bearings. The cast steel carrier hinge lug (figs. 3-5 and 3-7) provides two hinge projections for the carrier hinge pin, a lug for the closing latch lever, and a lug at either side for the closing valve. The hinge lug, shaped to fit the gun shoulder, is centered in position by a cover plate retained dowel and is bolted to the bottom of the gun shoulder. The two lugs for the carrier hinge bearings are provided with adjustable eccentric bushings. Inside the eccentric bushings, between the bushings and the hinge pin, are roller bearings which are retained by the hinge pin, nut, and carrier. The hinge pin fits the carrier and rotates with it in the hinge lug bearing.

Carrier holding-down latch. The holding-down latch (figs. 3-7 and 3-8) is a stiff leg or toggle between the hinge lug and the carrier; it locks the carrier down in a breech open position. A crank extends through the spring rod brackets and the carrier to act as a pivot pin for one lever of the stiff leg. It is keyed to that lever so that the crank, when depressed, pulls the holding-down latch past center and collapses it. While the breech is opening, the hinge spring straightens the holding-down latch and brings it past center to its locked position to secure the breech in an open position. To close the breech, the latch operating crank (or lever) is depressed by foot from the gun loader's platform.

Breech opening buffer. The breech opening buffer (fig. 3-9) is mounted on the recoil cylinder piston rod, below the breech. It contacts an integral raised pad of the carrier to buff the last 14 degrees of carrier opening rotation. The buffer is of the piston and cylinder type with three throttling grooves in the cylinder wall. An expansion chamber in the filler cap allows for the volume of liquid displaced by the piston rod, which extends through a Garlock type packing and packing gland. When the breech is closed, the piston is returned to the released position by a spiral spring.

Counterbalance and closing cylinder. The counterbalance and closing cylinder (fig. 3-5) is a dual

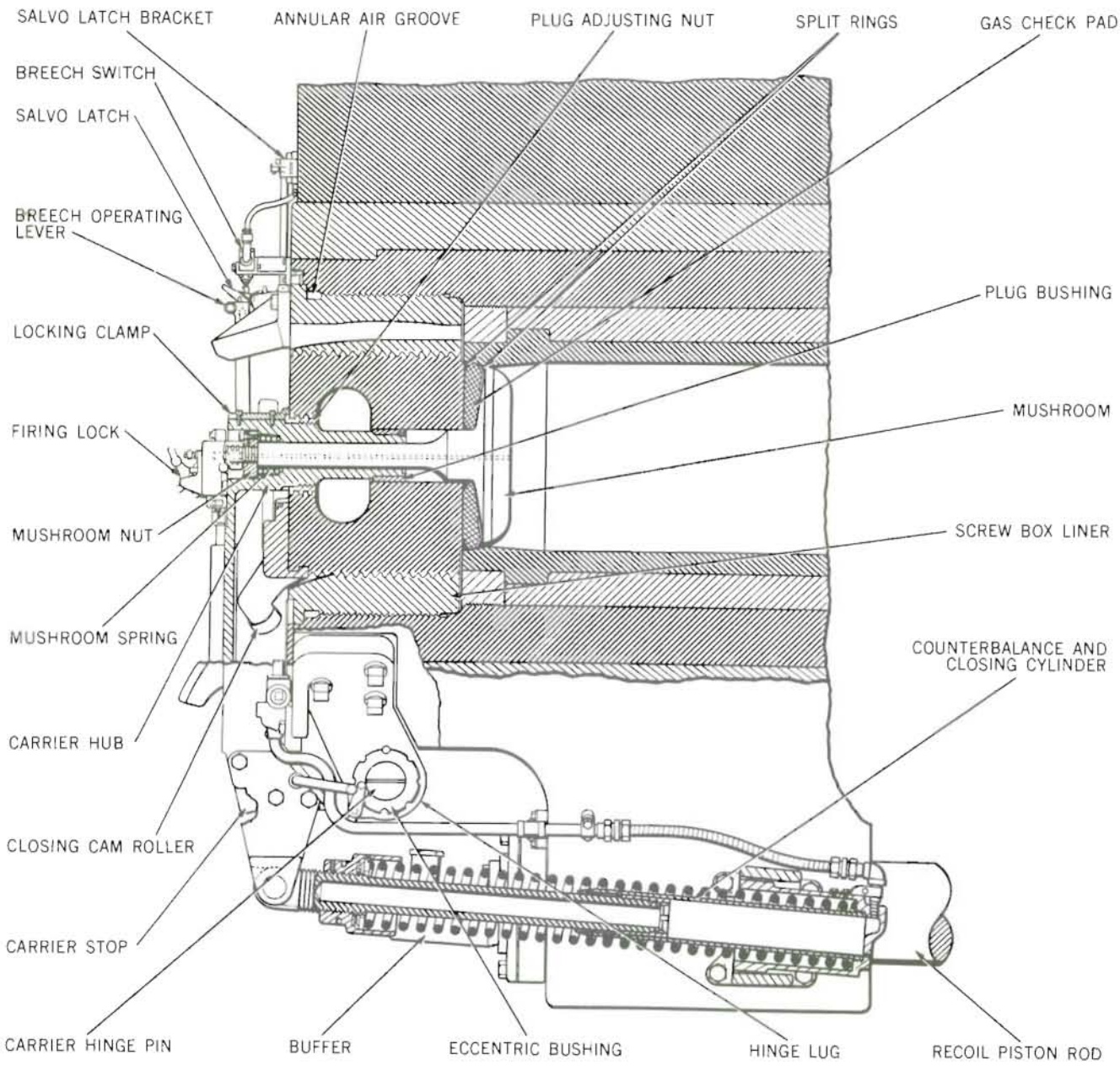


Figure 3-5. 16-inch Breech Mechanism Mk 4 Mod 0 - Sectional View

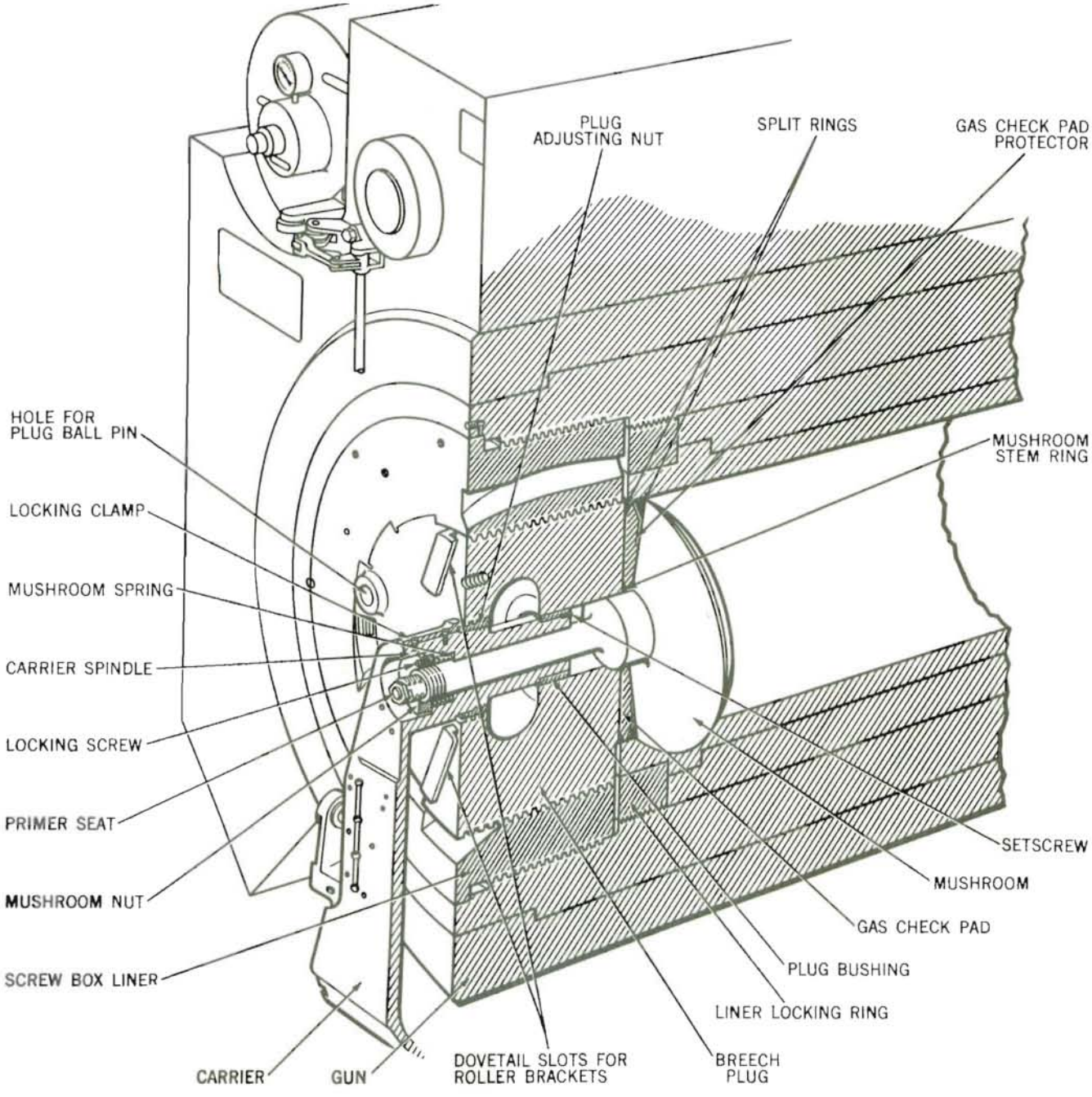


Figure 3-6. Breech Plug Obturator Assembly

arrangement for balancing the weight of the breech assembly in opening and for swinging the carrier upward in closing the breech. It is a spring and pneumatic type mechanism. The closing cylinder bracket is mounted on the yoke and provides bearings for the journals of oscillating bearings. These bearings permit oscillation of the assembly in opening and closing the breech, and provide spring seats and caps for the closing cylinders. Each air cylinder screws into its oscillating bearing. With the piston and spring, the air cylinder extends through the spring to the spring rod brackets and attaches to the carrier. The spring compresses between the oscillating bearing on one end, and a ball bearing washer within the spring adjusting nut at its other end. The spring is adjusted on both cylinders so that their combined action will prevent the breech down swing from being stopped with damaging shock, and yet allow the holding-down latch to secure the breech in the open position.

The air supply for operating this mechanism comes from the air supply of the gas ejector system. The gas ejector air pressure, from 150 to 200 pounds per square inch, is reduced to approximately 40 pounds per square inch by an adjustable air reduction valve. The desired air pressure for normal closing action is obtained by adjustment of a square-headed screw at the top of the reduction valve. The piping, at the outlet side of the reduction valve, directs the reduced air pressure to the closing control valve. The control valve ports air to the breech closing cylinders and is operated manually to open. When the control valve is opened, breech closing movement is started.

Reducing valve. The adjustable reduction valve, installed in this breech closure system, is a commercial product, either Mason or Foster type. Each is described below:

Mason type. The Mason type air reducing valve (fig. 3-11) is pilot valve controlled. The pilot valve, controlled by reduced gas ejector air pressure, is spring-held against a diaphragm. As the diaphragm is moved against the pressure of an adjusting spring by the reduced air pressure, it moves the pilot valve with it. The pilot valve controls the opening of the main valve by porting gas ejector air pressure through an air passage in the valve body to the stem of the piston. The piston, forced up by the gas objector air pressure, contacts the spring loaded main valve to unseat it and thus permit a flow reduced air pressure to the breech closing valve. Pressure in the outlet air pipe enters the chamber beneath the diaphragm, through an air port in the valve body, and controls the pilot valve. In action, the valves, the diaphragm, and the piston are constantly in motion, seating and unseating; thus the air pressure that is ported from the reducing valve is delivered to the breech closing valve at a pressure that is regulated

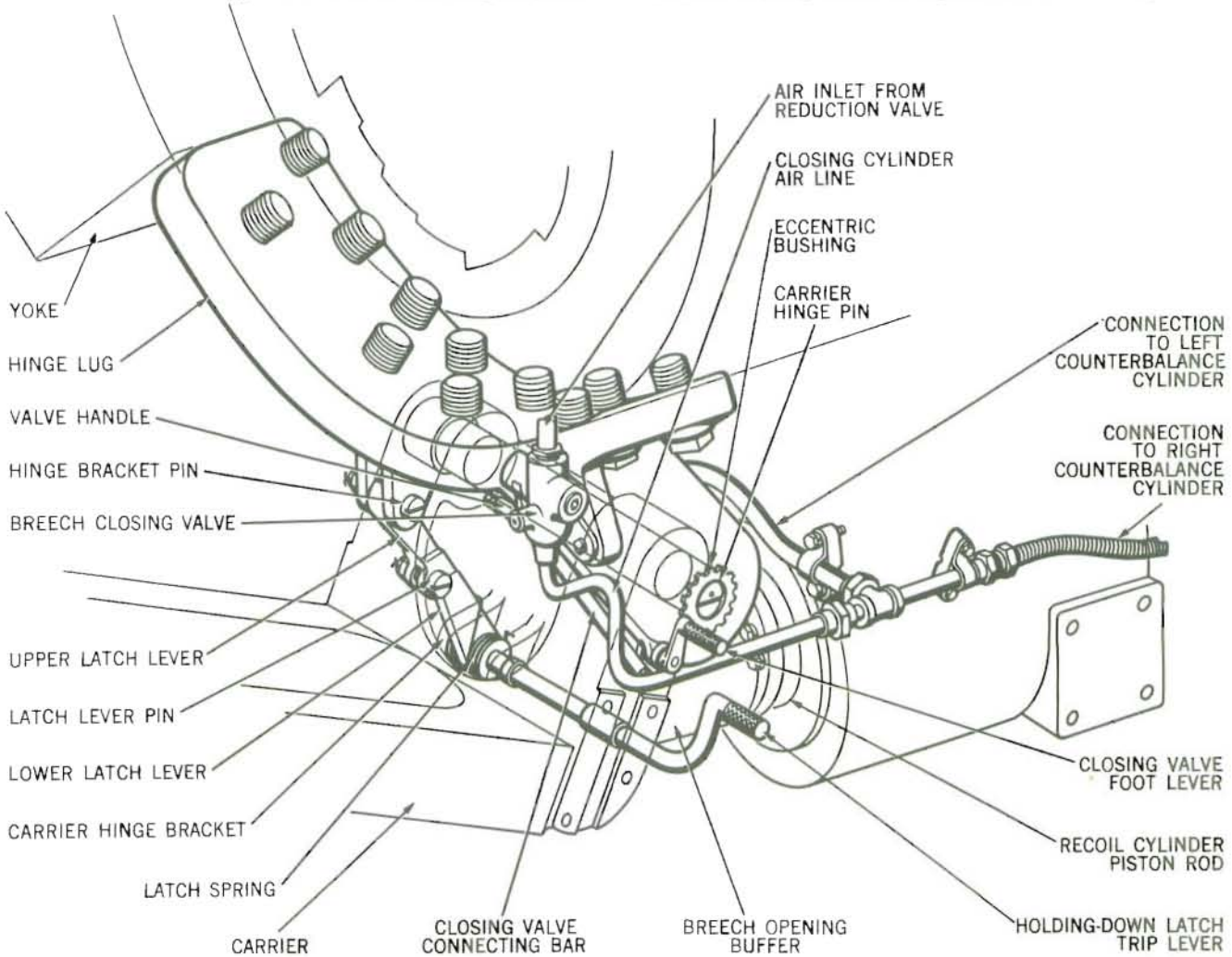


Figure 3-7. Hinge Lug, Holding-down Latch and Closing Controls, General Arrangement

by the setting of the adjusting screw. The piston is prevented from chattering by an integral dashpot arrangement. This valve assembly and the Foster valve are both 3/4 inch reducing valves with union connections to the air pipes, and both are secured to the face of the yoke by pipe clips.

Foster type. The Foster valve is used alternately as a reducing valve for the closing cylinder system. It functions, as does the Mason valve, to control air pressure. It consists of a valve, controlled by a spring-loaded diaphragm, between closing cylinder pressure and atmospheric pressure. The main valve is a faced plunger, spring-held against a funnel-shaped piece that extends through the valve port and connects to the diaphragm. The main valve operating piece extends through the diaphragm. It is held against the main valve by spring pressure and moved away from the main valve by ported closing cylinder pressure to allow the main valve to close. The amount of air pressure depends upon the spring pressure behind the diaphragm and is adjustable by a spring pressure adjusting screw on top of the valve.

Control valve. The rotary type breech-closing cylinder control valve (fig. 3-10) is manually opened by a lever on the hinge lug, adjacent to the holding-down latch trip lever. The valve is automatically closed when the carrier reaches the breech closed position. The actuating foot lever of the control valve is located so that it can be operated simultaneously with the trip lever of the holding-down latch. The control valve is bolted to the hinge lug.

Air strainer. The air line piping, at the inlet side of the reduction valve, is equipped with an air strainer. This insures filtered air in the breech operating air line.

Breech operating devices. The breech mechanism has operating devices for manually rotating the plug in opening. Other devices interlock the breech against opening until the gun has fired. Still other elements provide firing lock action which parallels the breech opening and closing movements. A description of the breech operating devices follows:

Operating lever. The steel breech-operating lever is pivoted on the side of the carrier (fig. 3-12). Motion of the operating lever about its pivot point moves the connecting rod to rotate the breech plug through 29 degrees. The operating lever contacts a rawhide bumper at the end of its opening swing. In closing, the swing of the operating lever is stopped by a buffer in the salvo latch bracket. The operating lever is secured in the salvo latch (when the breech is closed) by a spring-plunger type beveled catch in the lever handle.

Operating lever safety ratchet mechanism

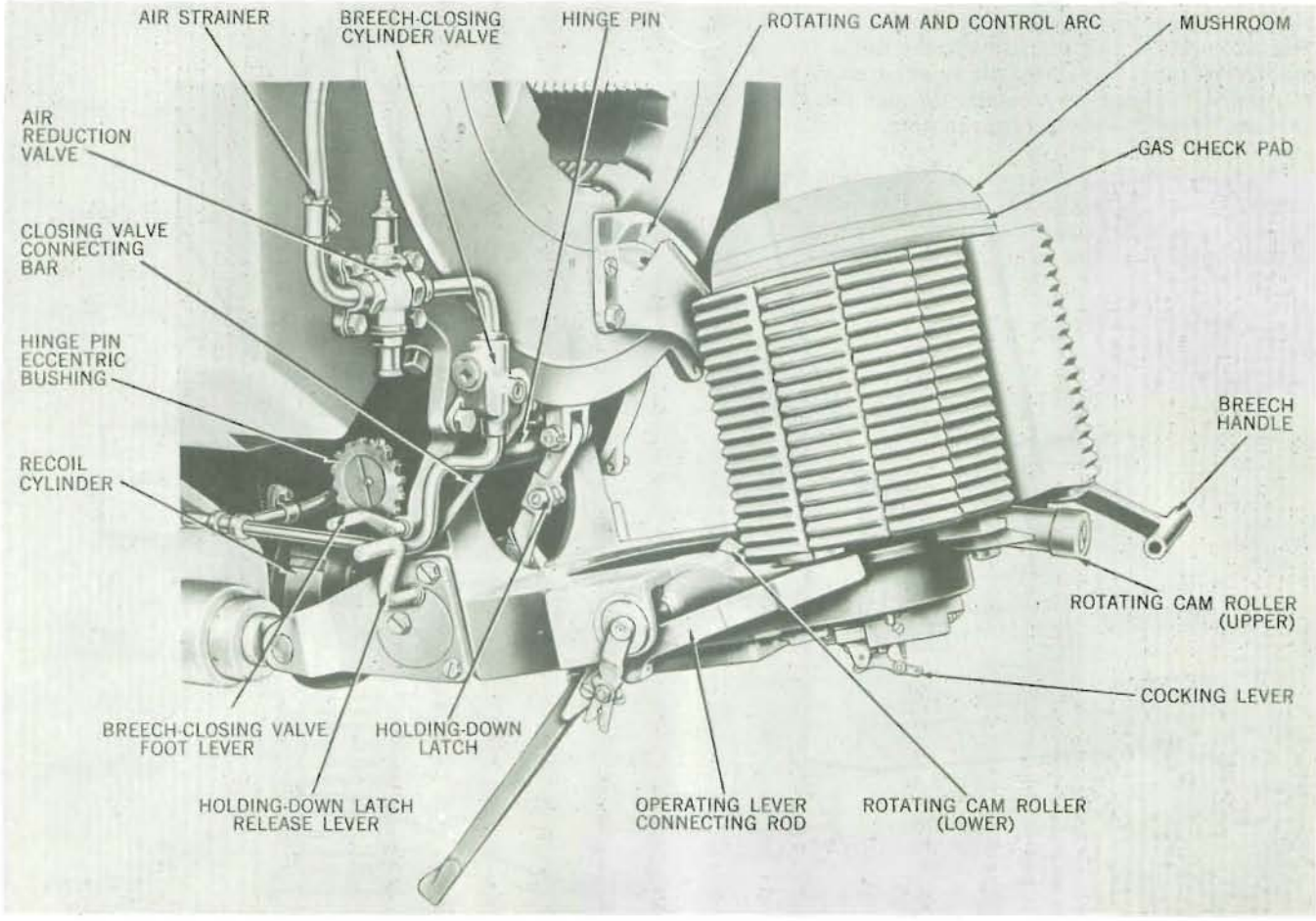


Figure 3-8. 16-inch Breech Mechanism Mk 4 Mod 0 - Breech Open Showing Holding-down Latch (Operating Lever Safety Latch Mechanism Assembly Not Shown; See Figure 3-3)

assembly. This assembly prevents the manual breech operating lever from reversing direction in the event it has not been fully latched during the breech closing operation. The assembly is composed of two subassemblies: the pawl and bracket assembly mounted on the operating lever, and the safety ratchet and ratchet bracket plate assembly mounted on the carrier. The pawl (attached to the operating lever) rides over the ratchet teeth (attached to the carrier) when the breech plug is opening. When the plug is fully retracted, the pawl returns to the neutral position. During the closing operation, the pawl engages the ratchet teeth. When the breech is fully closed and the handle in the latched position, the pawl swings free to the neutral position.

Connecting rod. The operating lever connecting rod extends from a pivot on the lever (2.75 inches from the lever pivot point) to a plug pin in the breech plug rear face. The connecting rod is joined to the operating lever by a pin. The breech plug end of the connecting rod has split socket bronze bearing into which the ball of the plug pin is fitted. This forms a universal-type joint between the breech plug and connecting rod.

Plug pin. The plug pin is a solid, cylindrical piece of steel, with a ball-like knob at its outer end. The ball of the plug pin is fitted to, and secured in, the split socket bronze bearing of the connecting rod. The stem of the plug pin fits into the outer face of the breech plug. The plug pin is secured by a locking pin that passes horizontally through the plug pin stem and screws into the breech plug.

Wedge retracting lever catch. The wedge retracting lever catch (fig. 3-14) is fastened to the breech mechanism operating lever. It connects the operating lever to the firing mechanism.

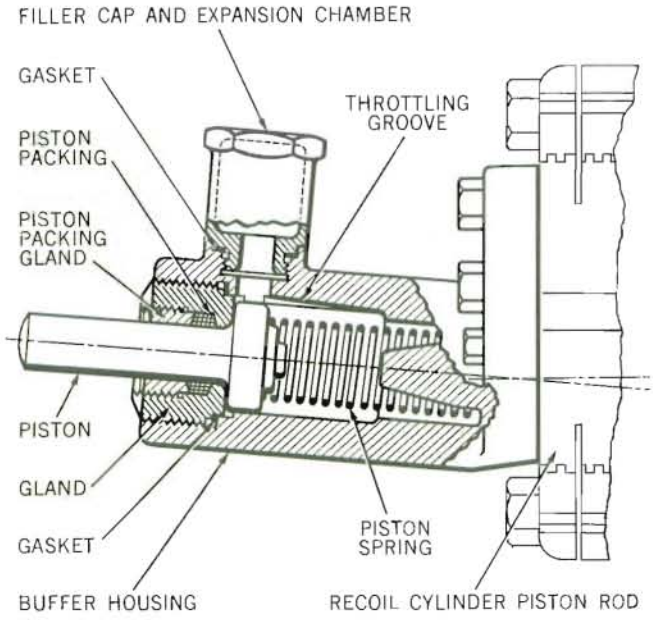


Figure 3-9. Breech-opening Buffer, Sectional View

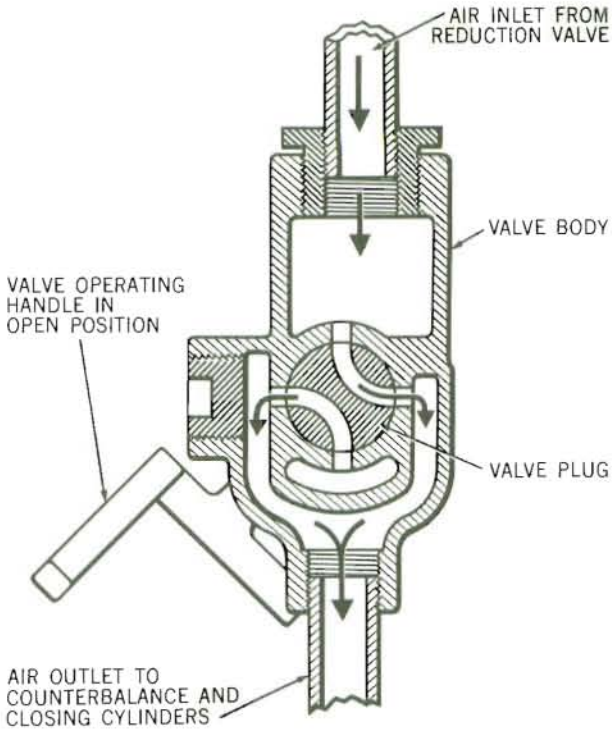


Figure 3-10. Breech-closing Cylinder Valve, Sectional View

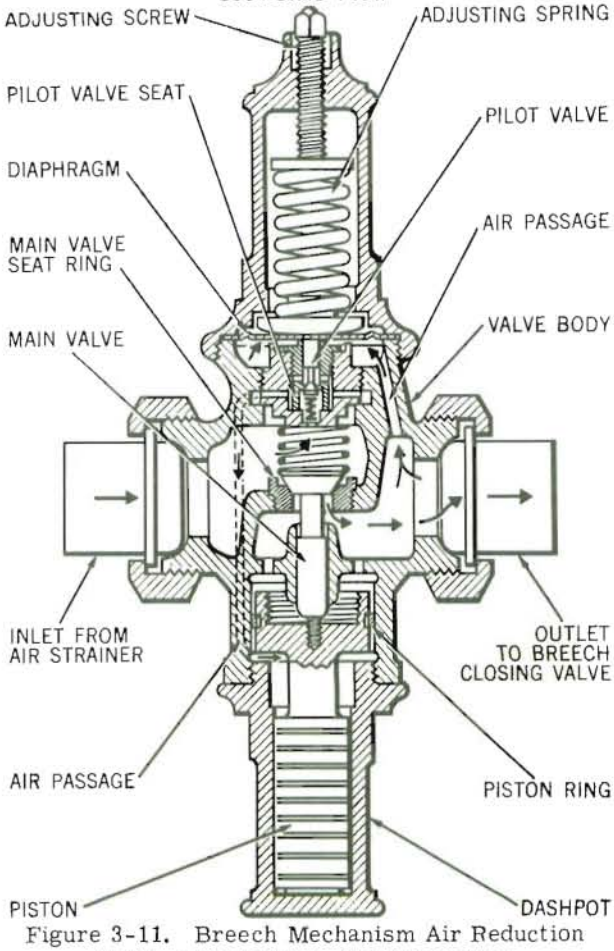


Figure 3-11. Breech Mechanism Air Reduction Valve, Mason Type, Sectional View

Rotating cams. When the breech is closed, plug and carrier swinging motion is changed to plug rotation by cam rollers (on the plug) in contact with stationary cams (on the breech). The stationary upper and lower cams, attached to the breech, are called rotating cams. The upper cams (fig. 3-12), secured to the screw box liner by two bolts, is further held by the lower salvo latch bracket, which fits into an undercut in the side of the cam flange. The lower cam (fig. 3-8) is fitted into a recess cut in the gun and screw box liner; it is secured with four bolts.

The upper and lower brackets for the cam rollers fit into dovetail slots (fig. 3-6) in the rear face of the breech plug and are each secured by a bolt. The rollers (fig. 3-12) are pin-mounted on the brackets.

After the plug has been completely rotated to open, a control arc retains the plug in its rotated position. The control arc, an integral part of the lower cam, is made on a radius about the carrier hinge center. With the breech closed, the control arc projects through the carrier.

The cams and cam rollers are carefully set at manufacture. Because of the exact position requirements, they are not provided with adjustment.

Firing mechanism. The firing mechanism (fig. 3-14) is a mechanical linkage between the firing lock and the breech operating lever. During breech opening movement, the firing mechanism acts to eject the empty primer case. The breech operating lever is connected to the wedge retracting lever by the wedge retracting lever catch. The crank shaft of the wedge retracting lever extends through the pivot end of the operating lever to the crank-operated crosshead. The crosshead slides in a vertical slot in the carrier. The crosshead is connected to the firing lock operating bar by a bearing block that is attached to the crosshead and slotted to the lock operating bar. This mechanism changes the rotation of the wedge retracting lever to vertical movement of the crosshead and lateral movement of the lock operating bar. The crosshead and the lock operating bar are retained in position by the bearing plate. A groove, machined in the bearing plate,

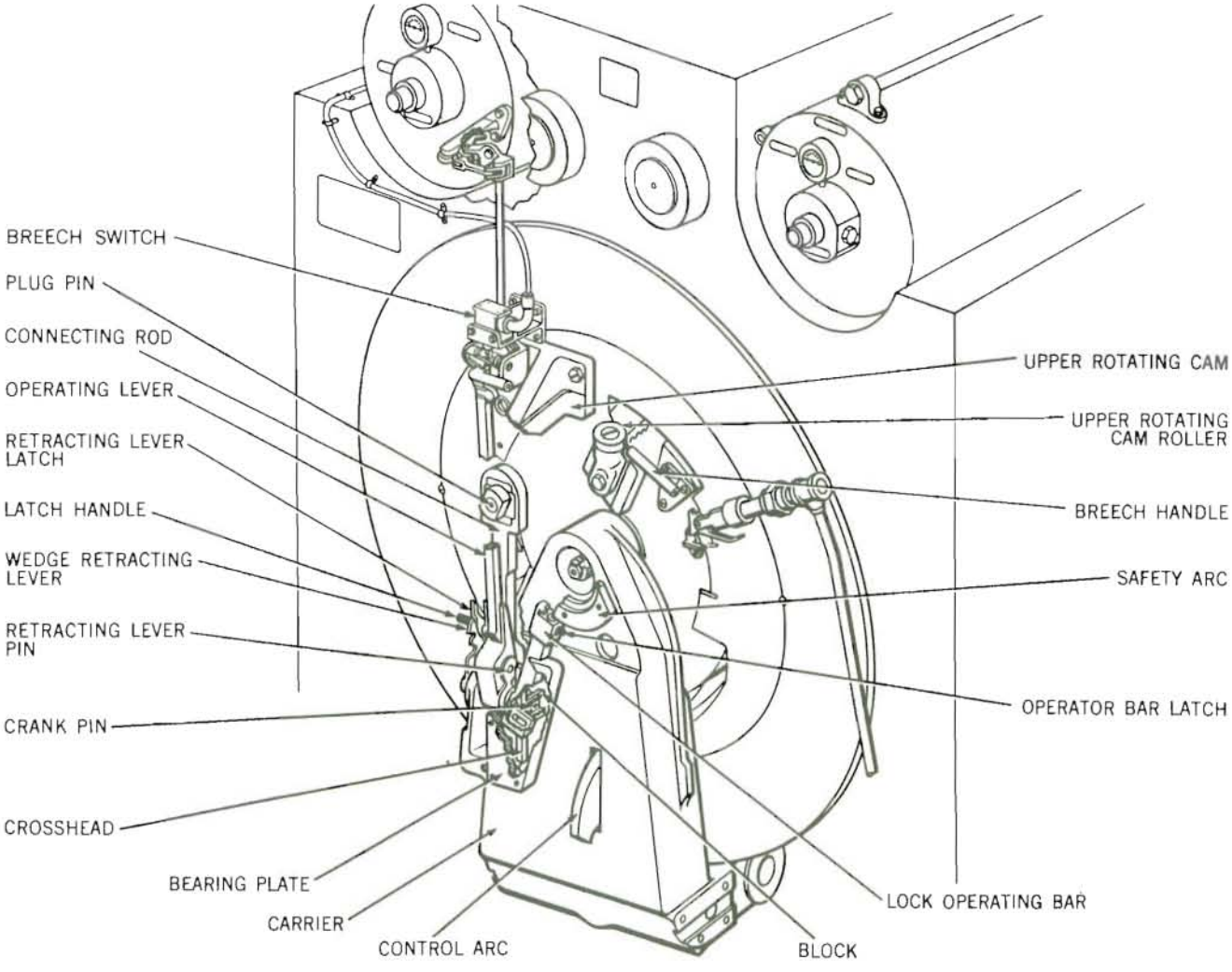


Figure 3-12. Breech Opening Mechanism, General Arrangement

receives the lock operating bar. In opening the breech, rotation of the wedge retracting lever causes the lock operating bar to retract the firing lock wedge and eject the used primer. In the case of a misfire, the wedge retracting lever can be unlatched and rotated independently of the breech operating lever to retract the wedge without opening the breech. Also, the firing lock can be removed without opening the breech.

The salvo latch is an automatic latching device which prevents opening the breech of a loaded gun. The salvo latch (fig. 3-13) prevents lifting of the operating lever latch when the breech is closed. Gun recoil operates the salvo latch to release the lever latch.

A lower salvo latch bracket is mounted on the gun. The salvo latch lever shaft, with the salvo latch lever cam at its upper end, extends from the lower latch bracket to the upper salvo latch bracket. The latch lever cam is positioned so that it contacts a cam roller mounted on a bracket on the left air bottle of the counterrecoil system. When the gun recoils, the cam roller moves aside the latch lever cam and rotates the latch lever shaft to displace the latch locking arm. Displacement of the latch locking arm allows the salvo latch catch (not visible in fig. 3-13) to rise and prevent the latch locking arm from returning to the lock position. The latch locking arm, attached to the lower end of the latch lever shaft, is positioned in the way of an integral lug of the operating lever latch; the lug prevents lifting of the lever latch. When the latch locking arm is held in its displaced position by the latch catch, the operating lever latch can be raised and the operating lever moved. When the operating lever is raised, it compresses the spring of the latch catch and allows the latch locking arm to be repositioned over the latch catch and in the way of the lug of the operating lever latch.

A deliberate act is required to defeat the purpose of the salvo latch. The operating lever cannot be released to open the breech until the gun has recoiled. However, if the latching arm is moved aside, the operating lever latch remains unlocked until it is lifted to release the operating lever. This action depresses the latch catch and resets the mechanism. The latch locking arm can be secured in its unlocked position for drill purposes by securing the latch locking pin in hole B in the lower salvo latch bracket. Immediately after drill, the latch locking pin must be removed from hole B and returned to the turret officer's booth.

The salvo latch caution plate is fastened to the gun at the left side of the lower salvo latch bracket. It reads:

CAUTION

SCREW PIN IN HOLE "B" FOR DRILL ONLY. AT ALL OTHER TIMES IT MUST BE KEPT IN TURRET OFFICER'S BOOTH.

Integral with the lower salvo latch bracket is the cylinder and expansion chamber of the operating lever buffer. The buffer is of the plunger type and is filled with recoil cylinder fluid. The buffer is filled to the level of the filling plug and, with the plug in place, contains sufficient air for operation.

Breech switch. Limit Switch MK 6 MOD 1 is mounted on the breech face of the gun as shown on figures 3-1 and 3-13. This microswitch is closed when the breech operating lever is latched. When closed, the breech switch, with closed blade contacts and with the recoil switch in battery position (ch. 4), retracts the gun captain's ready switch control solenoid and permits the switch to be moved to the READY position. It also illuminates a BREECH CLOSED indicator light adjacent to the gun captain's panel. The breech switch is part of Ready Light Circuit IR, described in chapter 15.

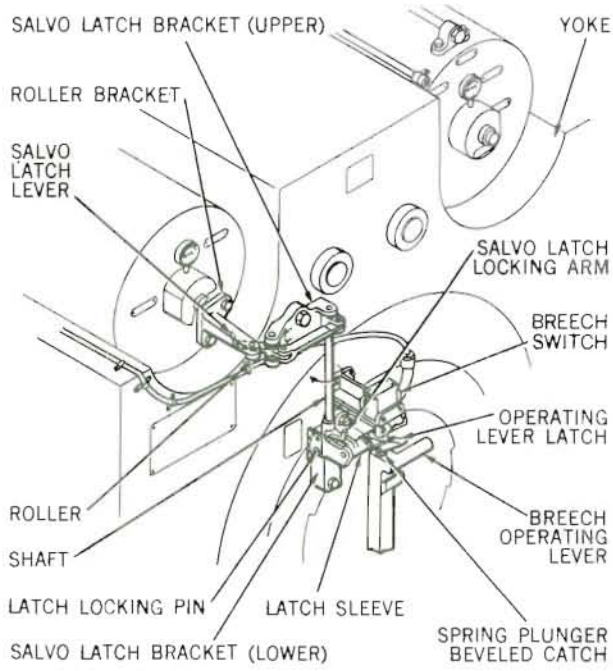


Figure 3-13. Breech Mechanism Salvo Latch

Firing lock

The firing lock, as shown in figures 3-15 and 3-16, fires the primer to ignite the powder charge in the gun. Normally, the primer is fired electrically; however the firing lock design provides for percussion firing in emergency. The firing lock is mounted on a bayonet-type joint at the breech end of the mushroom stem. The receiver, the main structural component of the lock, contains a wedge that slides back and forth to close or open the recess in which the primer is seated. This wedge, operated by the firing mechanism, is connected to the breech firing mechanism by a spring latch in the end of the lock operating bar. The receiver has a catch that retains the primer after it is inserted and an extractor that ejects the primer case after firing. The wedge contains an insulated firing pin which carries the

electric current to the primer bridge for firing. For percussion firing, a hammer, firing spring, and cocking lever attached to the wedge delivers a blow to the same firing pin that is used for electric firing.

For safety, the firing lock is constructed so that the primer cannot be fired either electrically or by percussion until both the breech and the lock are fully closed. The clearance to be maintained between the firing lock and the carrier is given in the instructions section of this chapter, page 3-20.

Components. The Firing Lock MK 14 MOD 5 consists of the following components:

Receiver
Wedge
Firing pin assembly
Cocking lever
Hammer
Contact piece
Hammer guide block
Primer retaining catch
Extractor and extractor cam
Extractor stop screw

Receiver. The receiver (fig. 3-15), approximately rectangular in shape, is milled out to receive the wedge. Secured to the breech mechanism by means of a bayonet-type joint on the end of the mushroom stem, the receiver is prevented from rotating by the

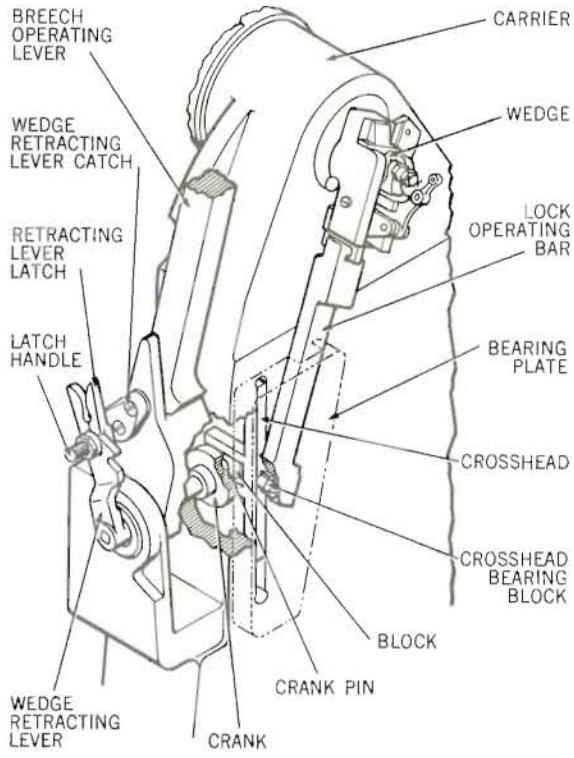


Figure 3-14. Breech Mechanism Firing Mechanism

lock operating bar, which is connected to the wedge. The receiver is drilled for the extractor pin and the necessary clearances are milled for the extractor. There is a slot on one side of the receiver into which a lug on the hammer slides. This lug prevents the hammer from being pulled back for percussion firing after the wedge has started to retract.

Wedge. The wedge (figs. 3-17 and 3-18), the operating component of the firing lock, slides in the receiver when it is actuated by the lock operating bar of the breech firing mechanism. A yoke on the end of the operating bar straddles the wedge and is secured to it by a pin. The opening in the wedge through which this pin passes is elongated to provide for the movement of the mushroom stem at the time of firing. Lost motion between the wedge and the operating bar is taken up by a spring and plunger.

The wedge stop screw (fig. 3-15) projects through the receiver into a slot in the wedge to prevent the wedge from being entirely withdrawn from the receiver.

The wedge face plate (fig. 3-17) is made of hardened steel with a hole through which the end of the firing pin passes. The face plate is dovetailed in the wedge. The center part of the face plate is insulated to prevent a short circuit in the firing system should the firing pin point come in contact with the face plate. The face plate takes the thrust of the primer when it is fired.

Firing pin assembly. The firing pin assembly (fig. 3-18) is held in position in the wedge by means of the firing pin bushing, a small steel sleeve threaded into the wedge where it bears against a shoulder on the firing pin sleeve. A small spring which surrounds the firing pin sleeve returns the pin to its normal position after firing.

The assembly of the firing pin, firing pin insulation sleeve, and firing pin sleeve are completely assembled during manufacture and are supplied only as a complete unit.

Cocking lever. The cocking lever (fig. 3-15) pivots on its axle, which is supported between two lugs that extend from the wedge. Incorporated within the cocking lever is a torsion spring that tends to move the lever toward the lock. One end of this spring engages a recess in its housing in the cocking lever, while the other end is engaged by a hole in the torsion washer, which functions as a bearing for the lever as well as a cover for the spring housing.

The cocking lever lug is on the right side of the cocking lever and extends toward the face of the wedge. This lug acts as a latch to engage the hammer catch when the hammer is pulled back for percussion firing. The cocking lever lug is of such a length that, when the cocking lever is in the normal (uncocked) position, it bears against the wedge and transmits any accidental blow directly to the wedge instead of through the hammer and firing pin.

Hammer. The hammer is pivoted on an axle (fig. 3-17) supported by the same two lugs on the wedge as is the cocking lever. A spring-operated hammer catch is fitted in the hammer and projects from the right side. This catch is engaged by the latch on the cocking lever and rides on it when the cocking lever is pulled back by the lanyard for percussion firing. When the lever has been pulled back

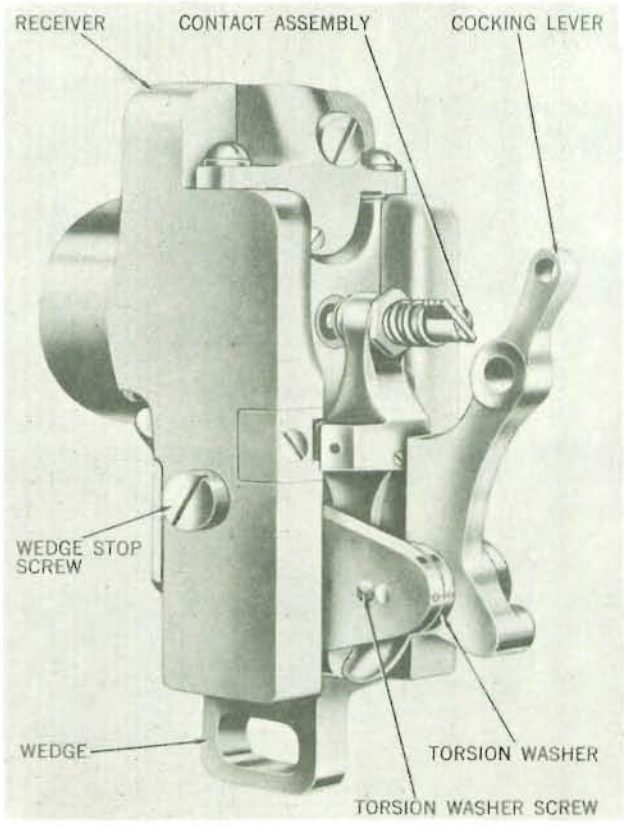


Figure 3-15. Firing Lock Mk 14 Mod 5 - Electrical Firing Position, Left Side

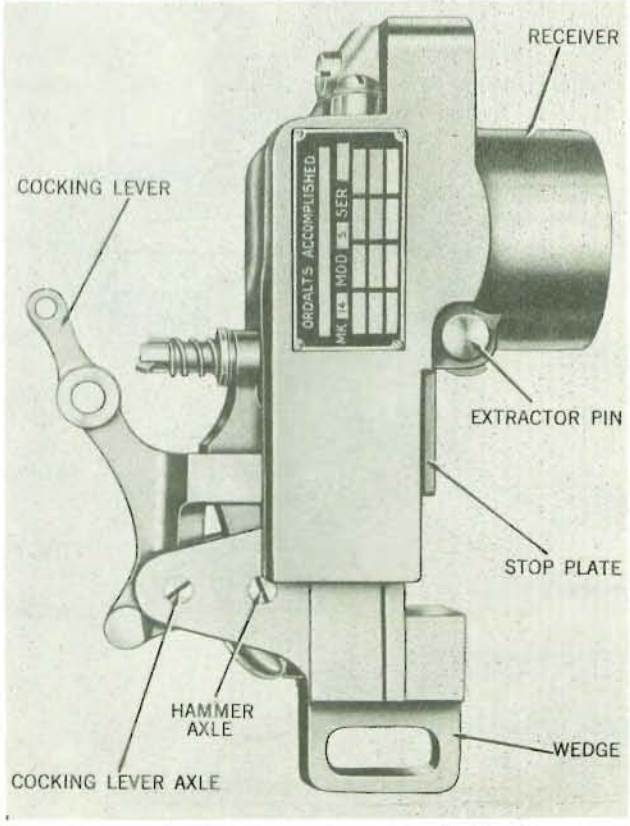


Figure 3-16. Firing Lock Mk 14 Mod 5 - Electrical Firing Position, Right Side

far enough, the hammer catch is released; the firing spring (fig. 3-18) acts through the hammer thrust pin to force the hammer to strike the firing pin sharply. When the lanyard is released, the cocking lever moves forward under its spring action, and the latch again engages the hammer catch.

Contact piece. The forward end of the contact piece rests upon the firing pin when the firing lock is closed. The contact piece is housed in, but insulated from, the upper end of the hammer. At the rear of the contact piece is a provision for quick positive connection of the electric firing cable.

Hammer guide block. The hammer guide block is fitted into the front face of the receiver on the side with the slot. This block is aligned with the slot to allow the hammer to be cocked only when the wedge is fully closed.

Primer retaining catch. The primer retaining catch (fig. 3-18) is a separately assembled unit bolted to the receiver. The unit consists of a housing, the catch, a catch retaining spring, and a guide screw that limits the outward movement of the catch. As the primer is pushed into position in the mushroom stem, the rim of the case first seats in a recess in the rear face of the extractor and then pushes the extractor forward until the rear of the primer has passed the primer retaining catch. The catch then moves down behind the primer to hold it in place until the wedge closes. The tapered cut on the wedge then completes the priming operation by pushing the primer case home. The wedge comes up against a stop plate, secured to the inner face of the receiver, to prevent the wedge overrunning and coming into

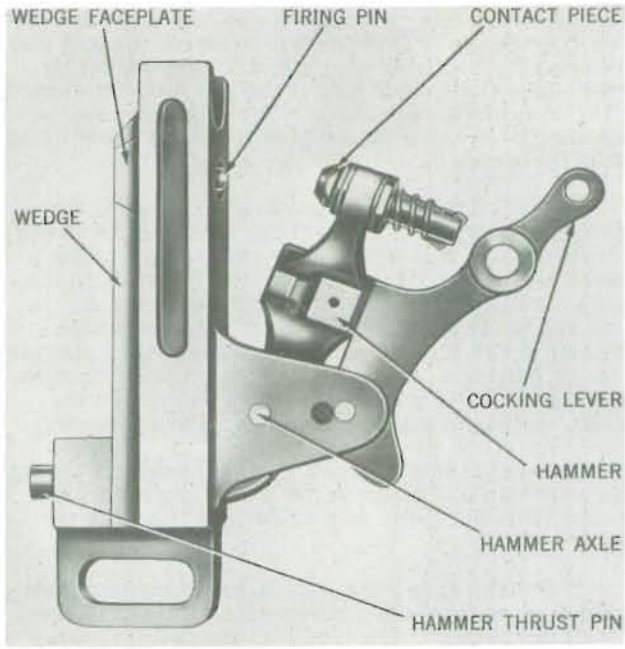
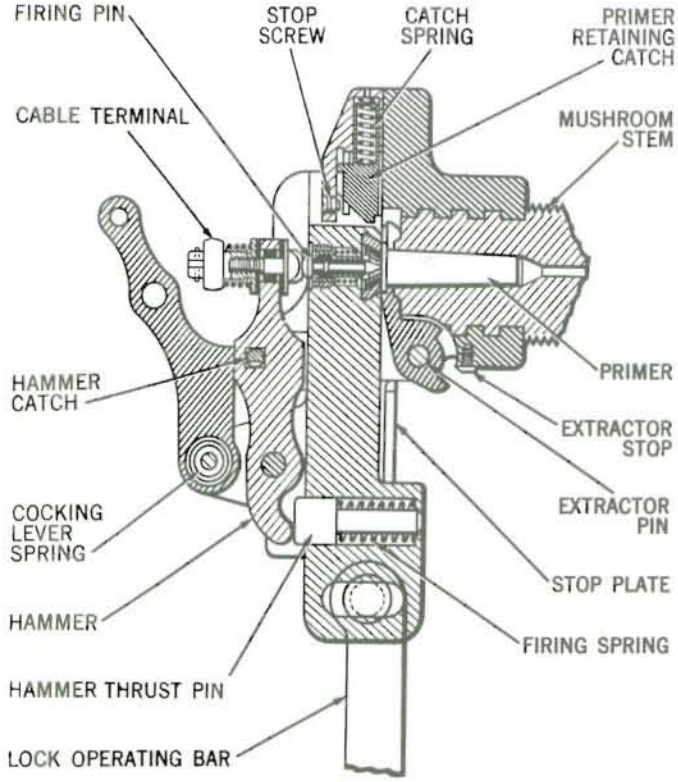


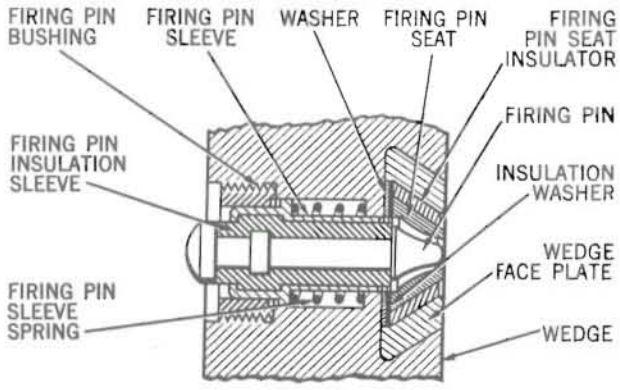
Figure 3-17. Wedge - Cocked Position, Left Side

contact with the primer retaining catch housing.

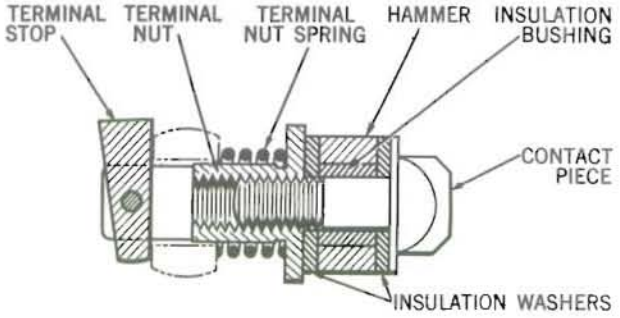
Extractor and extractor cam (figs. 3-19 and 3-20). The extractor and extractor cam are both pivoted on the extractor pin which passes through the receiver. The extractor cam is actuated by a



ELECTRICAL FIRING POSITION



FIRING PIN ASSEMBLY



CONTACT ASSEMBLY

Figure 3-18. Firing Lock - Electrical Firing Position, Right Side; Firing Pin Assembly; Contact Assembly

lug on the wedge face plate to operate the extractor. Fitted between the wedge and the mushroom stem, the arms of the extractor engage the primer case on two sides. When the wedge is retracted, the lug on the wedge strikes the extractor cam; this causes the extractor to move to the rear, push the primer retaining catch out of the way, and extract the primer case. A torsion spring returns the extractor cam to its original position.

Extractor stop screw. The extractor stop screw (fig. 3-20) limits the movement of the extractor.

Safety appliances. The following safety features are included in Firing Lock Mk 14 Mod 5:

1. The primer cannot be fired either by electricity or by percussion until the breech is completely closed.

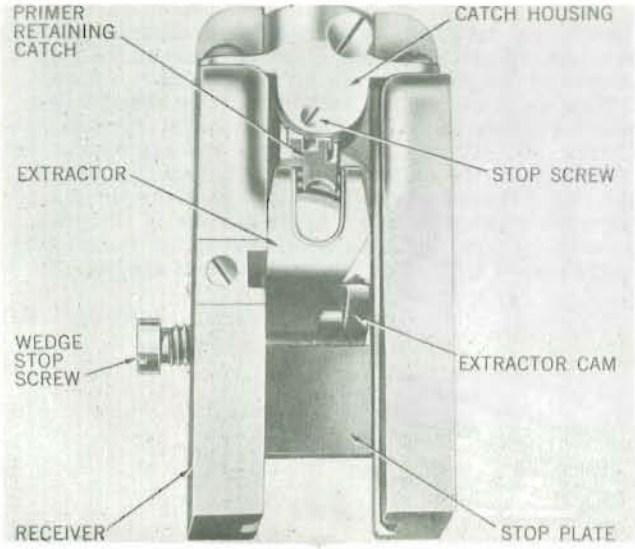


Figure 3-19. Firing Lock Mk 14 Mod 5 - Wedge Removed

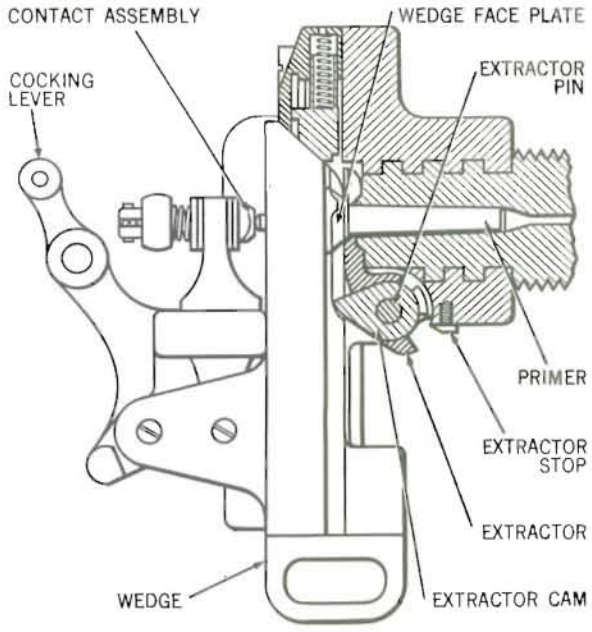


Figure 3-20. Firing Lock, Right Side, Sectional View - Wedge Closed

2. As the wedge is opened, lug on the hammer engages in a milled recess in the receiver to lift the hammer so as to break contact and prevent electric firing.

3. The same lug also prevents the hammer from being drawn back for percussion firing except when the wedge is closed.

4. A stop plate is secured to the receiver to prevent the wedge from over-riding and hitting the primer retaining catch housing.

5. A pin, screwed into the carrier and fitted against the receiver, prevents the firing lock from being turned in the wrong direction during disassembly or when the lock is being disengaged from the operating bar.

6. An arc plate secured to the face of the carrier prevents the lock from being turned until the wedge is retracted. It also prevents the wedge from being closed until the lock is in its proper position.

7. If the pin that locks the operating bar to the wedge is disengaged, the arc plate on the carrier automatically withdraws the wedge from the firing position. This prevents jamming and puts the wedge in the safe position so that the gun cannot be fired.

8. When the lock is in the closed position with the wedge disengaged from the operating bar, and the breech mechanism is open, the wedge is prevented from closing by a shoulder on the end of the breech mechanism in front of the wedge.

Gas ejector

16-inch Gas Ejector Mk 5 Mod 0 (fig. 3-21) is an automatic, low-pressure, air porting system. It is composed of an assembled air line with valves and a connection to an automatically opened valve mounted on each gun breech. The purpose of the gas ejector is to expel powder gases and burning fragments through the gun muzzle to clean the bore without fouling the gun room compartment. When the breech plug is opened, an attached trip plate automatically opens the gas ejector valve to direct jets of compressed air into the gun bore through orifices in the screw box. The valve is held open by a detent until closed manually.

The gas ejector delivers the ship's compressed air supply to the main and auxiliary gas ejector systems and furnishes the air supply for the breech closing system. Air, at 150 to 200 pounds per square inch pressure, is brought into the turret through the central column and is stored in five relay tanks located on the projectile handling decks. From the tanks, air is piped to swivel joints below the right slide trunnion of each gun. From the swivel joints at each gun, the air passes through pipe lines and an expansion joint to the gas ejector valve at the breech of the gun (fig. 3-21).

A 1-1/2-inch gate valve, below and adjacent to the swivel joints, permits local cut off of the gas ejector supply.

From a T-fitting below the gun pocket pan deck, a second air line extends upward to two storage tanks at the rear of the turret officer's booth. Air lines from these tanks deliver air to each gun room to a manually operated auxiliary gas ejector system that is used in case of a main system failure.

The auxiliary ejector, a hose fitted with a brass nozzle, is stowed overhead at the gun captain's station, adjacent to the breech.

Gas ejector valve. The valve unit (fig. 3-22) is a poppet type, arranged for semi-automatic operation. The valve is similarly located on each gun breech. The position of the valve in the valve port of the screw box liner is oriented for correct tripping by a cam bearing pin that seats in a reamed hole in the face of the liner. The valve cam is designed so that contact with the trip plate rotates the cam through an arc of 90 degrees. This raises and holds the poppet in open detent position, until a lanyard pull returns the cam and permits spring closure and air cut-off.

Air demand. Gas ejector air-supply pressure and air consumption data are:

System pressure, average sustained, psi	175
Free air demand:	
Each gun, cu ft per second	14.5
Each gun cu ft per round	25

Auxiliary gas ejector systems have substantially greater free air demand. With either system, the bore clearing performance is improved and the air demand is decreased when the turret is closed and the ventilating fans are on.

Yoke

16-inch yoke Mk 5 Mod 0 (fig. 3-1) is a large, cast steel, counterbalancing unit. It mounts on the gun shoulder and provides integral lug seats for the recoil cylinder piston rod and the counterrecoil cylinder yoke rods.

The yoke is mounted on the gun shoulder and secured to it with the yoke ring. This ring, made in semicircular halves, seats in an annular groove in the gun shoulder and engages a shoulder in the yoke bore. The yoke and yoke ring are locked to each other and to the gun shoulder by a yoke locking ring that is threaded into the forward face of the yoke and secured by a lock plate. The gun is prevented from rotating in the yoke bore by a key that is centered in the bottom of the bore and in the gun shoulder.

The yoke contour provides clearance spaces or attachment lugs for the breech mechanism and for elements of the gun slide. Two pockets in the top center of the yoke provide for lead balance weights. Below the pockets are two horizontally bored holes which receive the yoke rods of the counterrecoil cylinders. At either side of the yoke top are spaces for clearance of the counterrecoil cylinders. A slot at the top, forward part of the yoke receives the nut of the yoke locking device. At the bottom of the yoke, a large integral lug houses the end of the recoil cylinder piston rod. The lower section of the yoke is

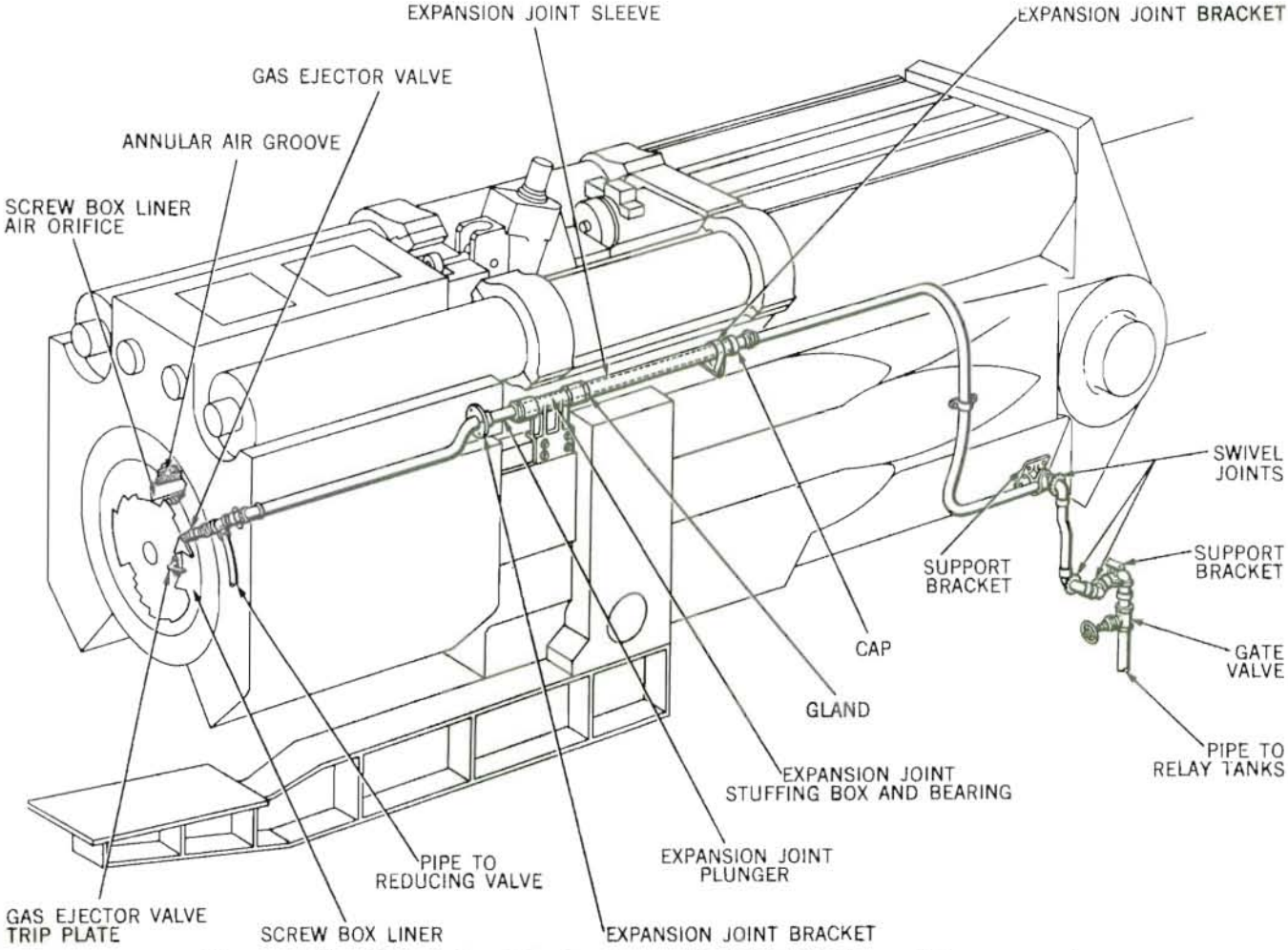


Figure 3-21. 16-inch Gas Ejector System Mk 5 Mod 0, General Arrangement

cut away rearward from the recoil piston rod seat to provide clearance for the carrier hinge lug and the breech opening buffer. The gas ejector air line is housed in a slot cast in the right side of the yoke.

OPERATION

General

The guns can be fired either electrically or by percussion. Gun operation consists of a series of manually initiated breech mechanism, gun, and gas ejector actions. Loading operations are performed at the LOAD position (five-degree elevation), after which the gun is laid on target either automatically or through gun layer's handwheel motion. The sequence of gun firing operations, starting with the gun ready to fire and continuing through one complete cycle, is described below. In addition, instructions on replacing a misfired primer, percussion firing, and non-firing operation are also included.

Firing operation

Ready to fire. The gun is ready to fire (fig. 3-23) after: (1) the salvo latch locking pin is not in hole "B", (2) the yoke locking device is released, (3) the primer is inserted into the firing lock receiver.

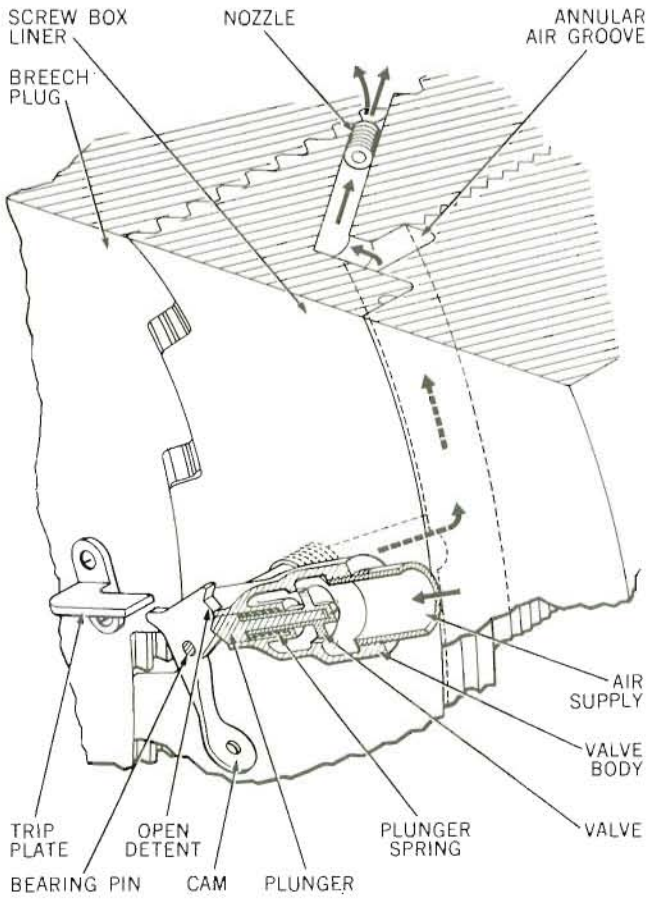


Figure 3-22. Gas Ejector Valve

(4) the projectile and six powder bags are rammed, (5) the breech is closed and latched, (6) the gun is on target.

Gun recoil and counterrecoil action. Upon firing (fig. 3-23A) the ignited powder causes the projectile to leave the bore and the gun to recoil. Recoil energy is expended (fig. 3-23B) in the recoil cylinder by forcing hydraulic fluid through the piston ports against the obstructing action of the throttling rods. The recoil action compresses air in the counterrecoil system. The hydropneumatic counterrecoil mechanism (fig. 3-23C) returns the gun back to battery (as explained in ch. 4). The buffing action of the recoil cylinder, shown on figure 3-23D, occurs during the last part of the counterrecoil movement.

Salvo latch actuation. The salvo latch lever cam (fig. 3-23E) is rotated clockwise by gun recoil. This movement rotates the locking arm to release the operating lever latch, permitting reopening of the breech for a new cycle of operation. If misfire occurs, it is evident by the locked position of the salvo latch arm and, therefore, the operating lever cannot be actuated to open the breech.

Breech opening. To open the breech for initial round loading only, the salvo latch locking arm is manually thrust aside and the operating lever latch is lifted. The released lever is then pulled rearward and down (fig. 3-23F). Motion of the breech operating lever rotates the plug to unlock and retract it and opens the breech. Opening rotation of the plug opens the gas ejector valve (fig. 3-23G). The valve ports compressed air through the gun bore. As the plug swings open and the operating lever swings downward, the crankshaft, actuated by operating lever movement, rotates in a clockwise direction (fig. 3-23H). This lowers the cross-head and, therefore, the lock operator bar to retract the firing lock wedge. As shown in figure 3-231, when the wedge is retracted, the lug on the wedge strikes the extractor cam. This action causes the extractor to move to the rear, pushing the primer retaining catch out of the way and extracting the spent primer.

In case of misfire, the wedge is retracted, without opening the breech, by unlatching the wedge retracting lever from the breech operating lever (figs. 3-23G and 3-23H).

During breech opening, the carrier-mounted plug swings to the rear and down, through a vertical arc, compressing the counterbalancing springs. The breech-opening buffer, during final movement, retards and stops the carrier. The holding-down latch then moves into a stiff-leg position and secures the fully opened carrier.

During this time, compressed air from the gas ejector system has been entering the gun powder chamber and bore through three holes in the screw box liner (fig. 3-23J). The gun captain wipes the mushroom with his special sleeve and verifies that the bore is clear (fig. 3-23K). He then depresses the bore clear switch momentarily, and manually shuts off the gas ejecting air supply by tripping the valve closing cam (fig. 3-23L).

Gun loading. The projectile cradle and spanning tray are lowered to the gun loading position. The spanning tray enters the open gun breech. The projectile is rammed, rammer retracted, and then the powder charge is rammed (figs. 3-23M and 3-23N). Then the cradle and tray are withdrawn. During this period, the primerman, using a special tool, inserts a primer into the receiver of the firing lock (fig. 3-23O).

Breech closing. With the gun loaded, the holding-down latch is foot operated to release the carrier (fig. 3-23P). The foot lever of the closing valve is operated at the same time to open the valve and port air pressure to the closing cylinder, as shown in figure 3-23Q. The carrier and plug swing up under spring load and air pressure. A guide aligns the cam rollers with the rotating cam. As the plug's forward thread contacts the stop thread of the screw box, the cams cause rotation and locking of the plug to close the breech. In this final movement the operating lever is actuated, by plug rotation of its pivot, to swing upward until it is almost to its latch. The operating lever is then latched by hand (fig. 3-23R). The operating lever safety ratchet mechanism acts to prevent the operating lever from reversing its direction in the event it has not been fully latched during the breech closing operation. In conjunction with plug rotation, the crank shaft is rotated to raise the wedge back into firing position.

Replacing misfired primer. In the case of misfire, the deficient primer can be removed without opening the gun breech. The primer is extracted by unlatching the wedge retracting lever from the operating lever and pulling it down (fig. 3-23S). A new primer is inserted; the lock is closed; the wedge retracting lever is re-latched; and firing is repeated.

Percussion firing. In the event of casualty to the gun-firing electrical circuit, the loaded gun can be fired by percussion. A hammer, contact piece, and cocking lever attached to the wedge (fig. 3-23T) function to deliver a blow to the firing pin. This is accomplished by drawing back the cocking lever by means of a lanyard. The cocking lever pulls the hammer back with it until a catch on the cocking lever releases the hammer. As the hammer is drawn back, the hammer spring is compressed. When the hammer is released, this spring drives it forward making the contact piece strike the firing pin, which transmits the blow to the primer to fire the gun.

Non-firing operation

For a non-firing breech operation the procedure is as follows: The firing lock is mounted in position only if a drill is planned, and is never mounted during maintenance. The slide securing pin is retracted and the gun elevated to its loading position of five degrees. When the breech is to be opened for a drill or for maintenance the salvo latch locking pin should be in hole "B", as directed by the salvo latch caution plate. However, the latch locking arm can be manually thrust aside to unlock the operating lever latch each time the breech is opened. The breech is opened and closed in the same manner as described previously. Upon securing from drill or completion of maintenance, the salvo latch locking pin must be removed from hole "B" and returned to the turret officer's booth. The gun is returned to five degrees elevation and the slide securing pin is run into its seat.

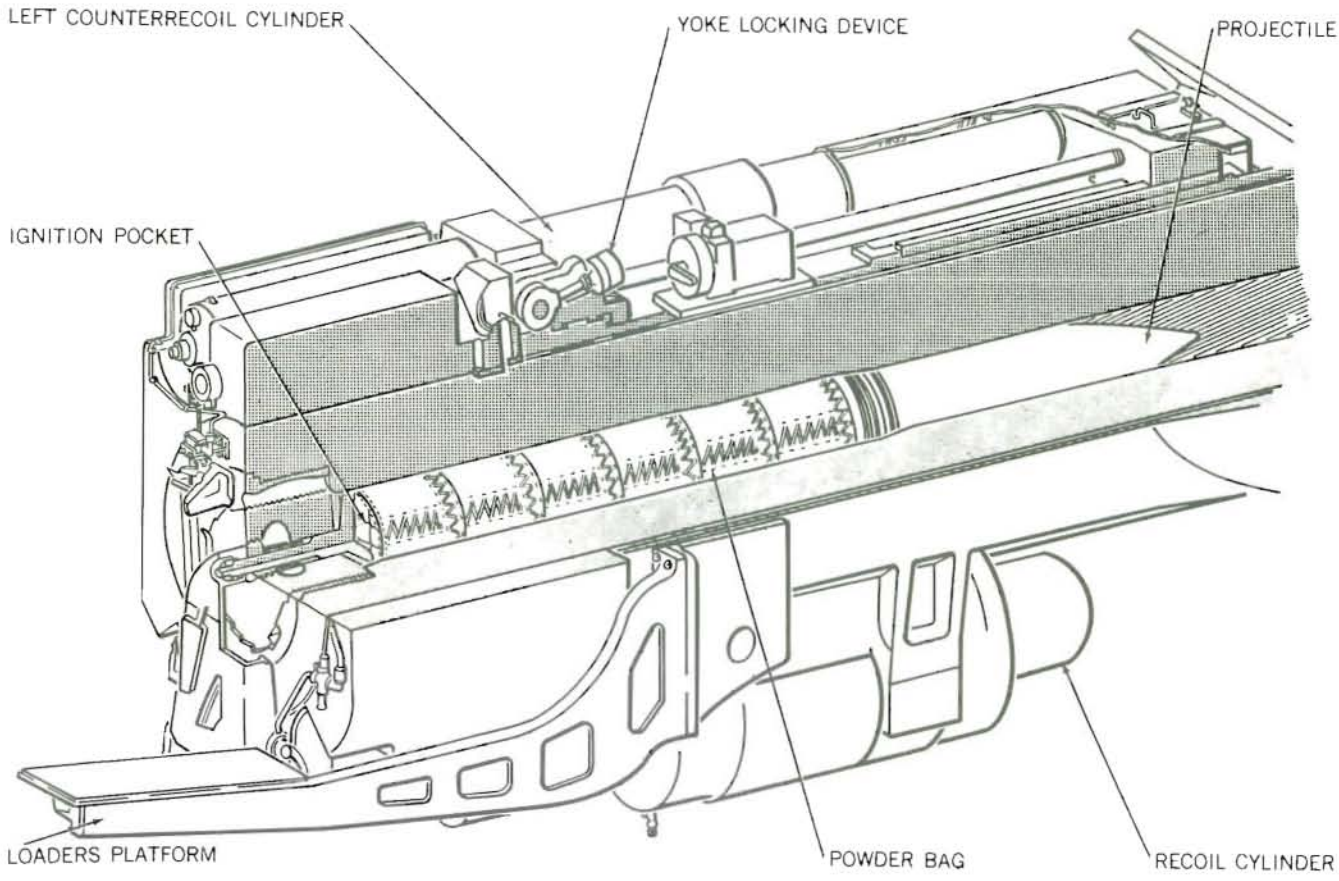


Figure 3-23. 16-inch Gun Assemblies. Gun Ready for Firing.

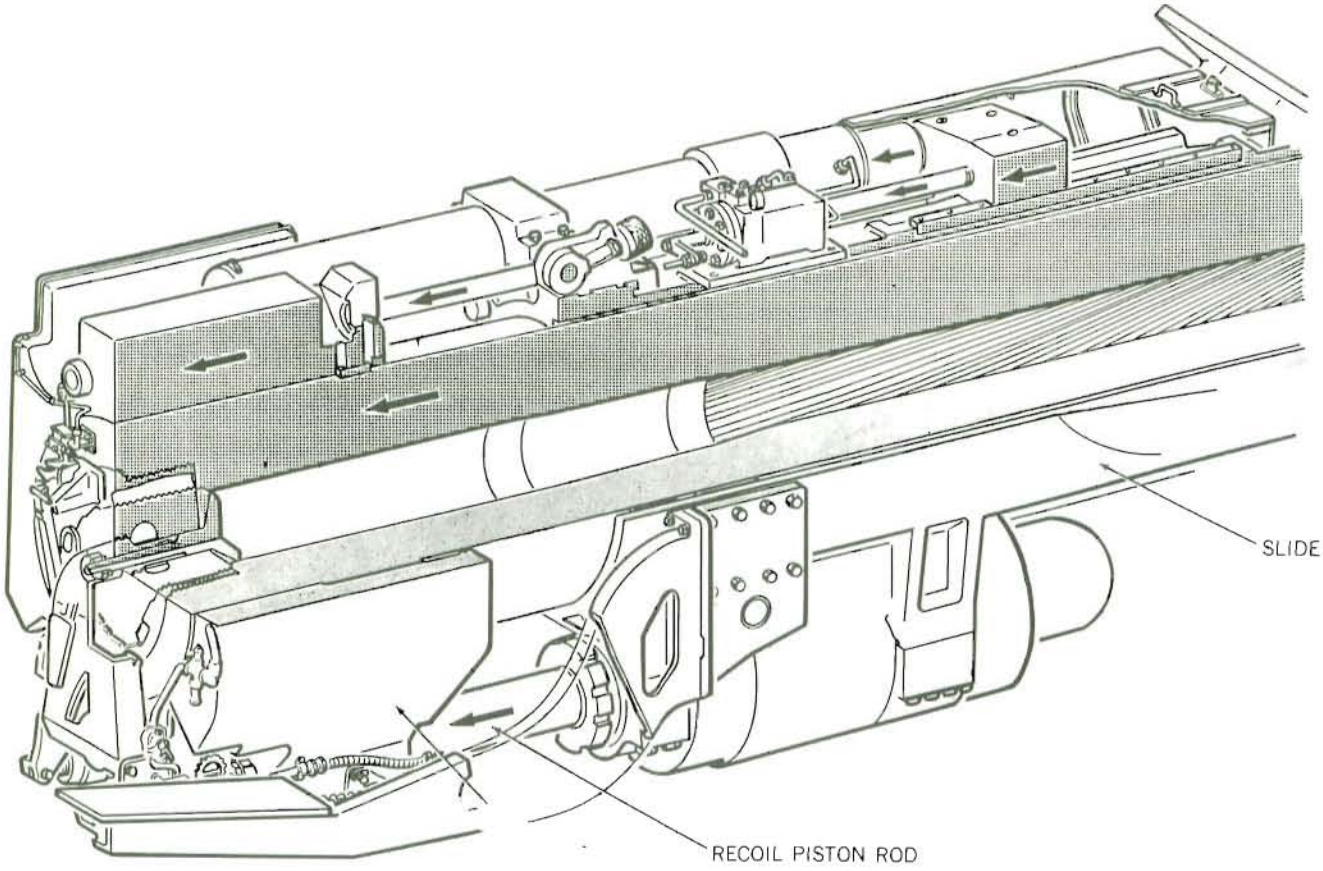


Figure 3-23A. 16-inch Gun Assemblies. Firing Gun Recoiling.

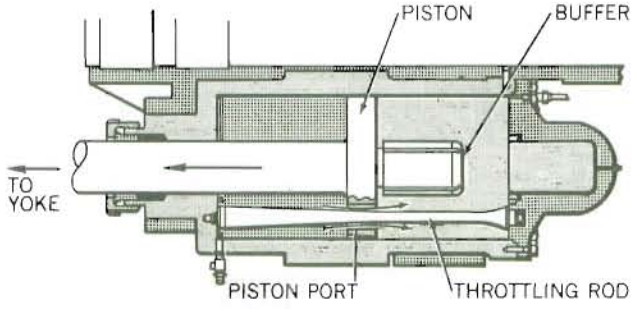


Figure 3-23B. 16-inch Gun Assemblies. Gun Recoiling Action.

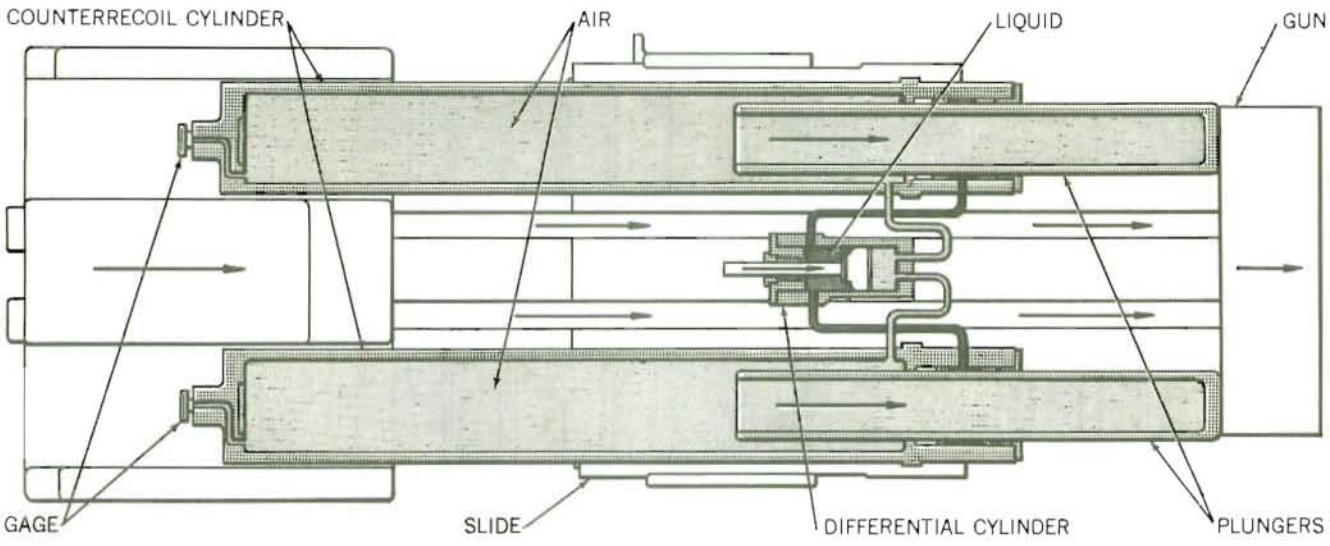


Figure 3-23C. 16-inch Gun Assemblies. Counterrecoil Action.

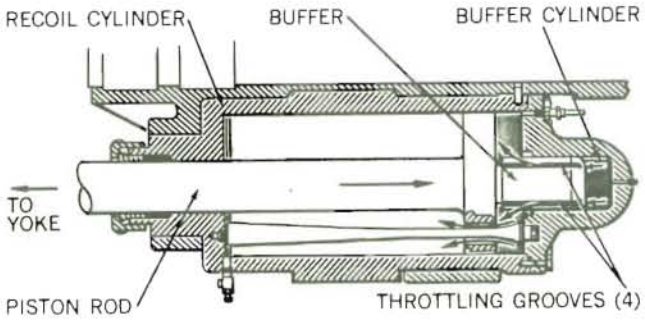


Figure 3-23D. 16-inch Gun Assemblies. Recoil Buffing Action During Counterrecoil.

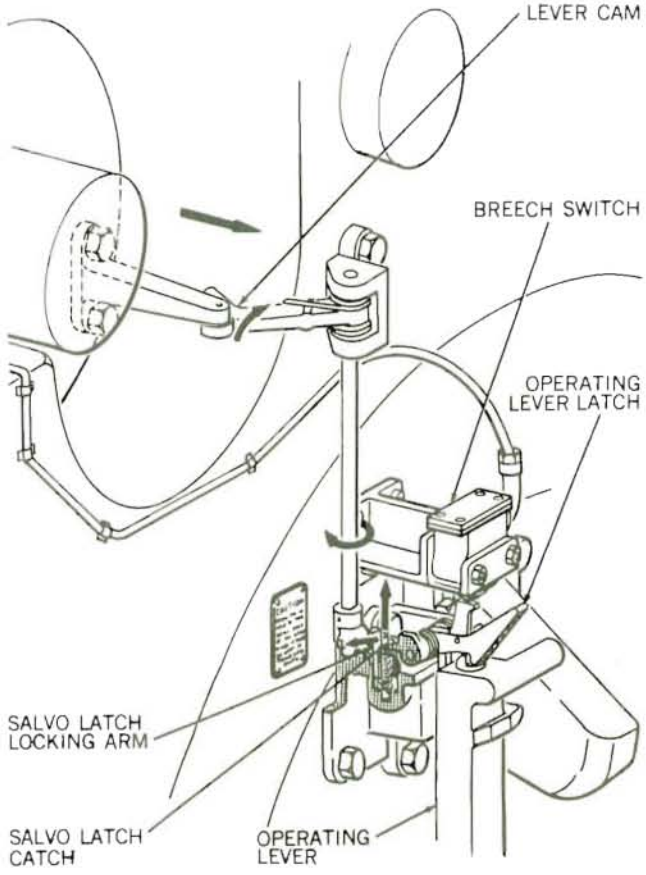


Figure 3-23E. 16-inch Gun Assemblies. Salvo Latch Actuation. Gun Recoil.

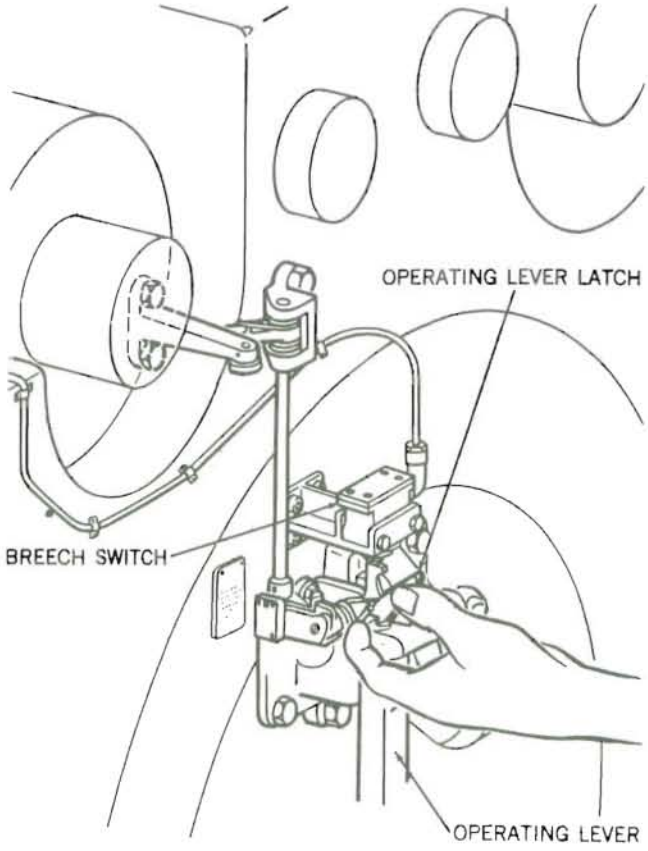


Figure 3-23F. 16-inch Gun Assemblies. Breech Opening. Manual Operation.

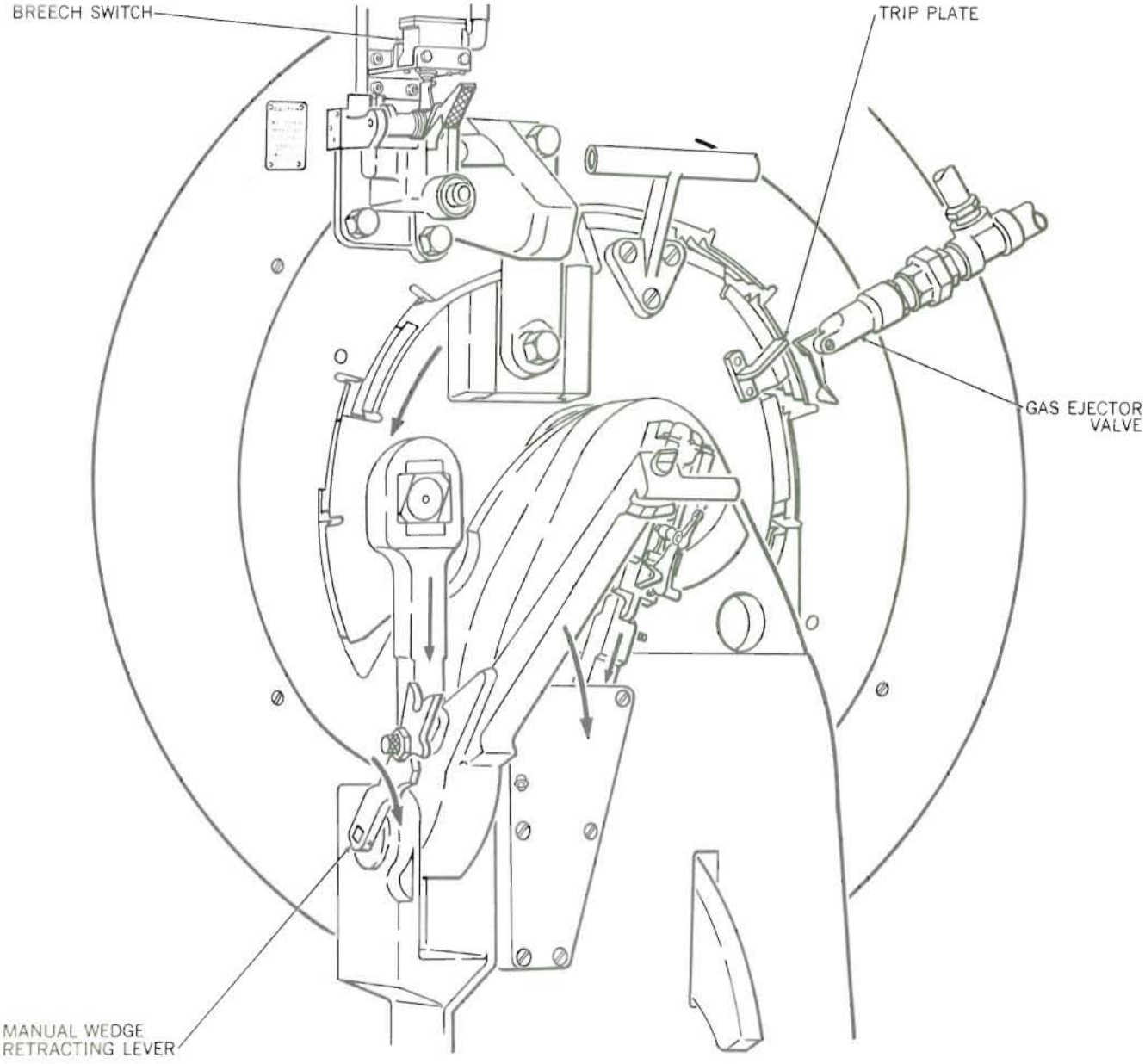


Figure 3-23G. 16-inch Gun Assemblies. Breech Opening. Plug Rotation. (Operating Lever Safety Ratchet Mechanism Assembly Not Shown; See Figure 3-3)

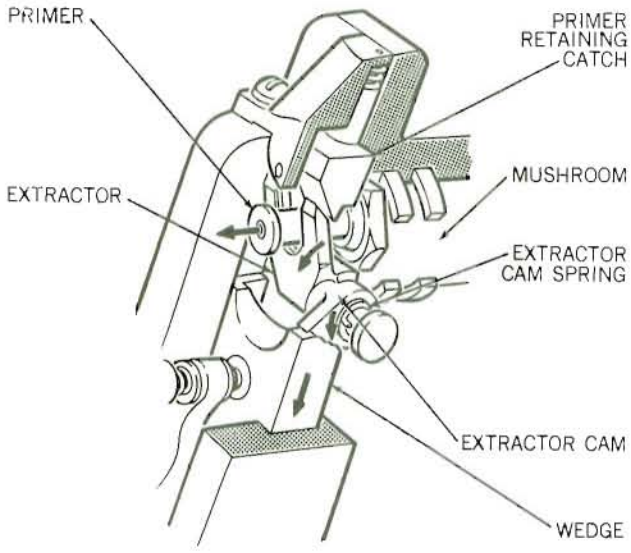


Figure 3-23H. 16-inch Gun Assemblies. Breech Opening Ejecting Primer.

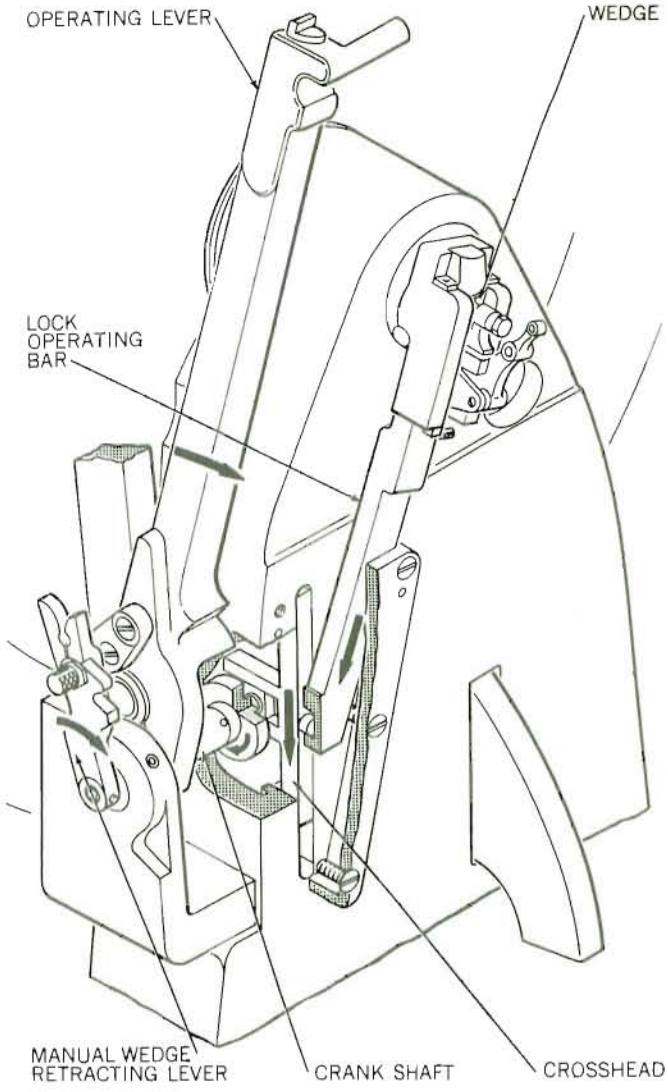


Figure 3-23I. 16-inch Gun Assemblies. Breech Opening. Extractor Cam Motion.

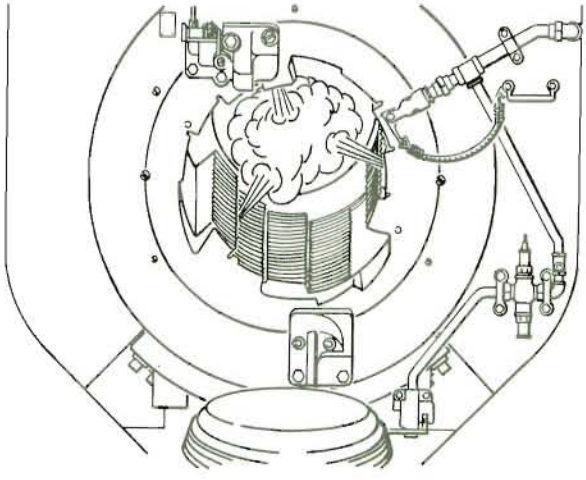


Figure 3-23J. 16-inch Gun Assemblies. Gas Ejector Action. Breech Open.

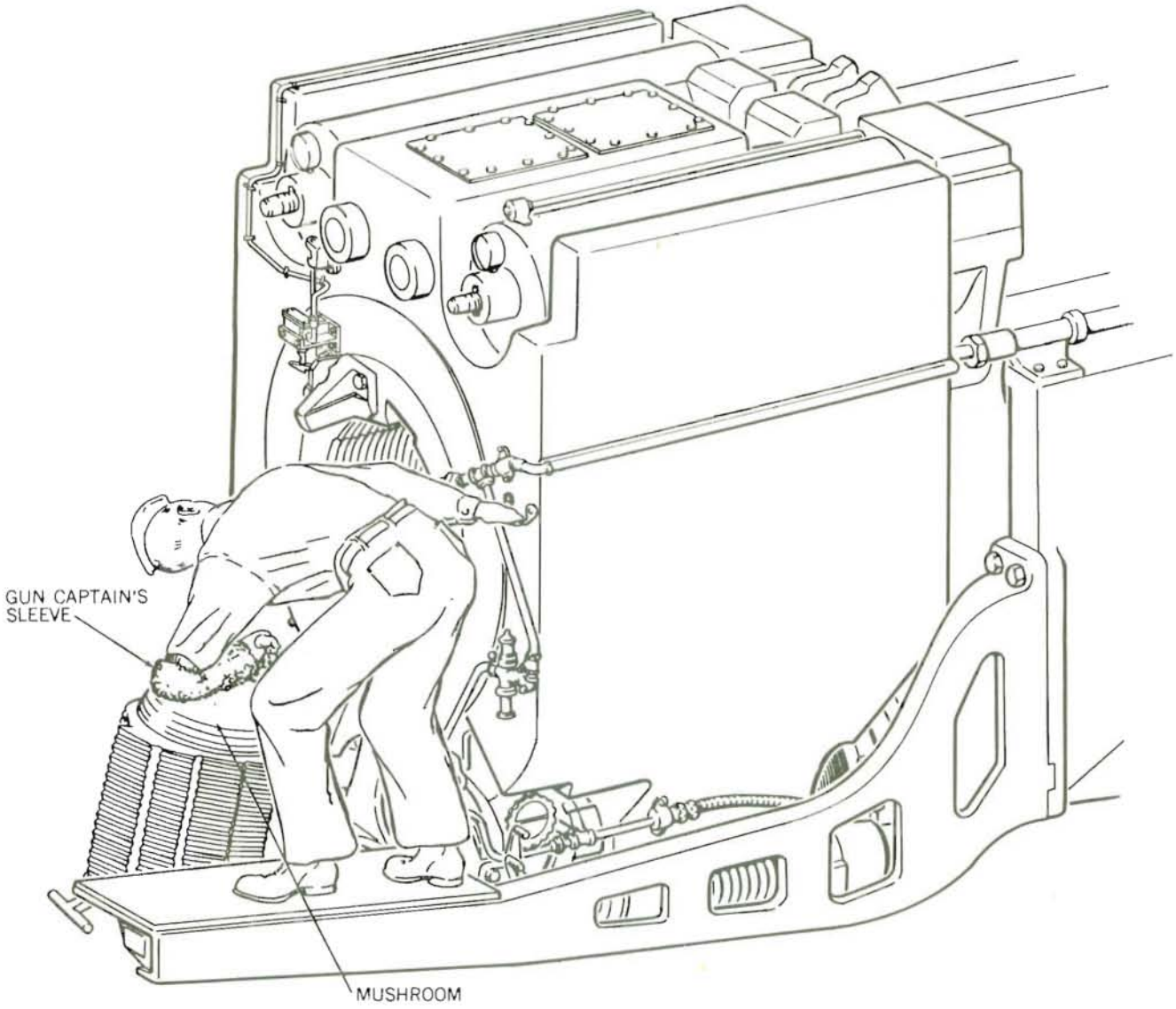


Figure 3-23K. 16-inch Gun Mk 6 Mod 1. Wiping Mushroom and Inspecting Gun Bore.

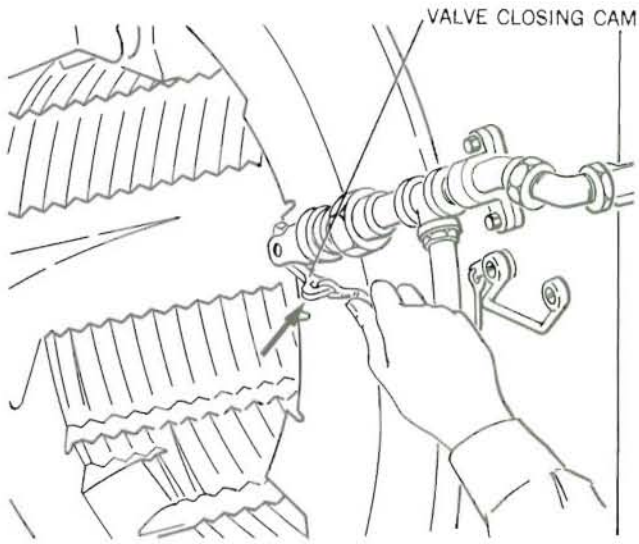


Figure 3-23L. 16-inch Gun Assemblies. Closing Gas Ejector Valve Manually.

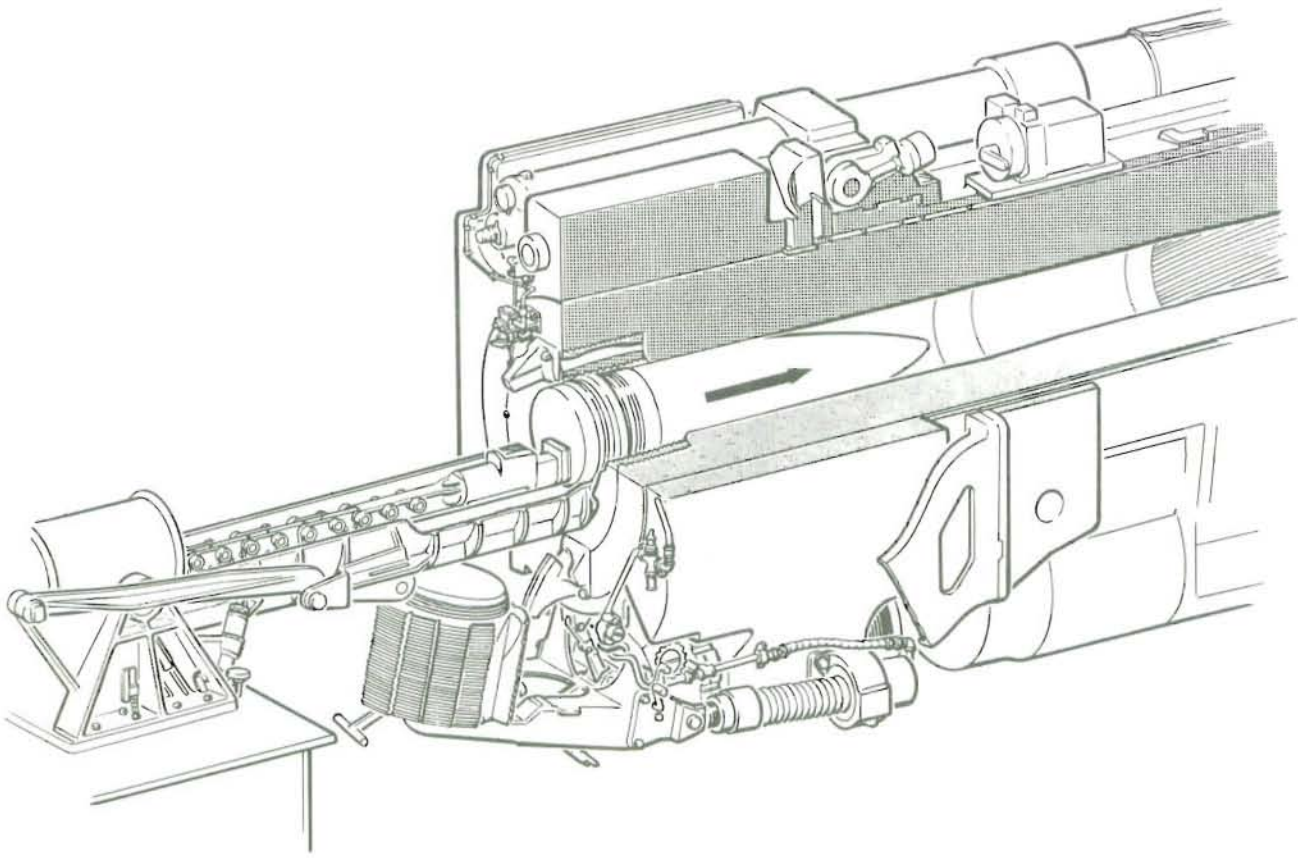


Figure 3-23M. 16-inch Gun Assemblies. Projectile Ramming Action.

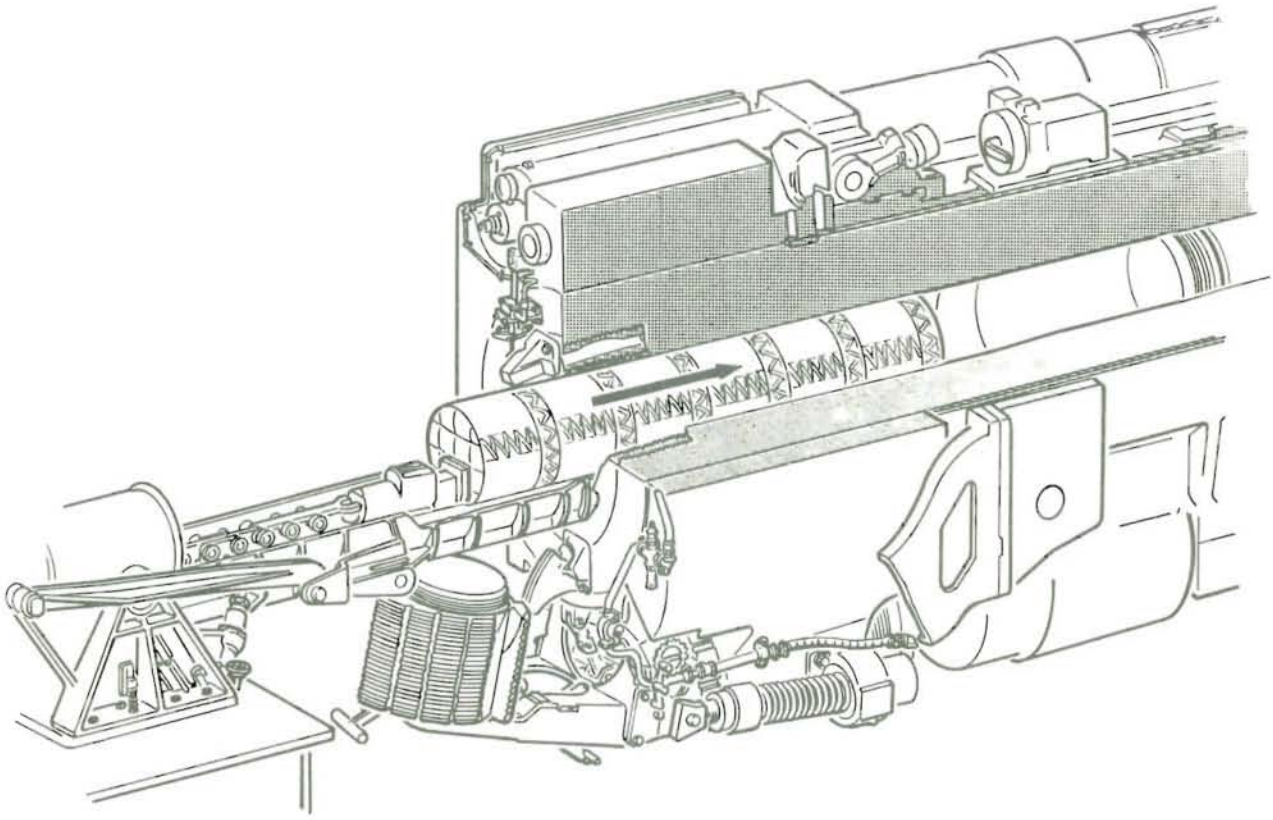


Figure 3-23N. 16-inch Gun Assemblies. Powder Ramming Action.

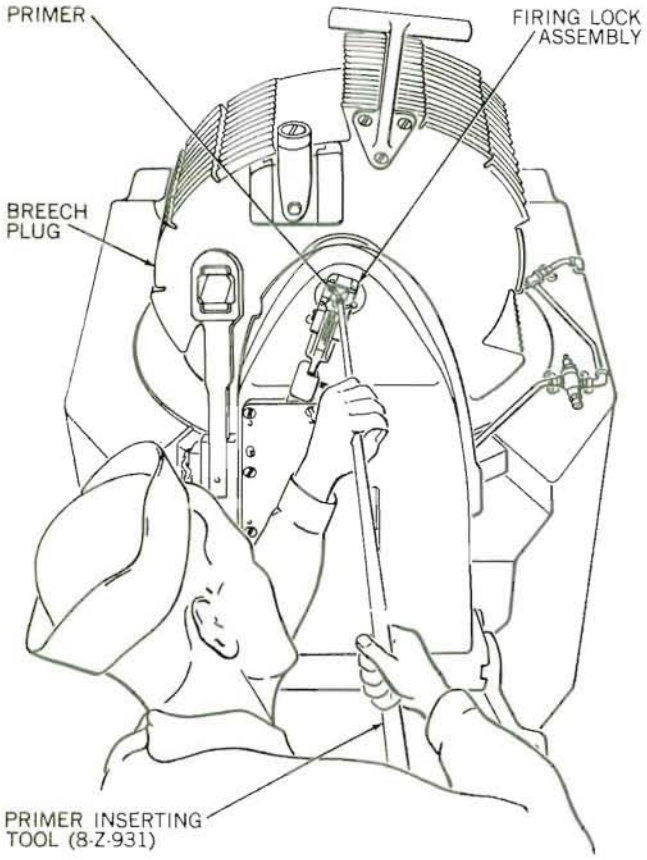


Figure 3-23O. 16-inch Gun Assemblies. Breech Open. Inserting Primer.

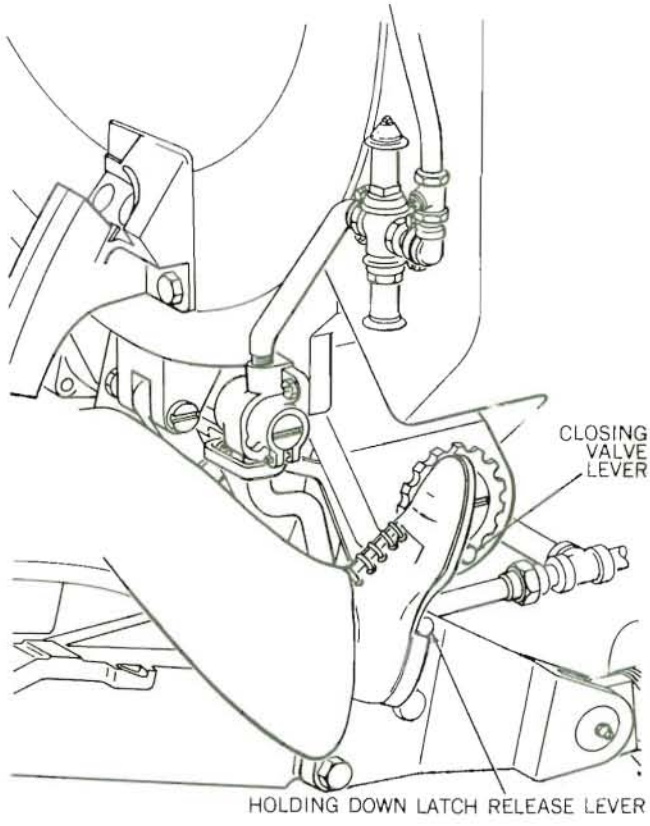


Figure 3-23P. 16-inch Gun Assemblies. Breech Closing Action.

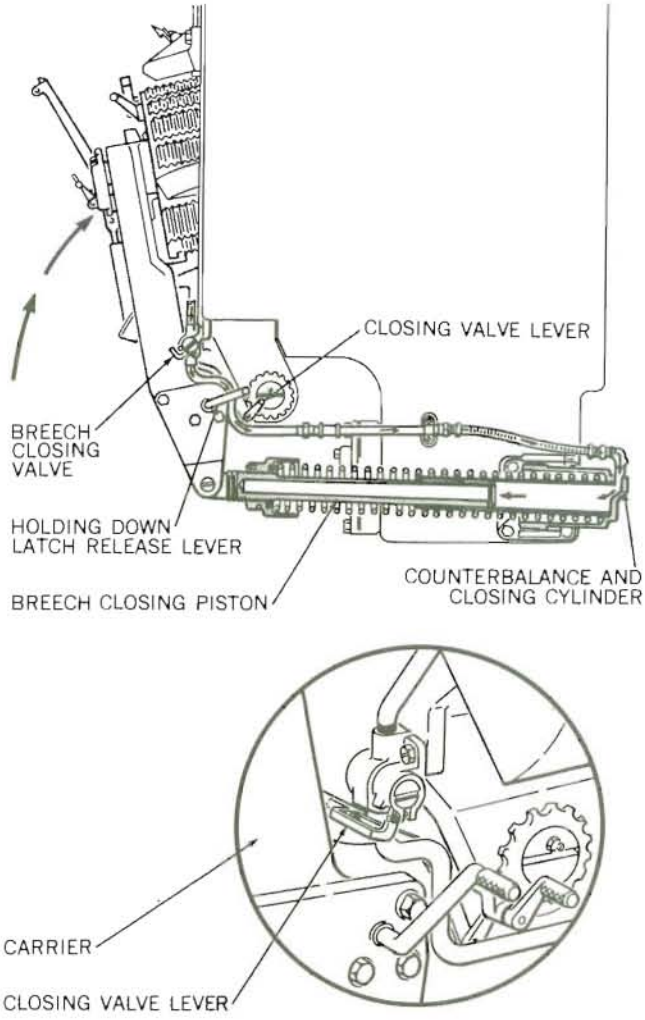


Figure 3-23Q. 16-inch Gun Assemblies. Breech Closing Cylinder Action.

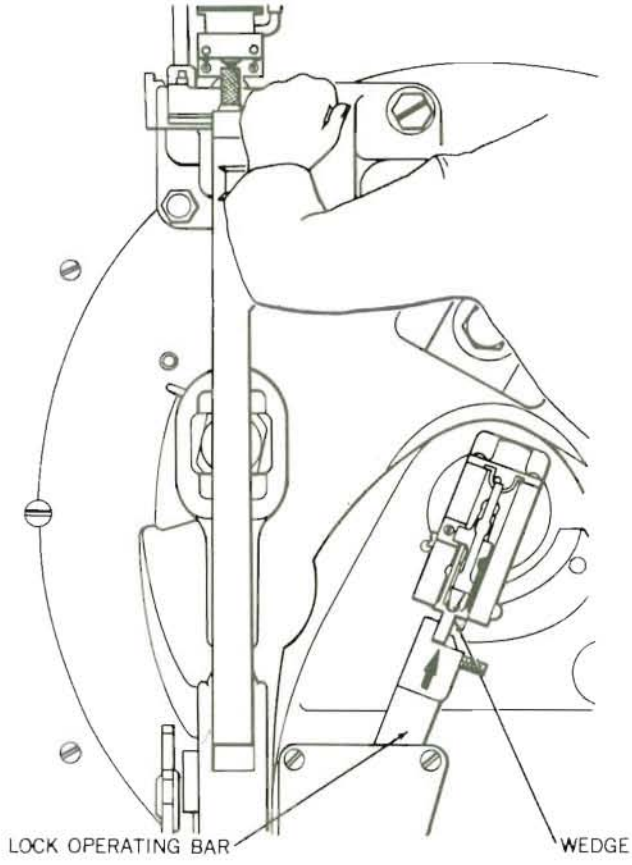


Figure 3-23R. 16-inch Gun Assemblies Final Breech Closing Action. Manual.

INSTRUCTIONS

General maintenance

The guns, breech mechanisms, firing locks, gas ejector systems, and yokes of each turret assembly are to be operated and maintained in accordance with the regulations of the Bureau of Ordnance Manual, the directions on the instruction plates of the assemblies, and the specific instructions in this chapter. Inspection, lubrication, and preservation are discussed in the following paragraphs.