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OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

HOME

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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.

NAVORD OP 769

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DEPARTMENT OF THE NAVY
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WASHINGTON, D. C. 20360

NAVORD OP 769 CHANGE 1
1 November 1967

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PAGE 1 OF 1 PAGE (S)

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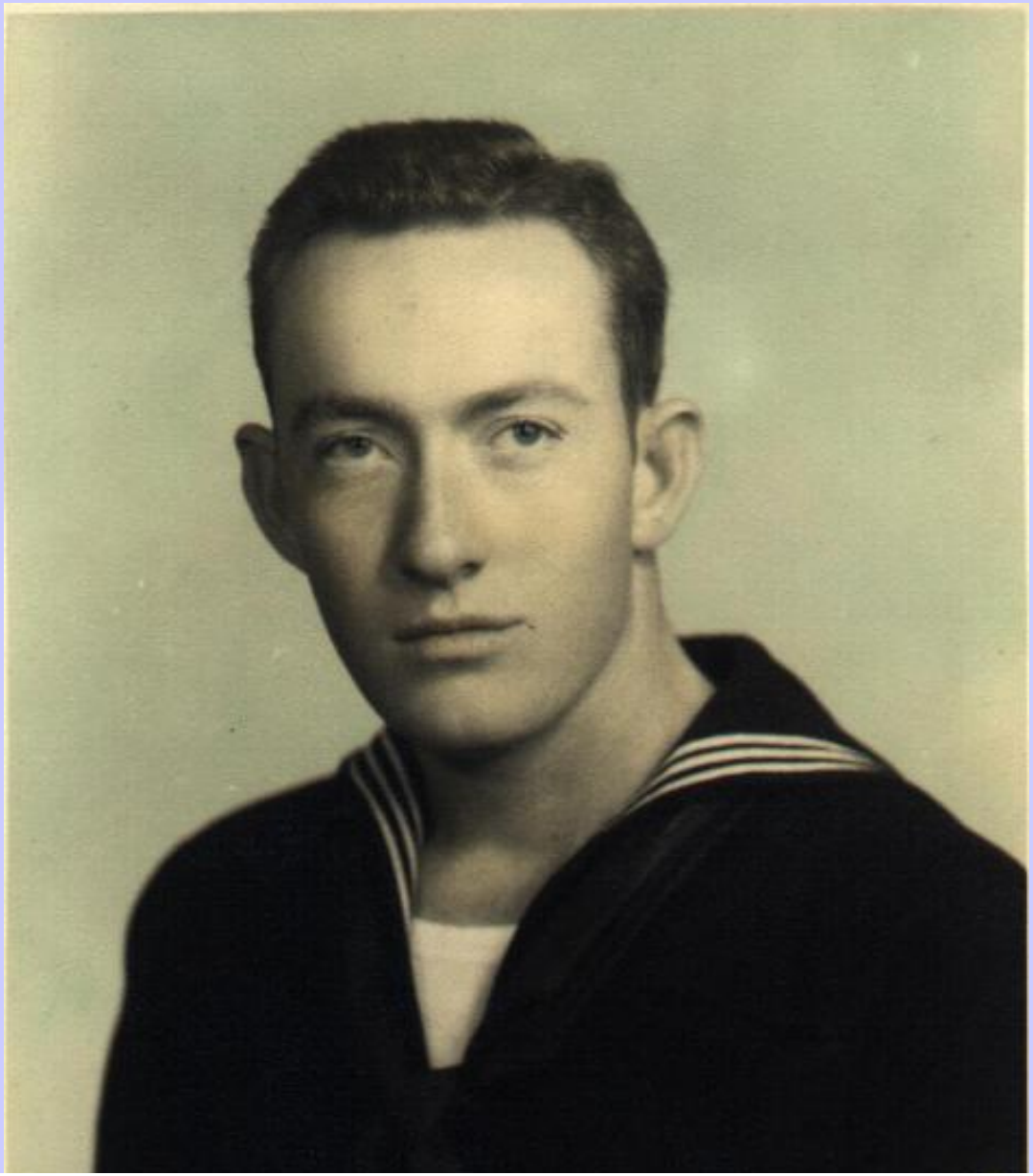
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US NAVY PAGES





GENE SLOVER

THIS PICTURE WAS TAKEN IN JAPAN. AT THE TIME THE JAPANESE DID NOT HAVE ANY COLOR FILM SO THE ORIGINAL PICTURE WAS BLACK AND WHITE. THE JAPANESE PHOTOGRAPHER WHO TOOK AND COLORED THE PICTURE KEPT ASKING ME WHAT COLOR MY HAIR WAS AND I KEPT TELLING HIM THAT IS WAS A VERY DARK RED.

WHEN I WENT BACK TO GET THE PICTURE FEW DAYS LATER HE EXPLAINED TO ME THAT MOST JAPANESE WERE COLORBLIND AND THAT HE COULD NOT TELL WHAT COLOR MY HAIR WAS.

HE KEPT APOLOGIZING FOR GETTING THE COLOR WRONG AND WAS MORE THAN WILLING TO TRY TO CORRECT IT.

HE COULD SEE ALL OF THE OTHER COLORS WHEN HE LOOKED AT ME. HE JUST COULD NOT SEE THE HAIR COLOR OR TINT.

I TOLD HIM THE PICTURE WAS FINE AS WE WERE GETTING UNDERWAY THE NEXT MORNING AND I MIGHT NOT BE BACK.

THE HEAD OF THE CROW ON THE RATING BADGE IS SUPPOSED TO LOOK TOWARD YOUR BODY.

THE REASON IT DOES NOT IS THAT THE PICTURE IS TAKEN RIGHT AFTER THE USN HAD EVERYONE PUT THEIR RATE BADGE ON THE LEFT ARM BUT THE RATING BADGE IN THE PICTURE IS FOR THE RIGHT ARM.

SOME RATINGS IN THE NAVY WERE RIGHT ARM RATED AND OTHERS WERE LEFT ARM RATED. THE NAVY DID AWAY WITH THE RIGHT ARM RATINGS AND FROM THEN ON EVERYONE WORE THEIR RATING BADGES ON THEIR LEFT ARM AS IN THE PICTURE.

THE INSIGNIA HAS A RANGEFINDER WHICH DESIGNATES ME AS A FIRE CONTROLMAN. IN THE EARLY 1950'S THE FIRE CONTROL RATING WAS CHANGED TO FIRE CONTROL TECHNICIAN. THE FIRE CONRTOL TECHNICIAN RATING BADGE HAD A DIRECTOR ON IT WITH A RECTANGULAR ANTENNA ON TOP OF THE DIRECTOR. IF YOU WERE RIGHT ARM RATED THEN YOU WERE ALSO CALLED A LINE PETTY OFFICER WHICH PUT YOU IN A LITTLE DIFFERENT CLASS.

E-MAIL ME

USN GUNS, AMMUNITION DESIGN AND TESTING

DD887 USS BRINKLEY BASS

US NAVAL ORDNANCE BOOKS

CONSTRUCTION OF NAVAL GUNS

GUN BARREL CONSTRUCTION

COASTAL AND RIVERINE CRAFT ARMAMENT

NAVAL ORDNANCE 1937

NAVAL ORDNANCE AND GUNNERY VOLUME 1, NAVAL ORDNANCE 1957 EDITION

NAVAL ORDNANCE AND GUNNERY VOLUME 2, FIRE CONTROL 1958 EDITION

FLOW SCHEMATIC DIAGRAM OF THE MK 1 MOD 7 FORD COMPUTER

ENGINEERING, OPERATION AND MAINTENANCE

MEANWHILE BACK AT THE GUN FACTORY

THE ROLE OF NAVAL ORDNANCE IN WAR

THE 5"/38 GUN BOOK

SELSYNS AND SYNCHROS

8”/55 RAPID FIRE GUN AND TURRET

NEW JERSEY IN TRANSIT

NEW JERSEY 1968 REACTIVATION

16"/50 GUN BOOK

USN GUNS MARKS AND MODS 1942

USN GUNS MARKS AND MODS 1956

RANGE AND BALLISTIC TABLES 1935

EXTERIOR BALLISTICS 1935 (UNDER CONSTRUCTION)

RANGE AND BALLISTIC TABLES 1946

A.A. RANGE TABLE FOR 16-INCH 50-CALIBER GUN

BB59 BOMBARDS JAPAN

SAGA OF A US BATTLESHIP

GREATEST MAN-o'-WAR

13 RUGGED OLD LADIES

LUZON EXPRESS

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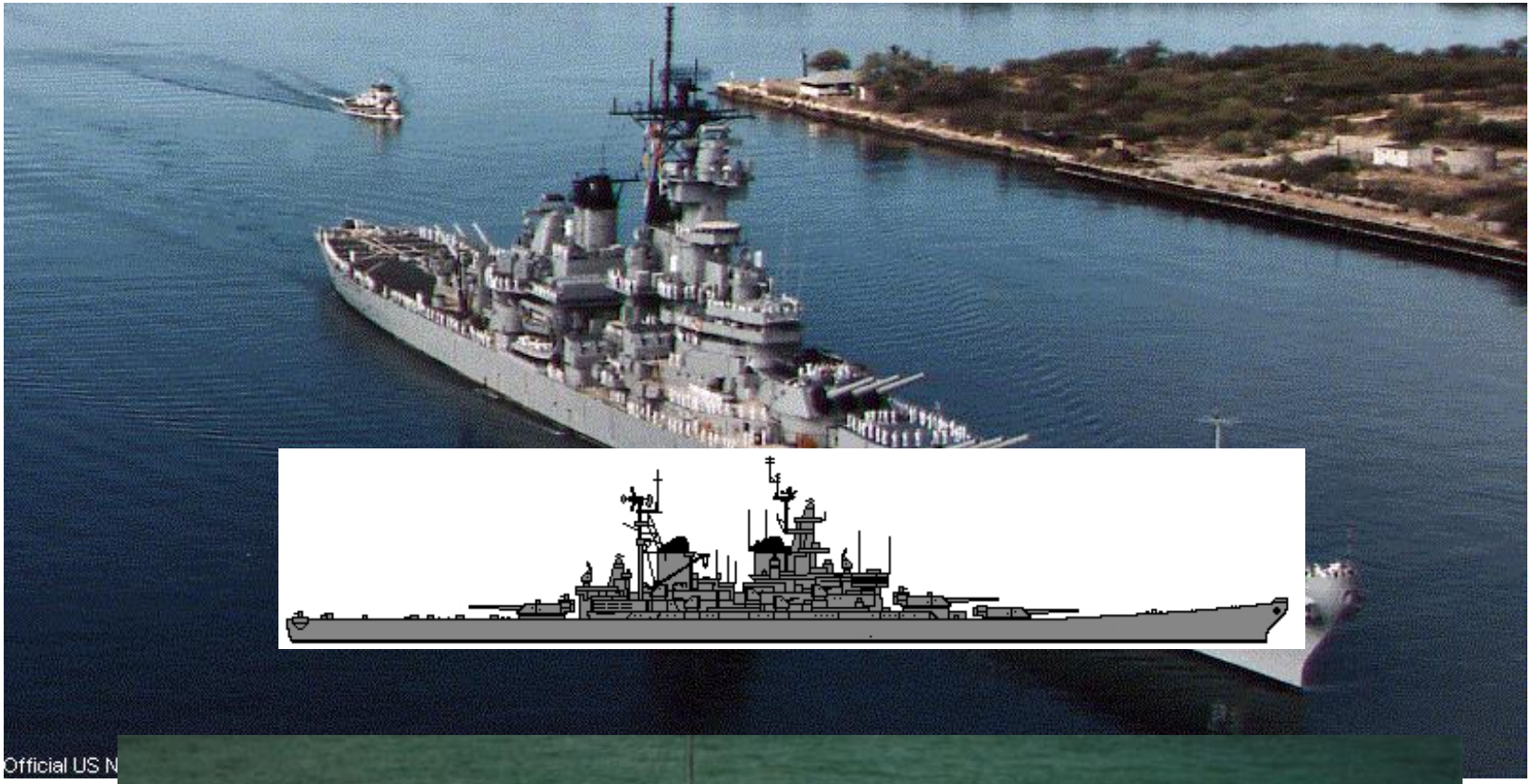
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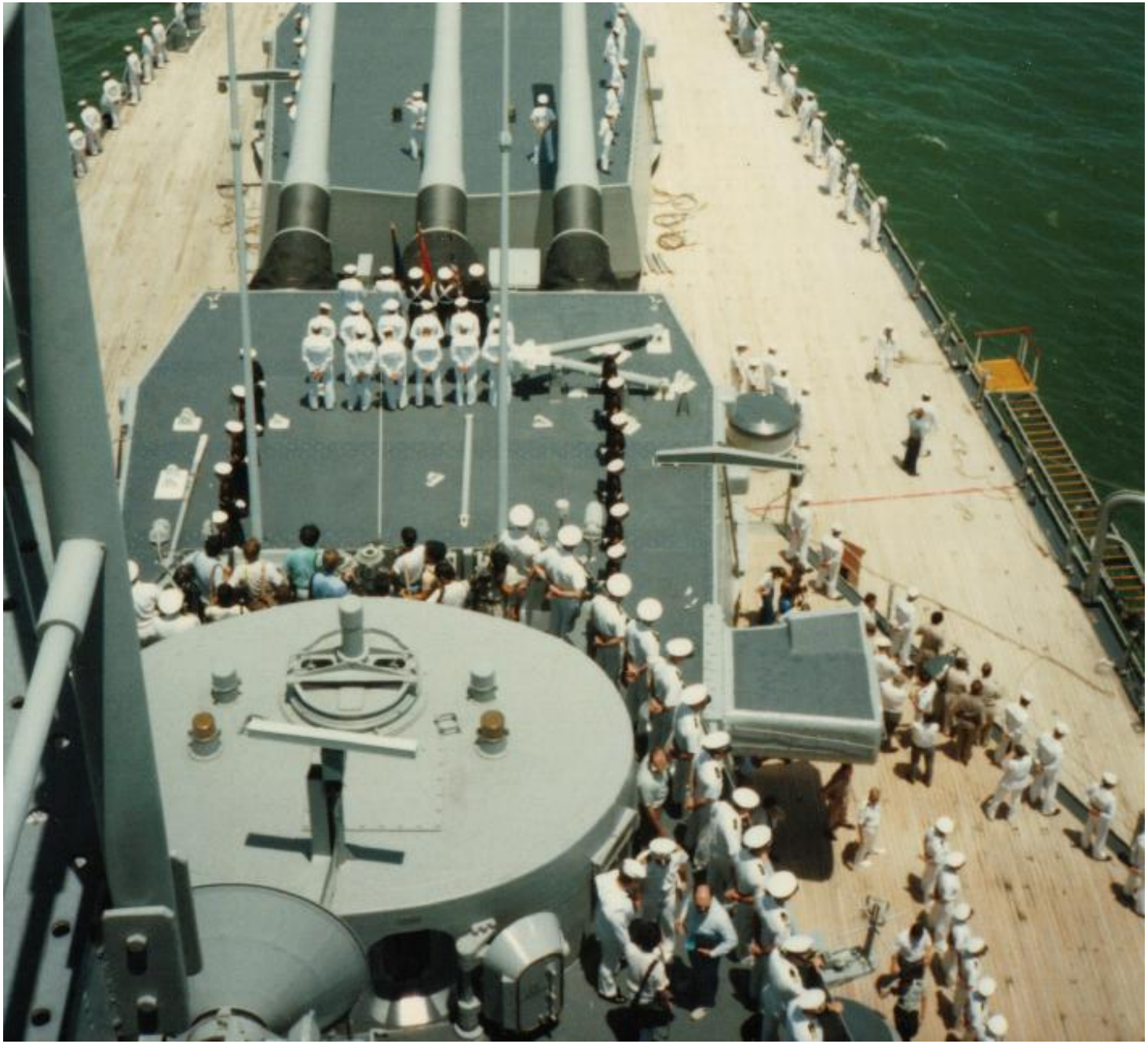
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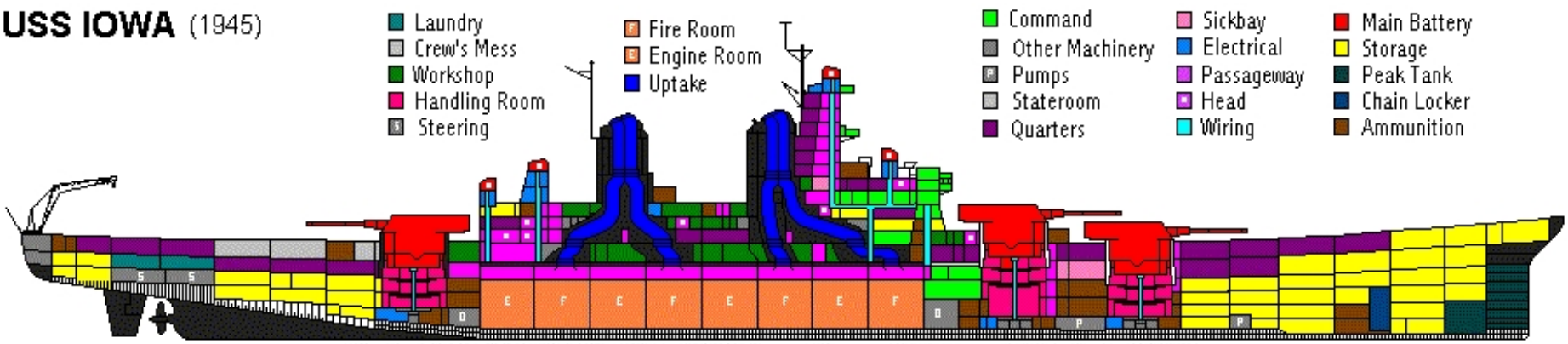


Photo # DN-ST-85-05379 USS Iowa fires a full broadside, July 1984





Photo # DN-SC-84-06362 USS New Jersey firing 16" guns, 1984




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Photo # NH 44530 USS Wisconsin at sea, 1952



Photo # NH 97207-KN USS Wisconsin firing 16-inch guns, ca. 1988-91



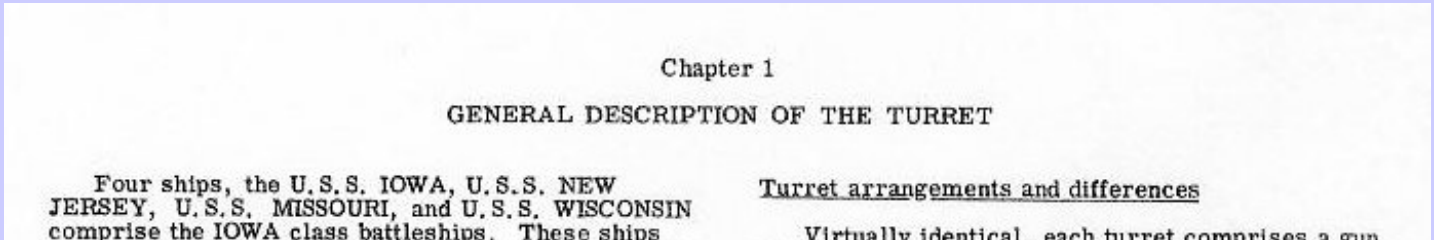
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TITLE AND FORWARD

CHAPTER 1 GENERAL DESCRIPTION OF THE TURRET



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

Turret arrangements and differences

Virtually identical, each turret comprises a gun

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	298	69.25
III	642	63.00

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.

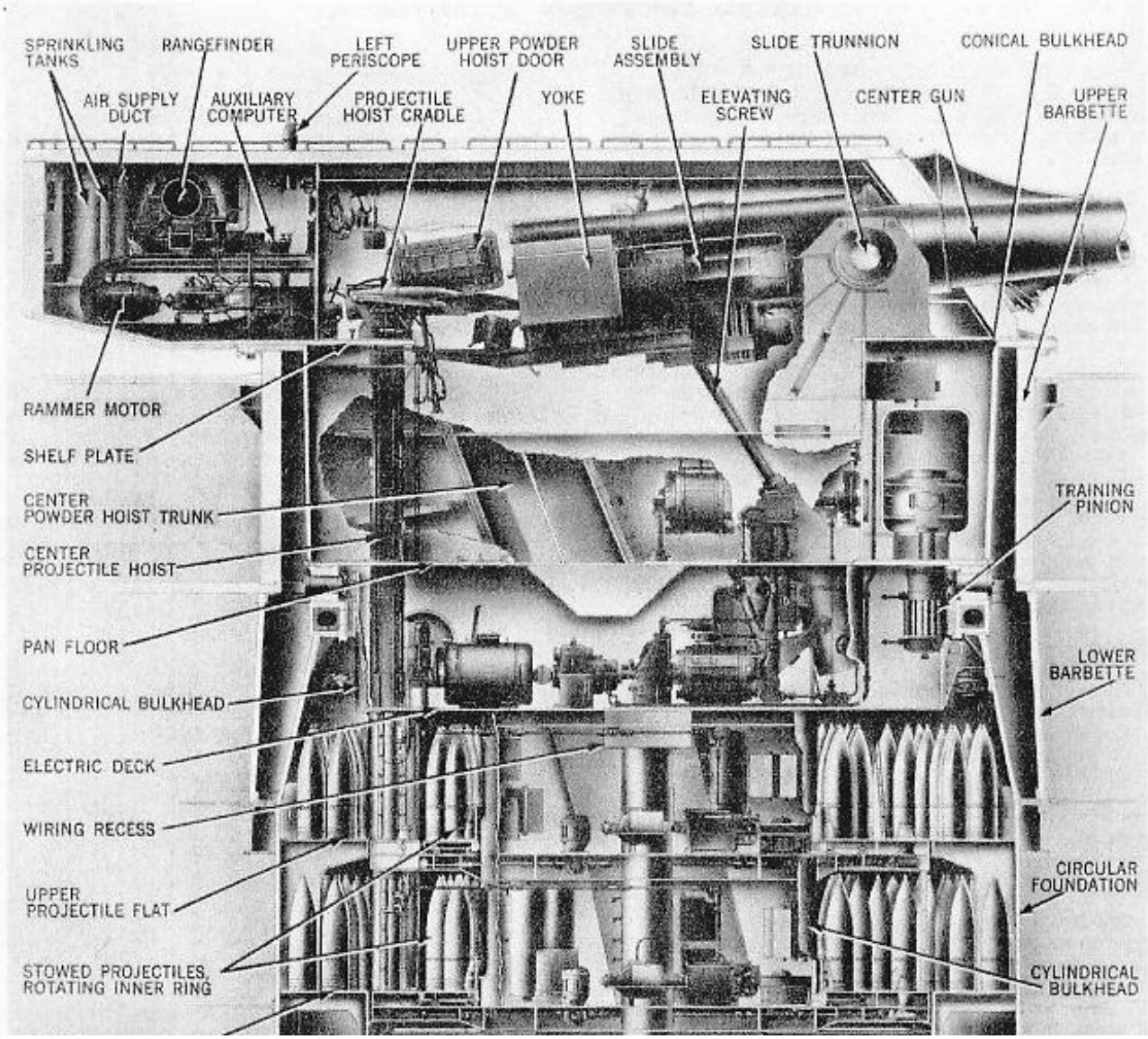
List of design components:

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)


SPRINKLING TANKS
RANGEFINDER
LEFT PERISCOPE
UPPER POWDER HOIST DOOR
SLIDE ASSEMBLY
SLIDE TRUNNION
CONICAL BULKHEAD
AIR SUPPLY DUCT
AUXILIARY COMPUTER
PROJECTILE HOIST CRADLE
YOKE
ELEVATING SCREW
CENTER GUN
UPPER BARBETTE
RAMMER MOTOR
SHELF PLATE
CENTER POWDER HOIST TRUNK
CENTER PROJECTILE HOIST
TRAINING PINION
PAN FLOOR
LOWER BARBETTE
CYLINDRICAL BULKHEAD
ELECTRIC DECK
WIRING RECESS
CIRCULAR FOUNDATION
UPPER PROJECTILE FLAT
STOWED PROJECTILES, ROTATING INNER RING
CYLINDRICAL BULKHEAD

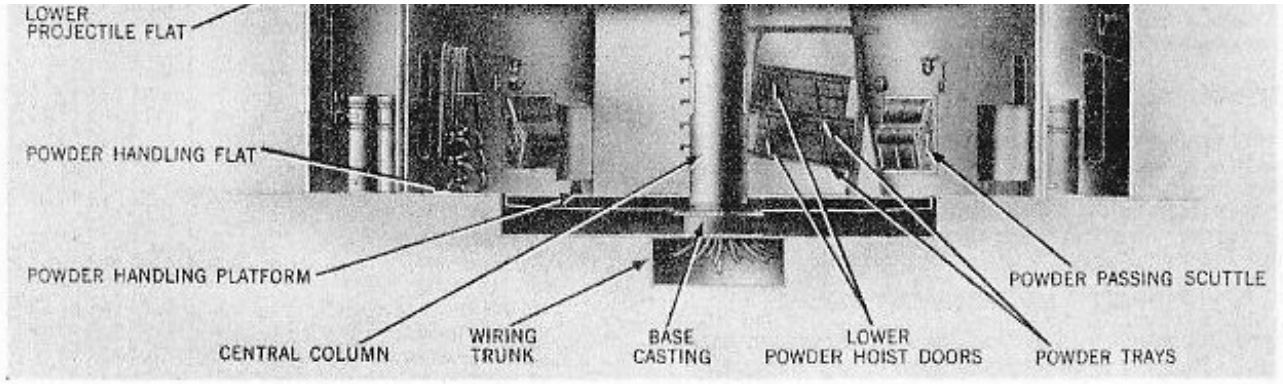


Figure 1-1. Turret General Arrangement - Longitudinal Section

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.

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 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:

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

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 I and

reveal the position of the deck legs 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

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.

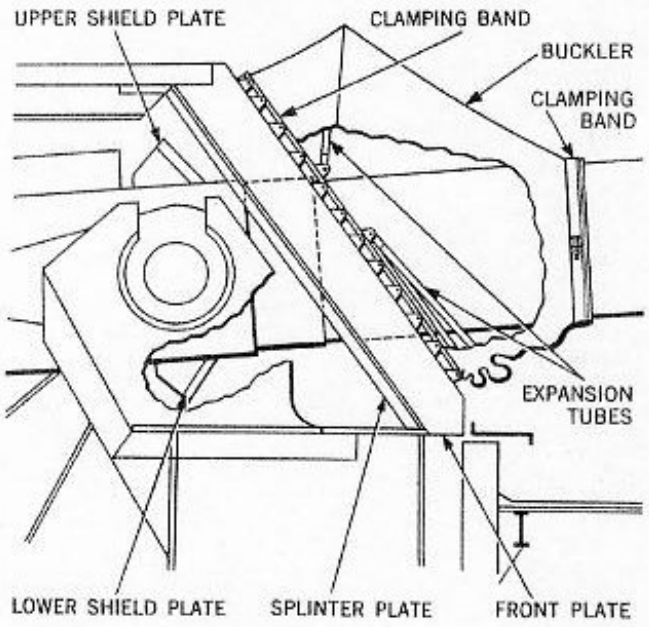


Figure 1-2. Gun Port Arrangement

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).

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

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

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.

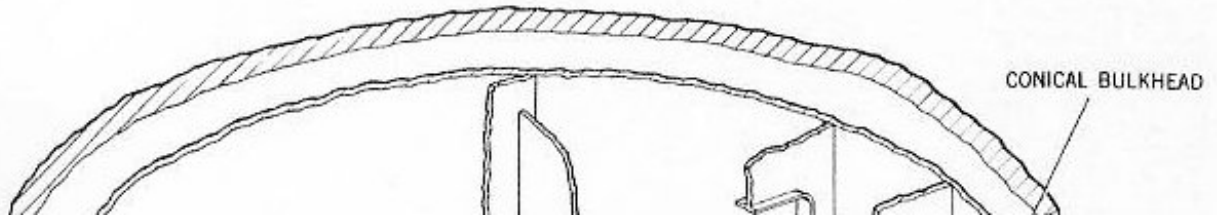
Skirt plate. A cylindrical plate extends from the bottom of the pan floor into the electric deck space. Called the circular skirt plate, it is a tight fit within the enclosing cylindrical bulkhead of the electric deck. A structural element, it provides for riveted attachment of the suspended structure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



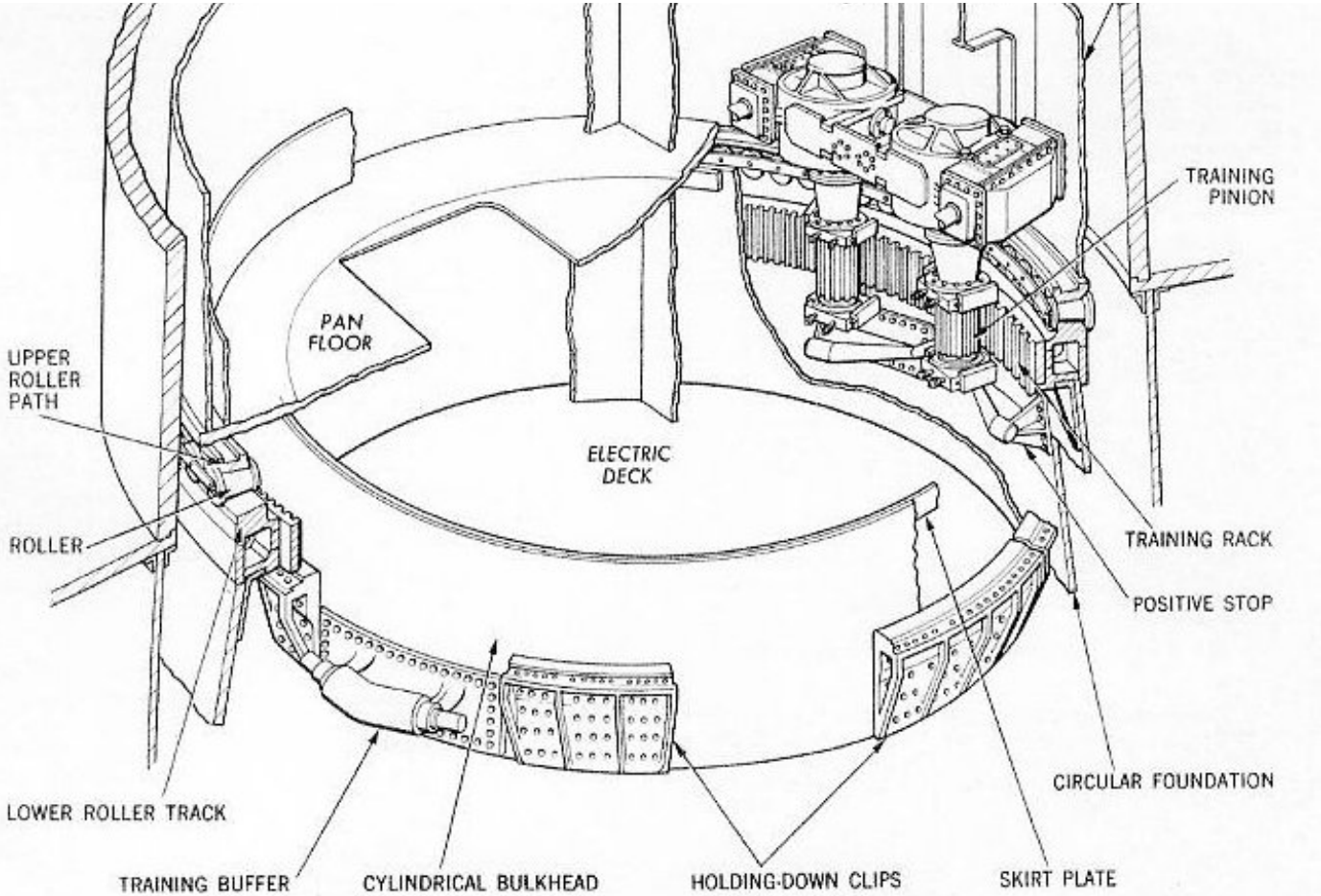


Figure 1-3. Turret Roller Carriage Arrangement

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) 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.

car 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

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.

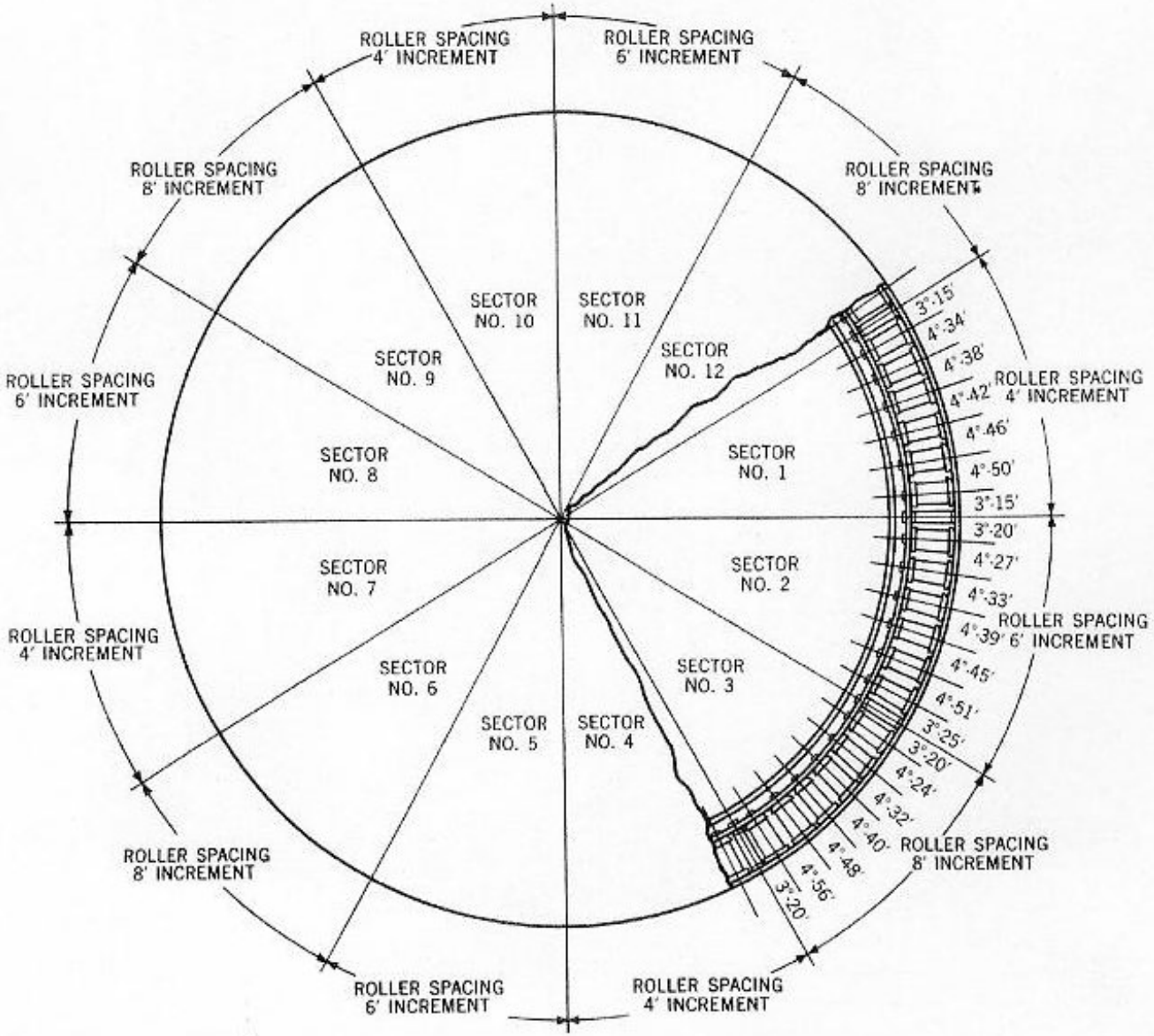
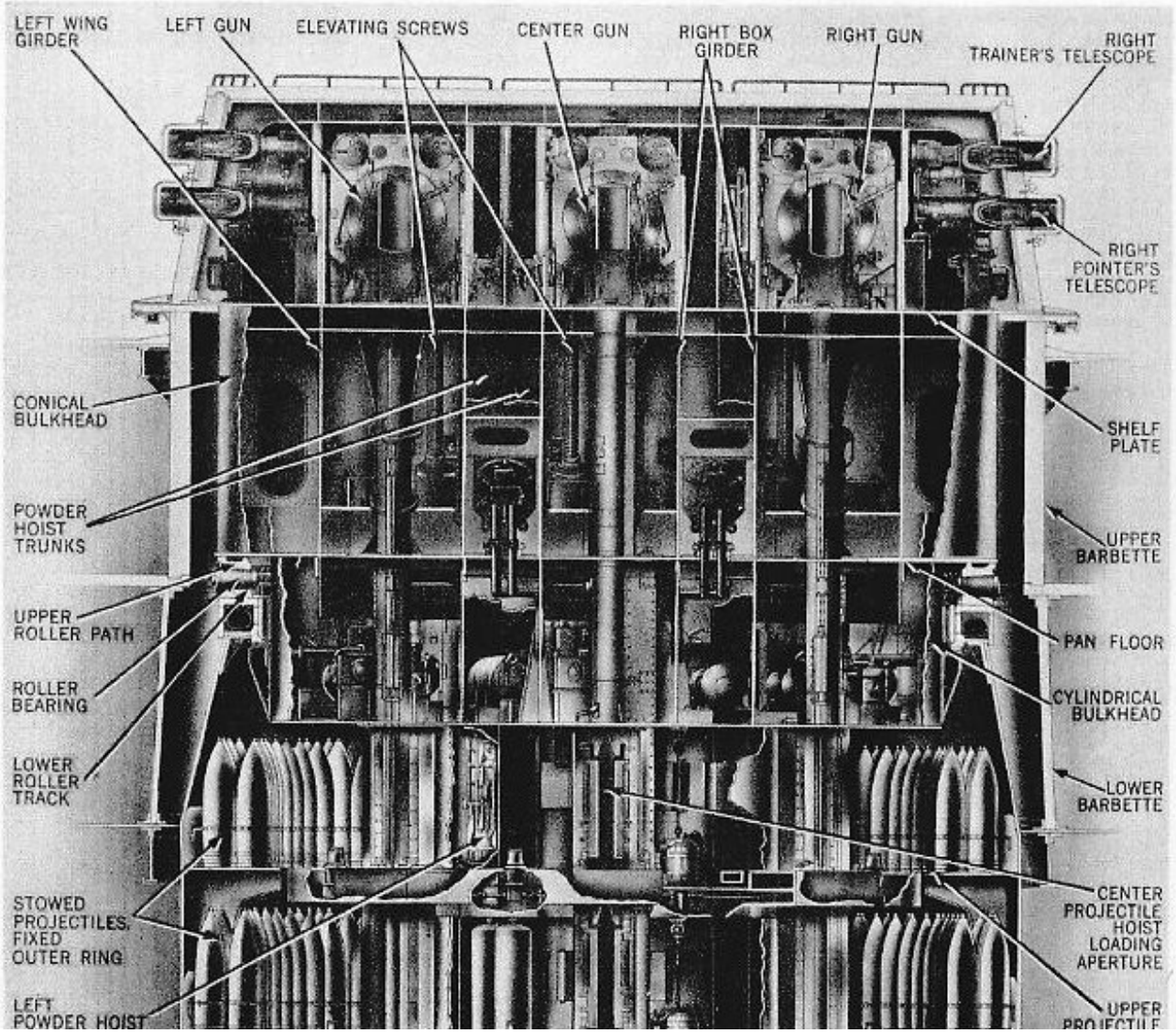


Figure 1-4. Cage Sector and Roller Spacer Details


LEFT WING GIRDER
LEFT GUN
ELEVATING SCREWS
CENTER GUN
RIGHT BOX GIRDER
RIGHT GUN
RIGHT TRAINER'S TELESCOPE
RIGHT POINTER'S TELESCOPE
CONICAL BULKHEAD
SHELF PLATE
POWDER HOIST TRUNKS
UPPER BARBETTE
UPPER ROLLER PATH
PAN FLOOR
ROLLER BEARING
CYLINDRICAL BULKHEAD
LOWER ROLLER TRACK
LOWER BARBETTE
STOWED PROJECTILES, FIXED OUTER RING
CENTER PROJECTILE HOIST LOADING APERTURE
LEFT POWDER HOIST
UPPER PROJECTILE

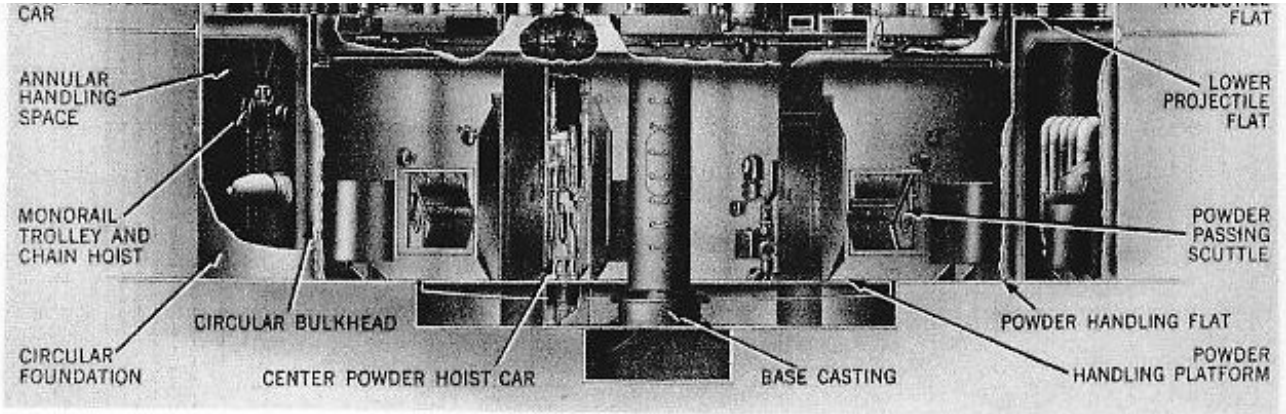


Figure 1-5. Turret General Arrangement - Transverse Section

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

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.

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.

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

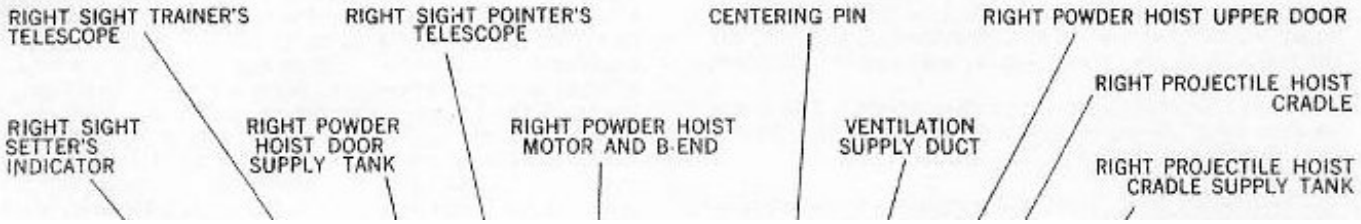
Ordnance design identities. Ordnance equipment of the above types include one or more units of the following 16-inch design identities.

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



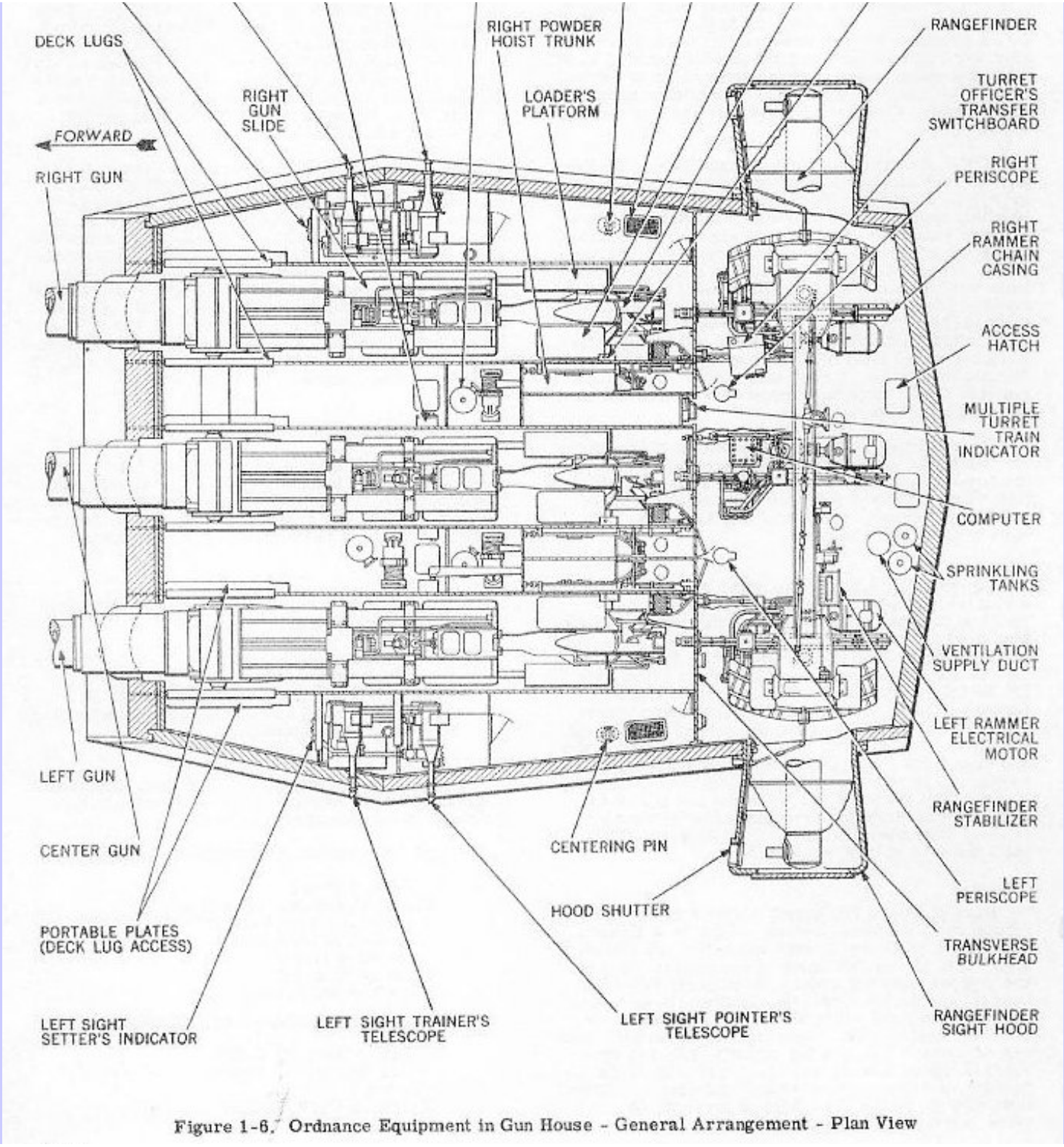


Figure 1-6. Ordnance Equipment in Gun House - General Arrangement - Plan View

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

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

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

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

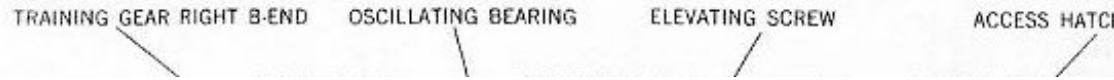
The turret ordnance designs listed on page 1-9 have the following design features and characteristics.

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.



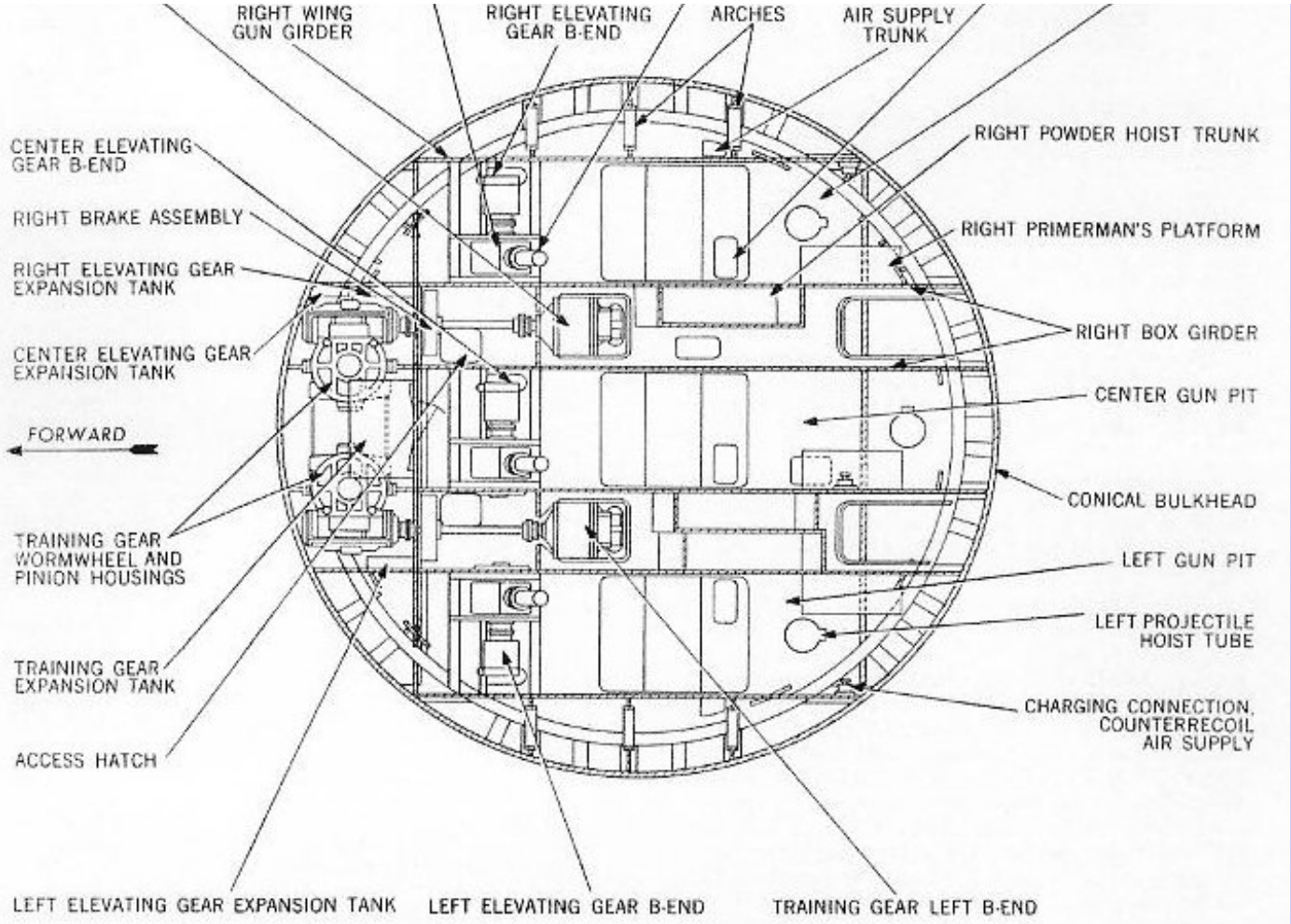


Figure 1-7. Ordnance Equipment on Pan Floor - General Arrangement - Plan View

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 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

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 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.

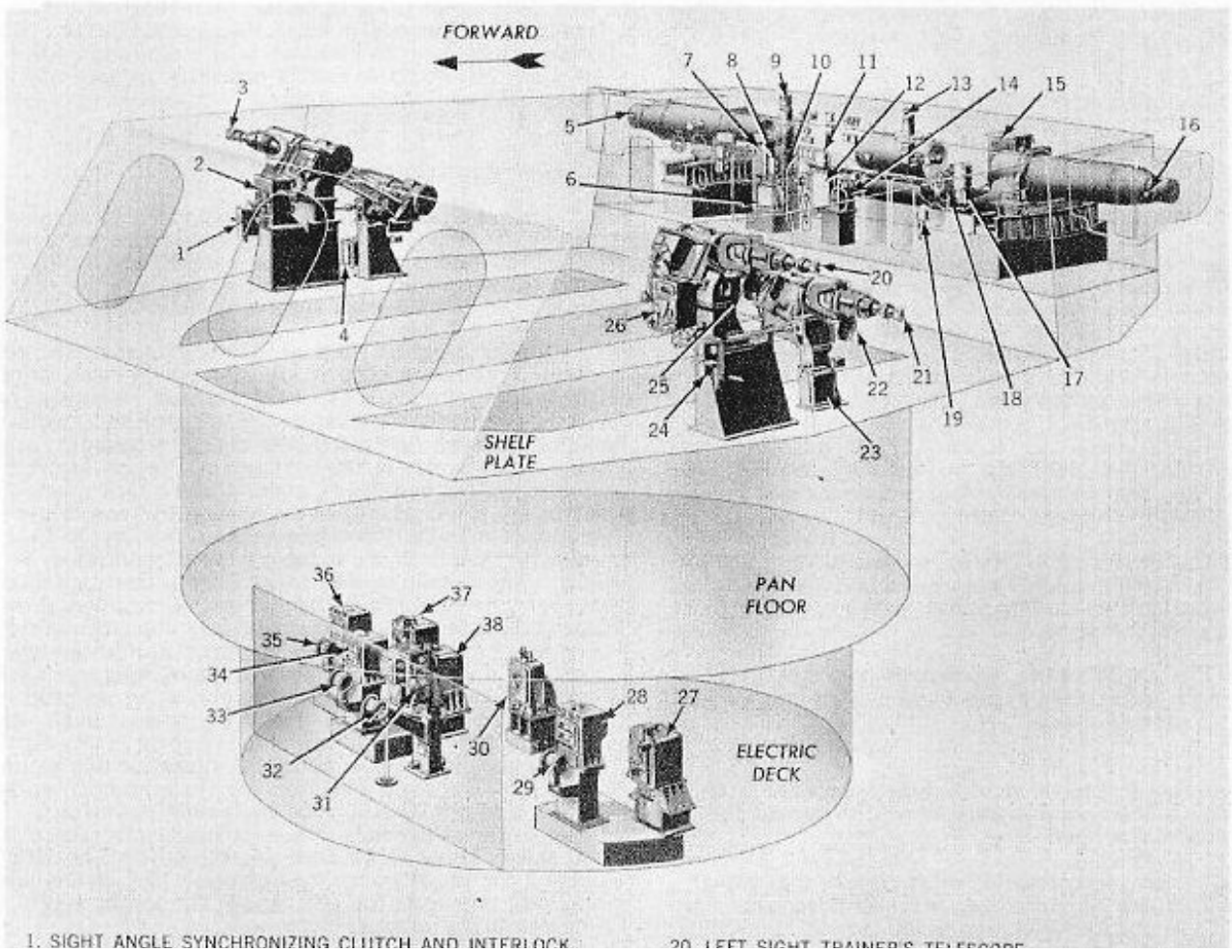
Each sight station is a pedestal and bracket mounted arrangement of a sight trainer's and sight pointer's line-of-sight optic with a sight setter's indicator. The lines of sight are mechanically connected for simultaneous offset in deflection and sight angle from the sight setter's input. All lines of 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.

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.

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 ... 20. LEFT SIGHT TRAINER'S TELESCOPE

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

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:

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

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

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

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.

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 (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

tile 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).

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

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

56. Intake and supply trunk

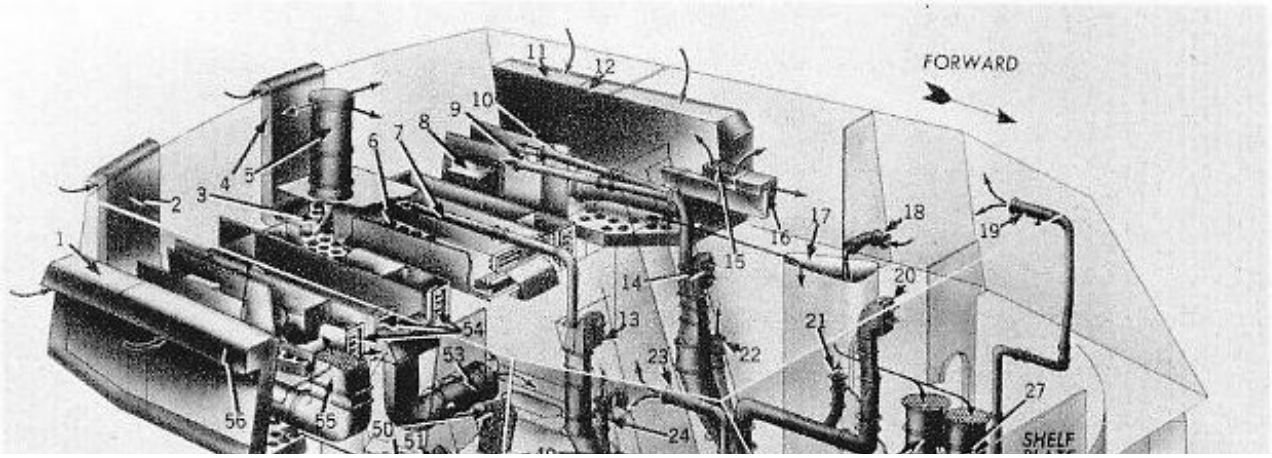
Set 2 — From turret overhang (forward of the right, rear corner) to right sight control station, right powder hoist, powder hoist and training gear power drive spaces, and right side of electric deck and upper and lower projectile flats

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

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



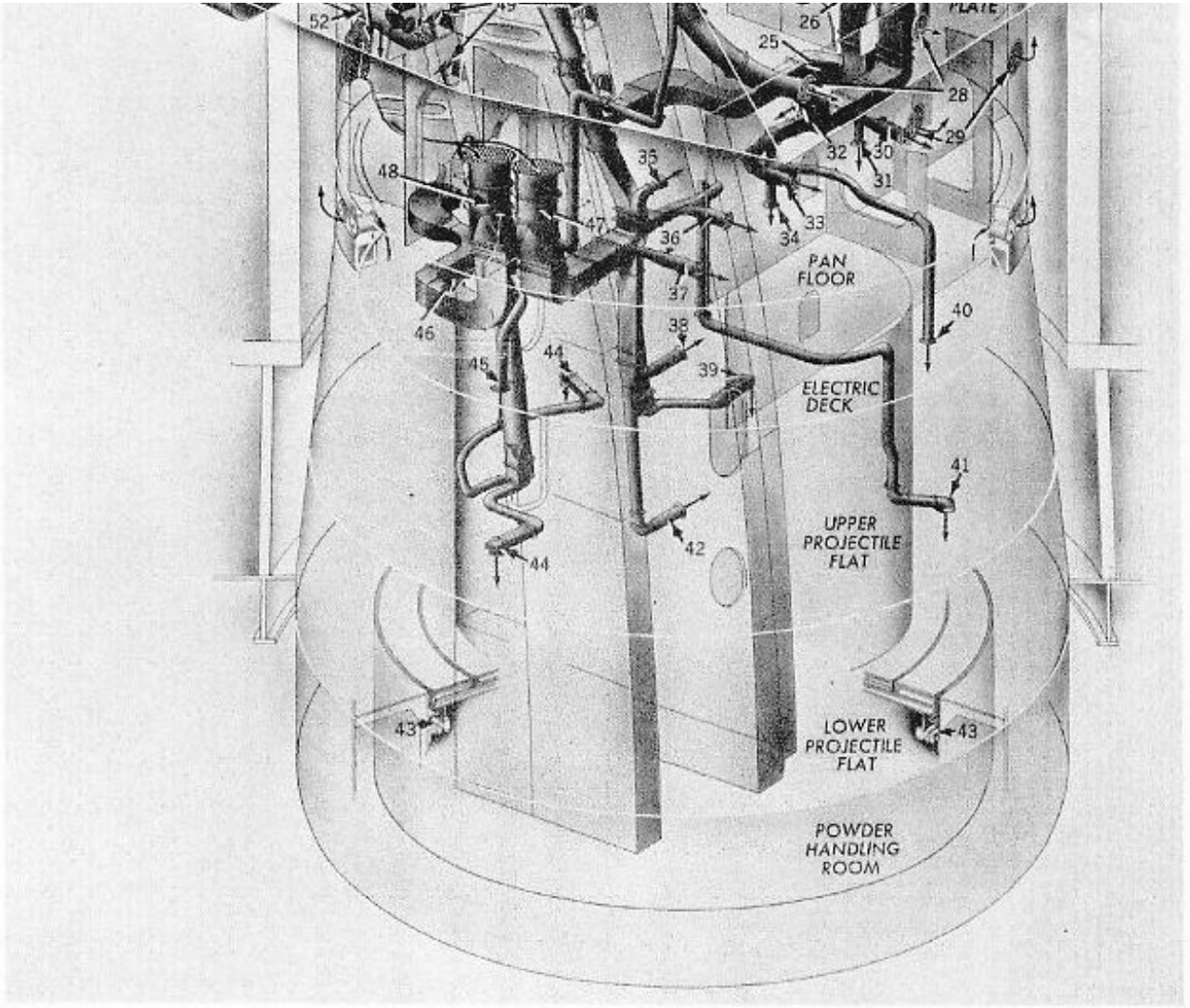
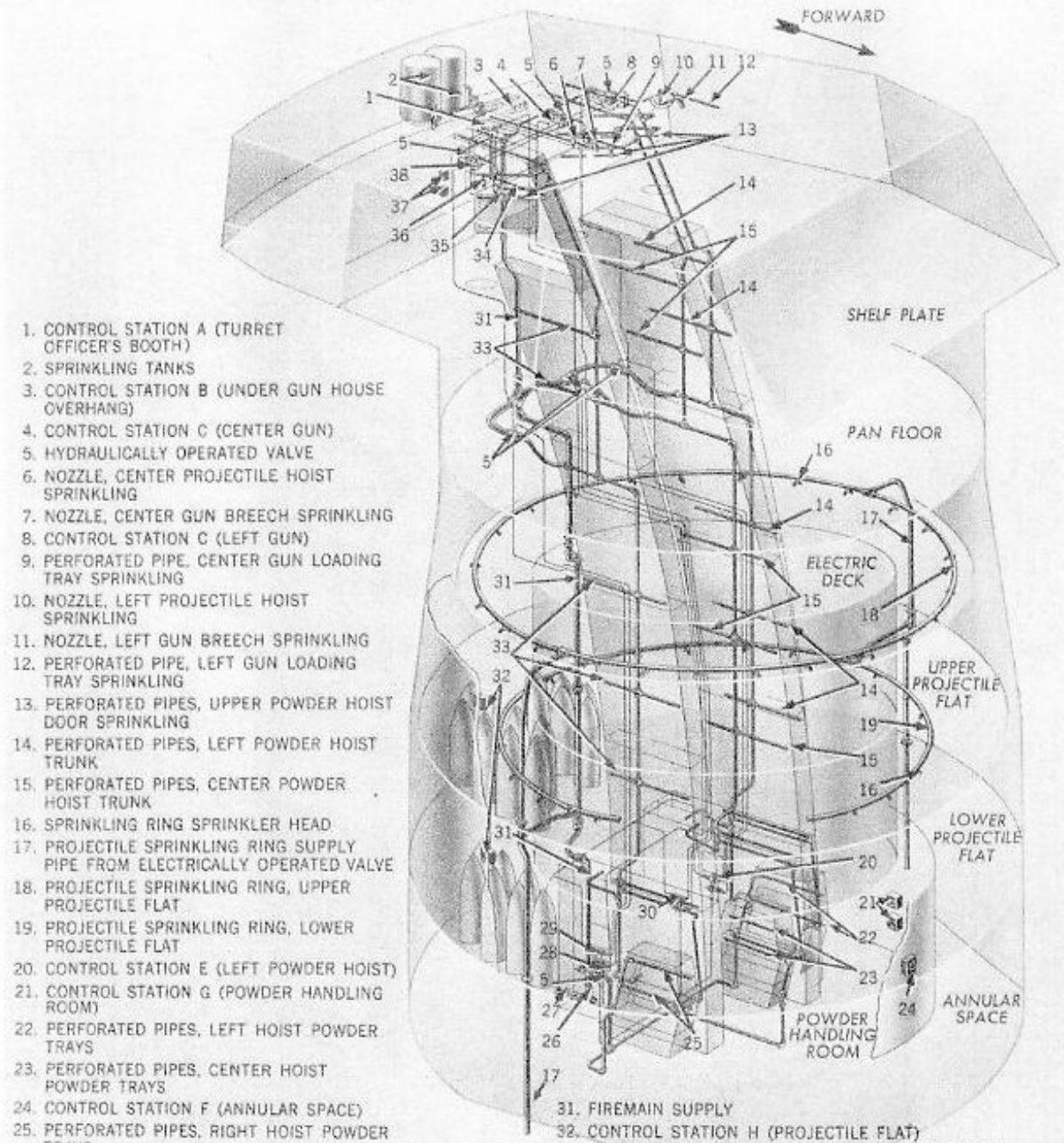


Figure 1-12. Turret Ventilating Systems - General Arrangement


FORWARD
SHELF PLATE
PAN FLOOR
ELECTRIC DECK
UPPER PROJECTILE FLAT
LOWER PROJECTILE FLAT
POWDER HANDLING ROOM
ANNULAR SPACE
1. CONTROL STATION A (TURRET OFFICER'S BOOTH)
2. SPRINKLING TANKS
3. CONTROL STATION B (UNDER GUN HOUSE OVERHANG)
4. CONTROL STATION C (CENTER GUN)
5. HYDRAULICALLY OPERATED VALVE
6. NOZZLE, CENTER PROJECTILE HOIST SPRINKLING
7. NOZZLE, CENTER GUN BREECH SPRINKLING
8. CONTROL STATION C (LEFT GUN)
9. PERFORATED PIPE, CENTER GUN LOADING TRAY SPRINKLING
10. NOZZLE, LEFT PROJECTILE HOIST SPRINKLING
11. NOZZLE, LEFT GUN BREECH SPRINKLING
12. PERFORATED PIPE, LEFT GUN LOADING TRAY SPRINKLING
13. PERFORATED PIPES, UPPER POWDER HOIST DOOR SPRINKLING
14. PERFORATED PIPES, LEFT POWDER HOIST TRUNK
15. PERFORATED PIPES, CENTER POWDER HOIST TRUNK
16. SPRINKLING RING SPRINKLER HEAD
17. PROJECTILE SPRINKLING RING SUPPLY PIPE FROM ELECTRICALLY OPERATED VALVE
18. PROJECTILE SPRINKLING RING, UPPER PROJECTILE FLAT
19. PROJECTILE SPRINKLING RING, LOWER PROJECTILE FLAT
20. CONTROL STATION E (LEFT POWDER HOIST)
21. CONTROL STATION G (POWDER HANDLING ROOM)
22. PERFORATED PIPES, LEFT HOIST POWDER TRAYS
23. PERFORATED PIPES, CENTER HOIST POWDER TRAYS
24. CONTROL STATION F (ANNULAR SPACE)
25. PERFORATED PIPES, RIGHT HOIST POWDER TRAYS
26. GLOBE VALVE, FIREMAIN SUPPLY
27. HOSE CONNECTION, FIREMAIN SUPPLY
31. FIREMAIN SUPPLY
32. CONTROL STATION H (PROJECTILE FLAT)
33. PERFORATED PIPES, RIGHT POWDER HOIST TRUNK
34. PERFORATED PIPE, RIGHT GUN LOADING TRAY SPRINKLING
35. NOZZLE, RIGHT GUN BREECH SPRINKLING

28. CONTROL STATION D (POWDER HANDLING ROOM)
29. CONTROL STATION E (RIGHT POWDER HOIST)
30. CONTROL STATION E (CENTER POWDER HOIST)
36. NOZZLE, RIGHT PROJECTILE HOIST SPRINKLING
37. CONTROL STATION I (TURRET OFFICER'S BOOTH)
38. CONTROL STATION C (RIGHT GUN)

Figure 1-13. Turret Sprinkling System - General Arrangement

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.

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.

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

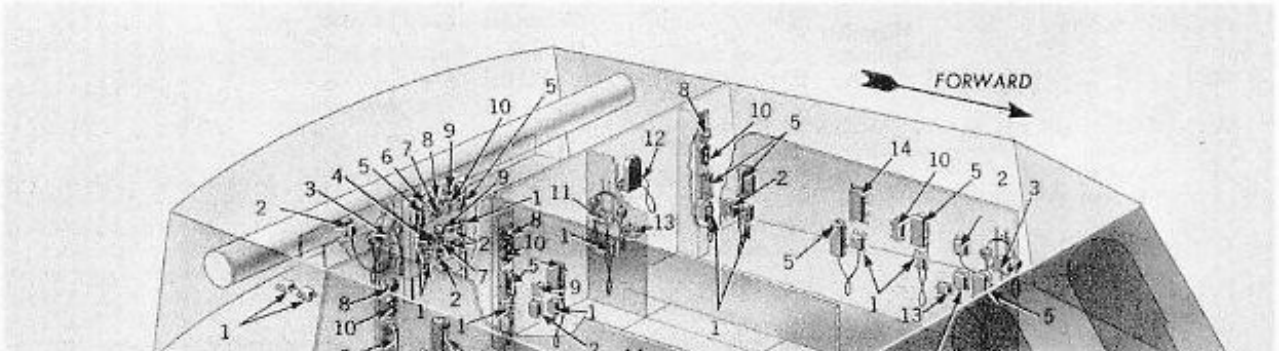
The primary circuits which provide various types of communications within each turret, between turrets, and between the turrets and other ship stations are listed below. A brief description of each circuit follows the listing. Circuit extent and arrangements are shown in figures 1-14 and 1-15.

SYSTEM	CIRCUIT IDENTITY
Depression and train stop signal	DS
Intra-turret emergency alarm	RA
Train warning signal	TW

Turret announcing 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.



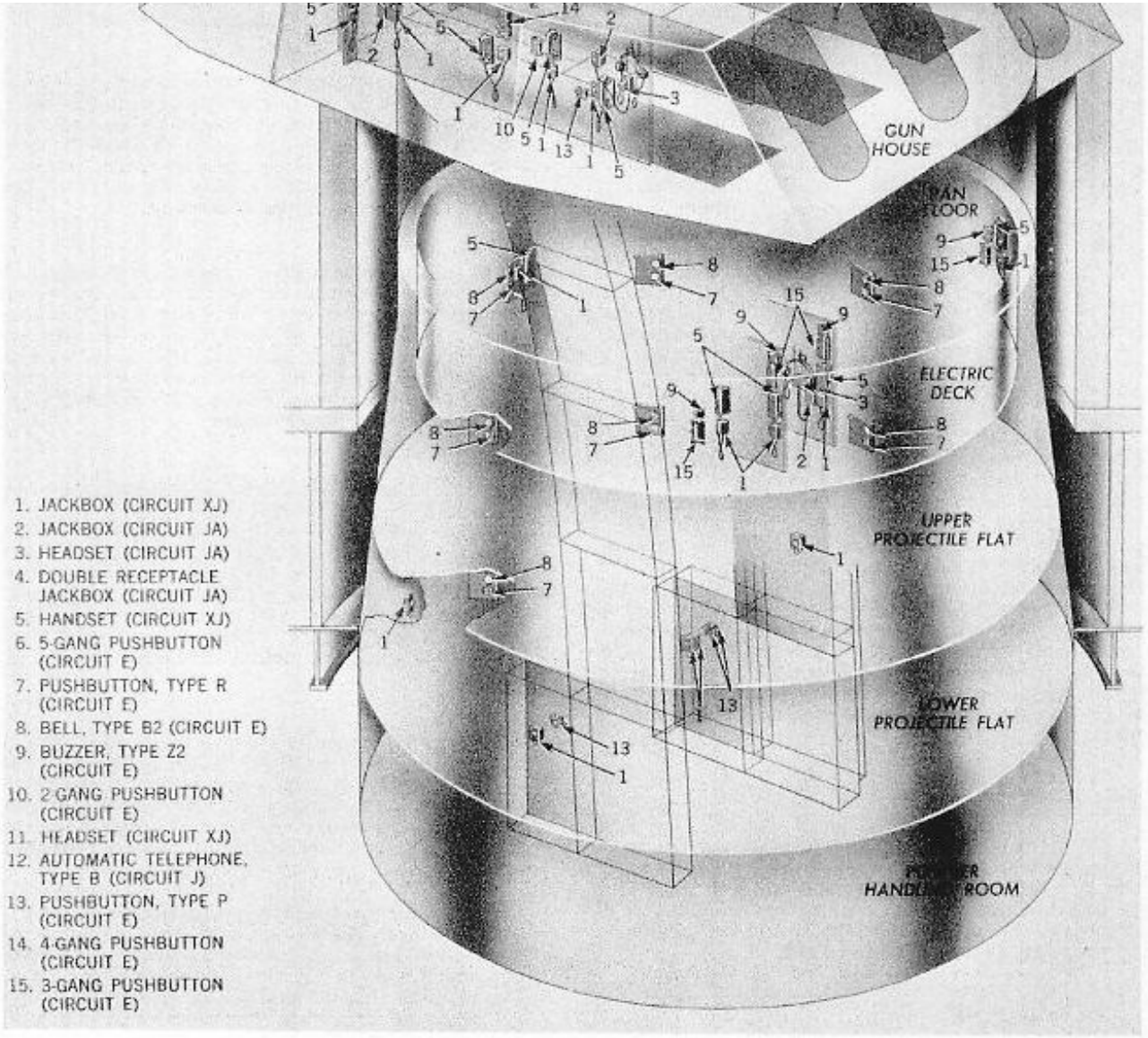
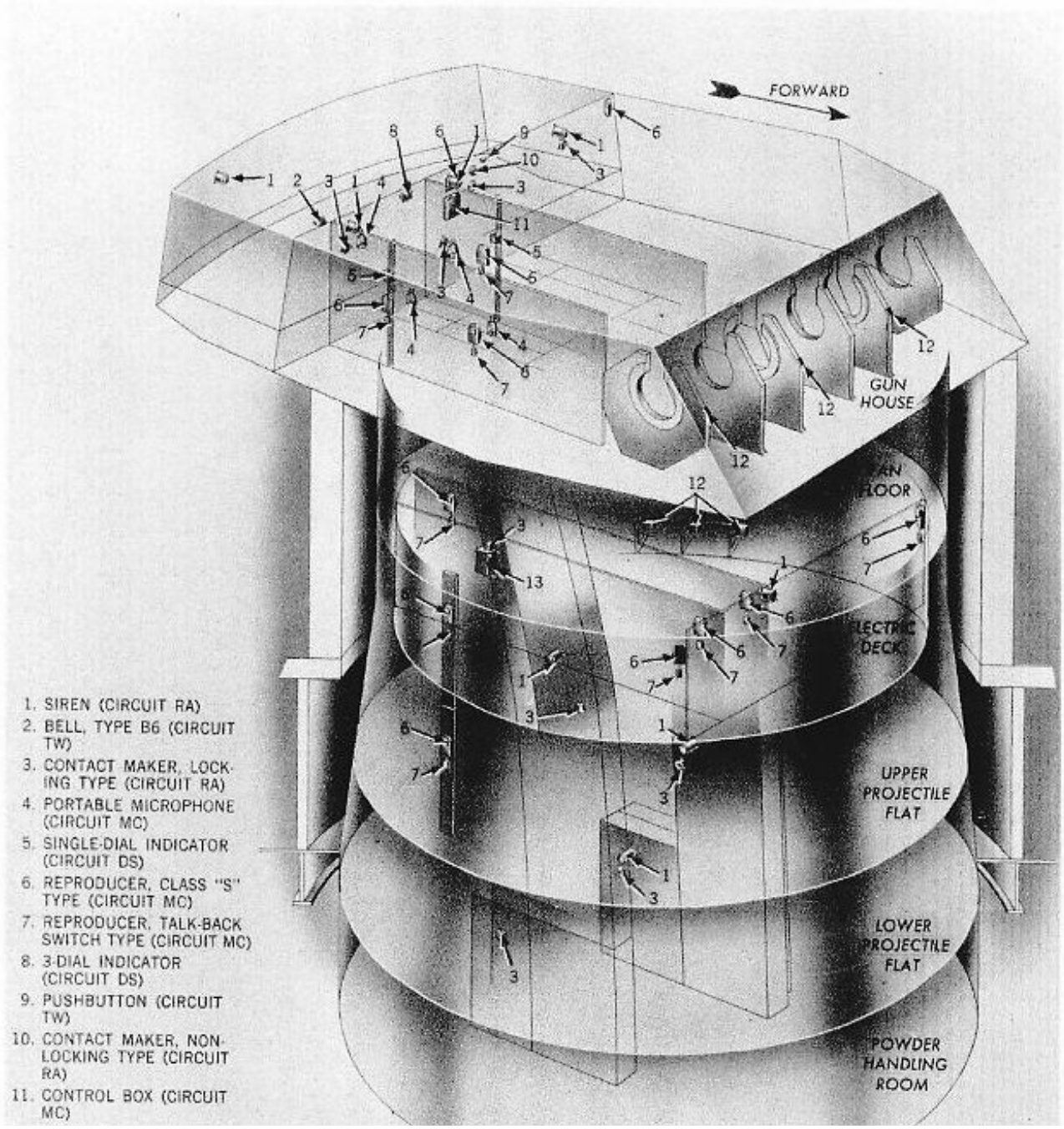
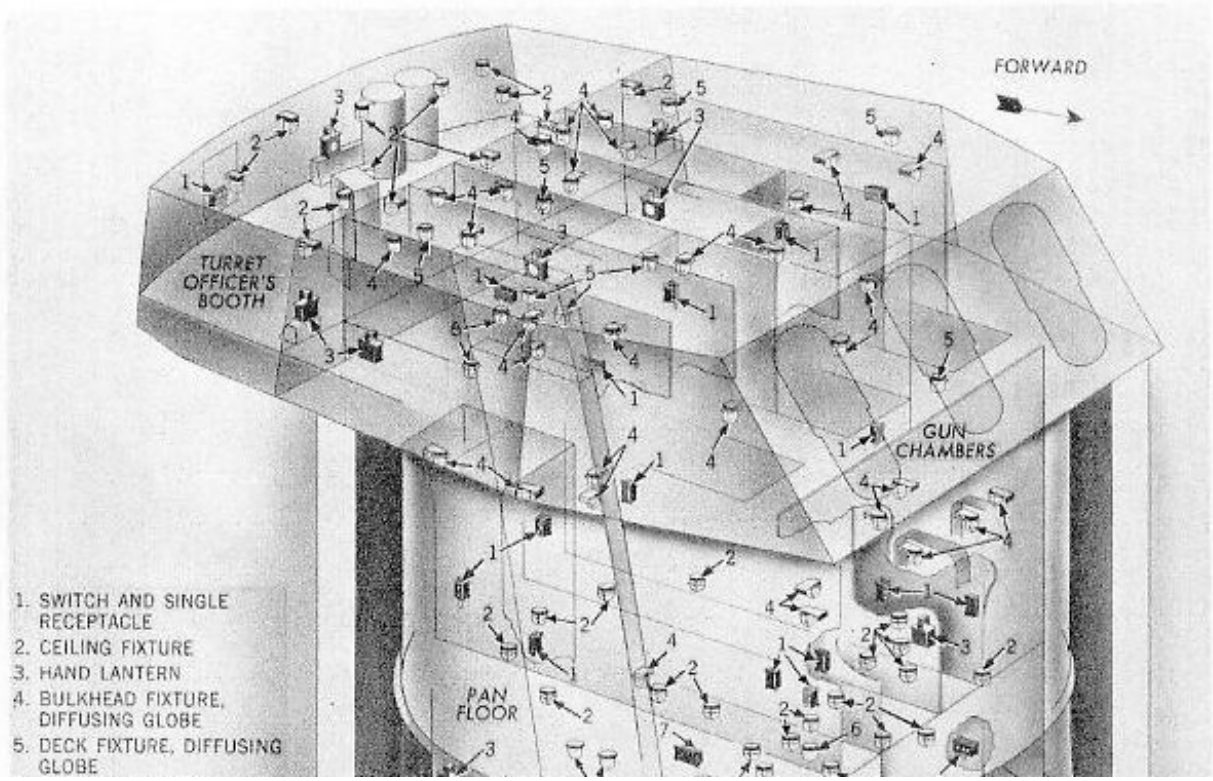


Figure 1-14. Turret General Communications System - General Arrangement


FORWARD
GUN HOUSE
UPPER PROJECTILE FLAT
LOWER PROJECTILE FLAT
POWDER HANDLING ROOM
1. SIREN (CIRCUIT RA)
2. BELL, TYPE B6 (CIRCUIT TW)
3. CONTACT MAKER, LOCKING TYPE (CIRCUIT RA)
4. PORTABLE MICROPHONE (CIRCUIT MC)
5. SINGLE-DIAL INDICATOR (CIRCUIT DS)
6. REPRODUCER, CLASS "S" TYPE (CIRCUIT MC)
7. REPRODUCER, TALK-BACK SWITCH TYPE (CIRCUIT MC)
8. 3-DIAL INDICATOR (CIRCUIT DS)
9. PUSHBUTTON (CIRCUIT TW)
10. CONTACT MAKER, NON-LOCKING TYPE (CIRCUIT RA)
11. CONTROL BOX (CIRCUIT MC)

12. DANGER ZONE CUTOUT SWITCH (CIRCUIT DS)
13. AMPLIFIER (CIRCUIT MC)

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



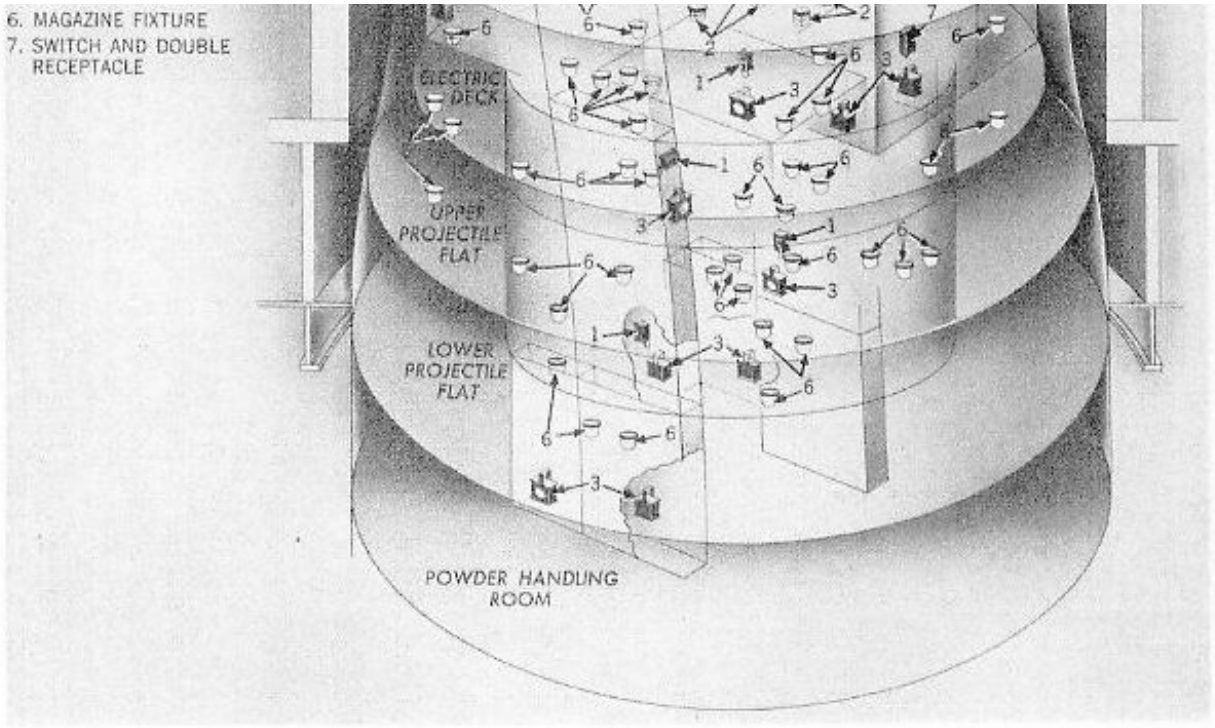


Figure 1-16. Turret Illumination - General Arrangement

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

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 walls

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.

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.

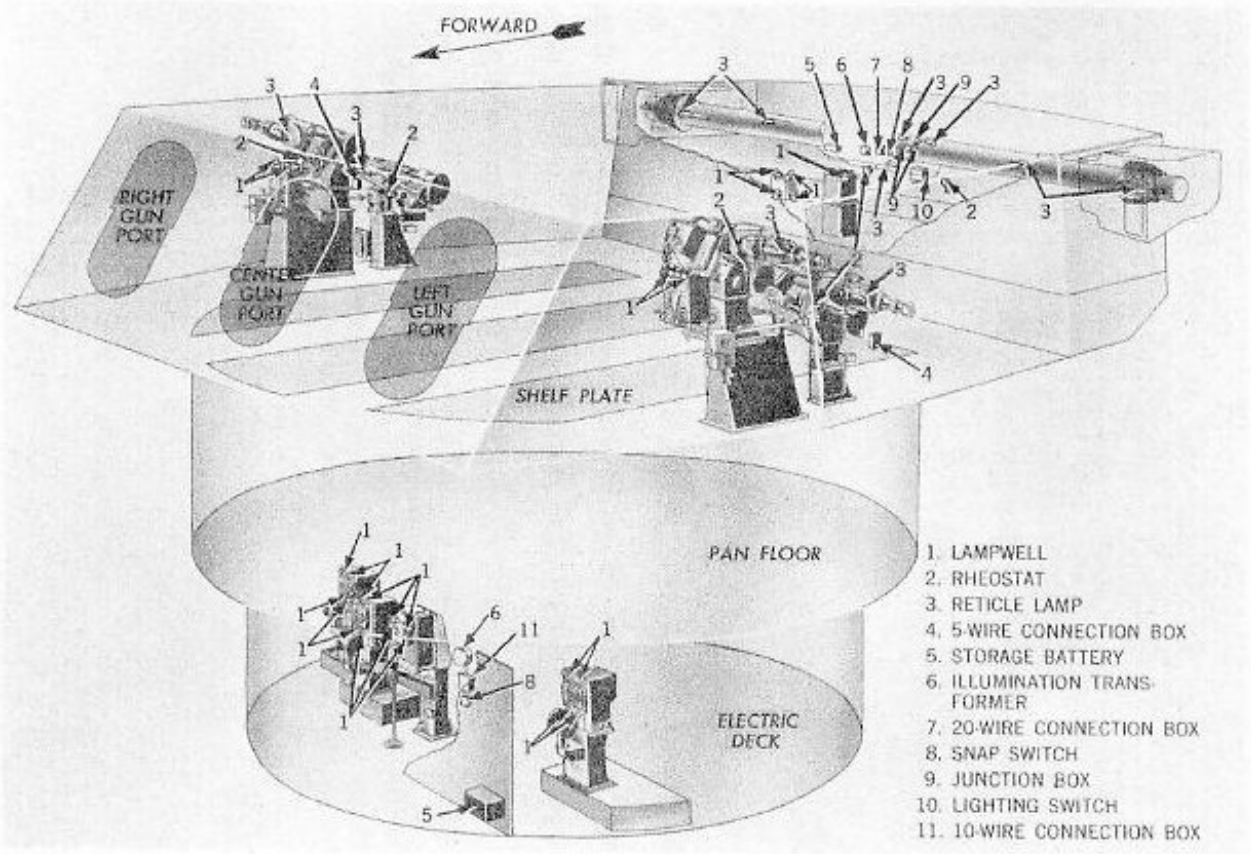
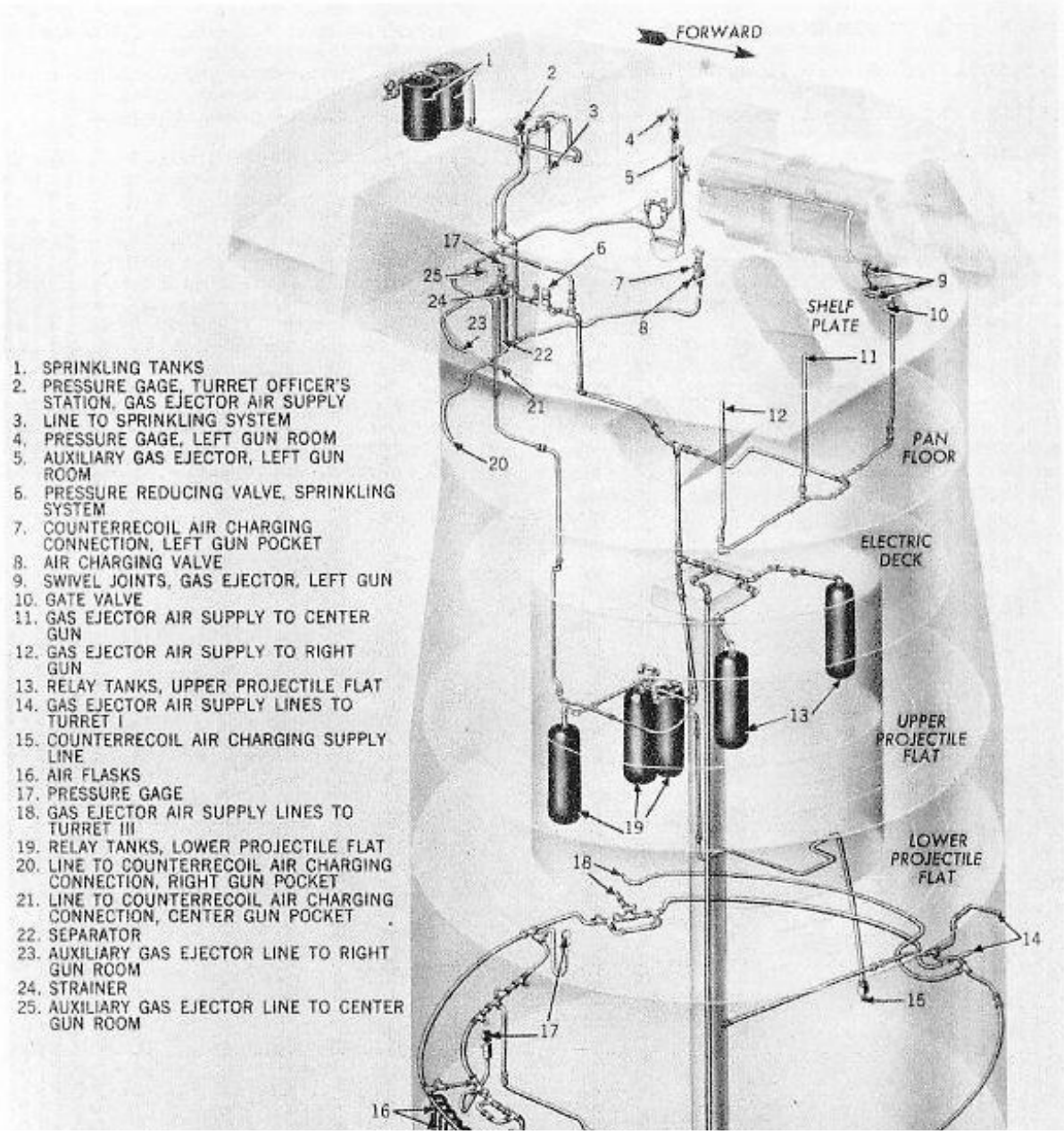


Figure 1-17. Turret Instrument Illumination - General Arrangement



1. SPRINKLING TANKS
2. PRESSURE GAGE, TURRET OFFICER'S STATION, GAS EJECTOR AIR SUPPLY
3. LINE TO SPRINKLING SYSTEM
4. PRESSURE GAGE, LEFT GUN ROOM
5. AUXILIARY GAS EJECTOR, LEFT GUN ROOM
6. PRESSURE REDUCING VALVE, SPRINKLING SYSTEM
7. COUNTERRECOIL AIR CHARGING CONNECTION, LEFT GUN POCKET
8. AIR CHARGING VALVE
9. SWIVEL JOINTS, GAS EJECTOR, LEFT GUN
10. GATE VALVE
11. GAS EJECTOR AIR SUPPLY TO CENTER GUN
12. GAS EJECTOR AIR SUPPLY TO RIGHT GUN
13. RELAY TANKS, UPPER PROJECTILE FLAT
14. GAS EJECTOR AIR SUPPLY LINES TO TURRET I
15. COUNTERRECOIL AIR CHARGING SUPPLY LINE
16. AIR FLASKS
17. PRESSURE GAGE
18. GAS EJECTOR AIR SUPPLY LINES TO TURRET III
19. RELAY TANKS, LOWER PROJECTILE FLAT
20. LINE TO COUNTERRECOIL AIR CHARGING CONNECTION, RIGHT GUN POCKET
21. LINE TO COUNTERRECOIL AIR CHARGING CONNECTION, CENTER GUN POCKET
22. SEPARATOR
23. AUXILIARY GAS EJECTOR LINE TO RIGHT GUN ROOM
24. STRAINER
25. AUXILIARY GAS EJECTOR LINE TO CENTER GUN ROOM

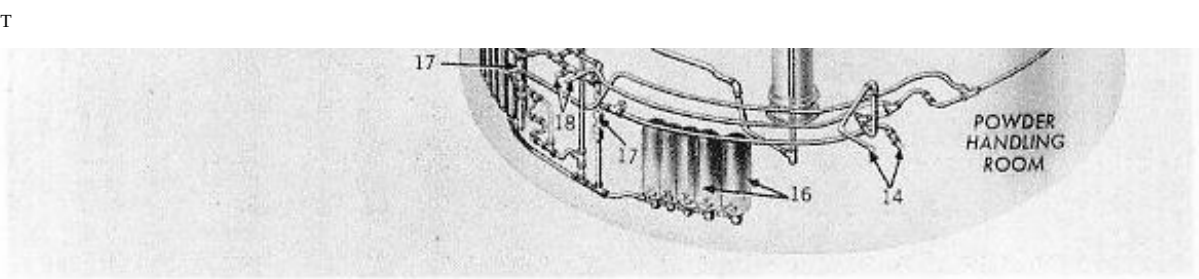


Figure 1-18. Gas Ejector and Counterrecoil Air Supply Pipe System. Turret II - General Arrangement

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.

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CHAPTER 2 TURRET OPERATION

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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.

Secondary control is turret control by a 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, range-finder, 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).

In secondary control, a turret acts as a controlling director, in combination with main battery

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.

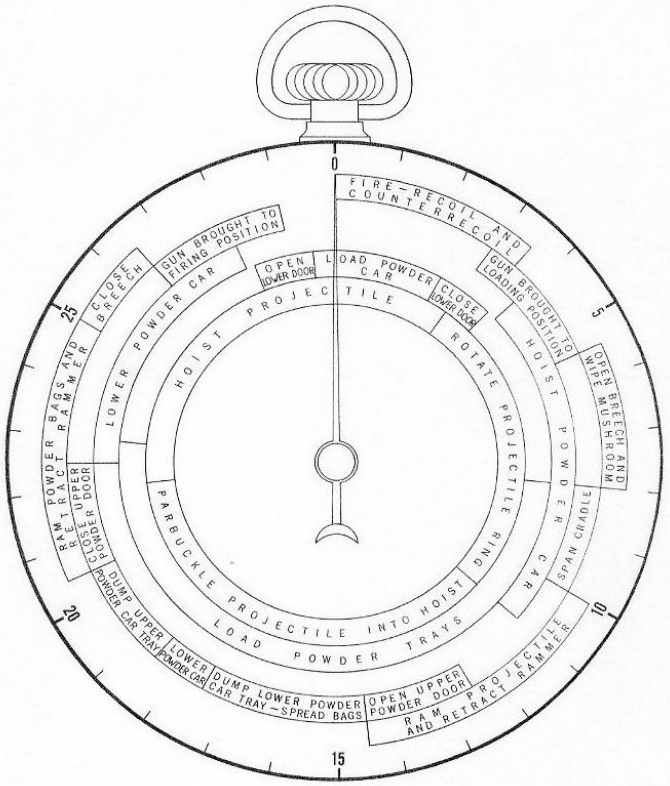


Figure 2-1. Firing Cycle Operations

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 (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

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.

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

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 officers except that it has no switches; an emergency alarm contact maker which, when held open, stills the alarm sirens; a train warning pushbution 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 push-button-controlled transmitter.

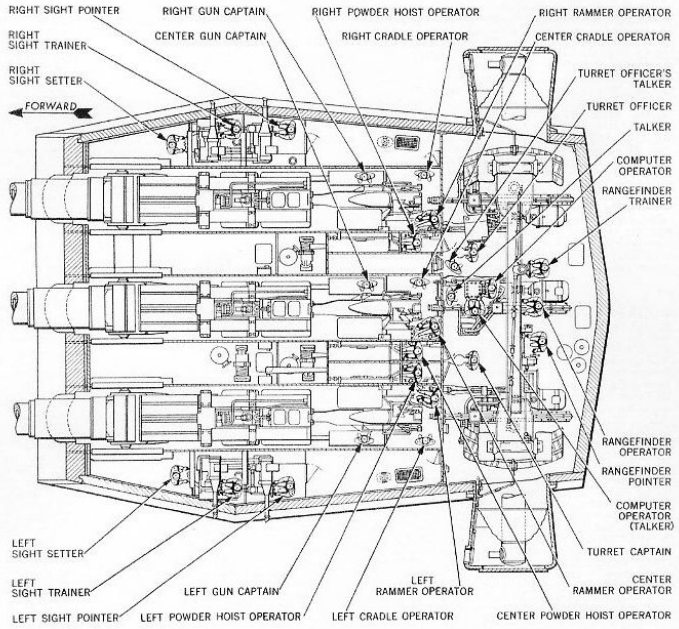


Figure 2-3. Turret Personnel Arrangement. Gun House Stations

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)

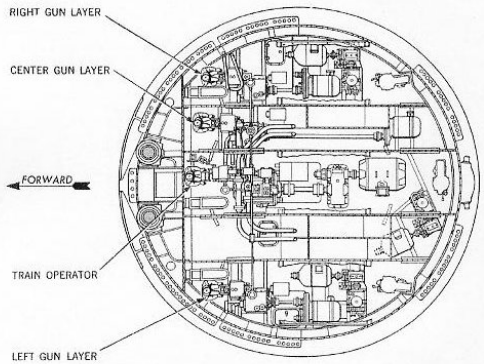
Duties. The sight trainers (fig. 2-3) are at stand-by duty in primary and secondary control. One of them assumes control of turret train (in local control) when directed by the turret officer. They maintain communications with each other, with the sight pointers, and with the turret officer (through 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).



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.

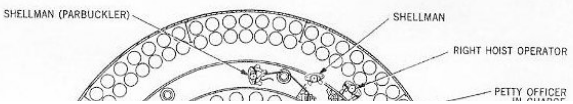
Equipment used. The sight setters use: the sight setters' indicators; telephone headsets with breastplate-supported and pushbutton-controlled transmitters; and synchronizing clutches (which provide for correct engagement of the sight angle cross-shaft system) and clutch indicators (which indicate the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



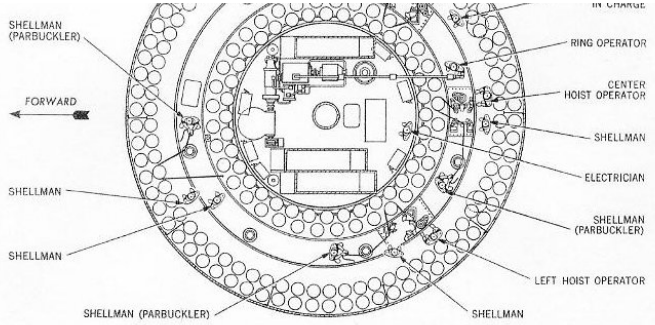


Figure 2-5. Turret Personnel Arrangement. Projectile Flat Station.

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.

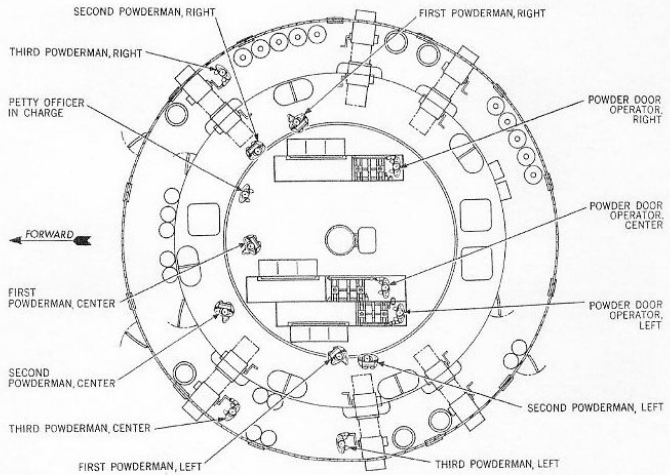


Figure 2-6. Turret Personnel Arrangement. Powder Handling Room Stations

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.

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.

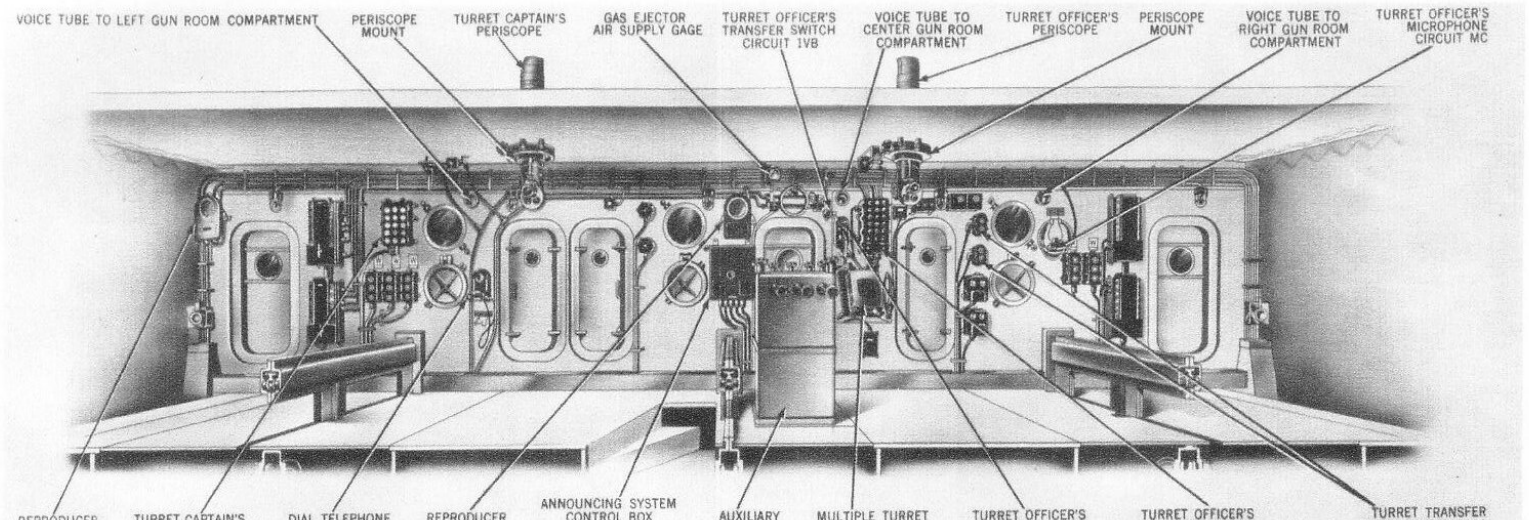
When the elevating gear is operated in HAND control, the gun layer observes the gun order signal indicated by the pointers (dials) in the elevation indicator and compares that signal with the indicated position of the gun. If there is a "matching error" in the pointers, he operates his handwheels in 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



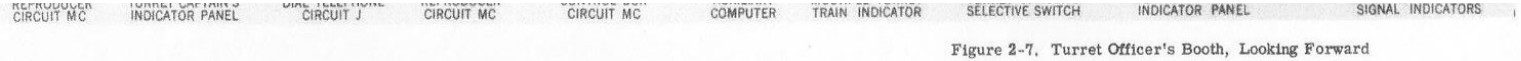


Figure 2-7. Turret Officer's Booth, Looking Forward

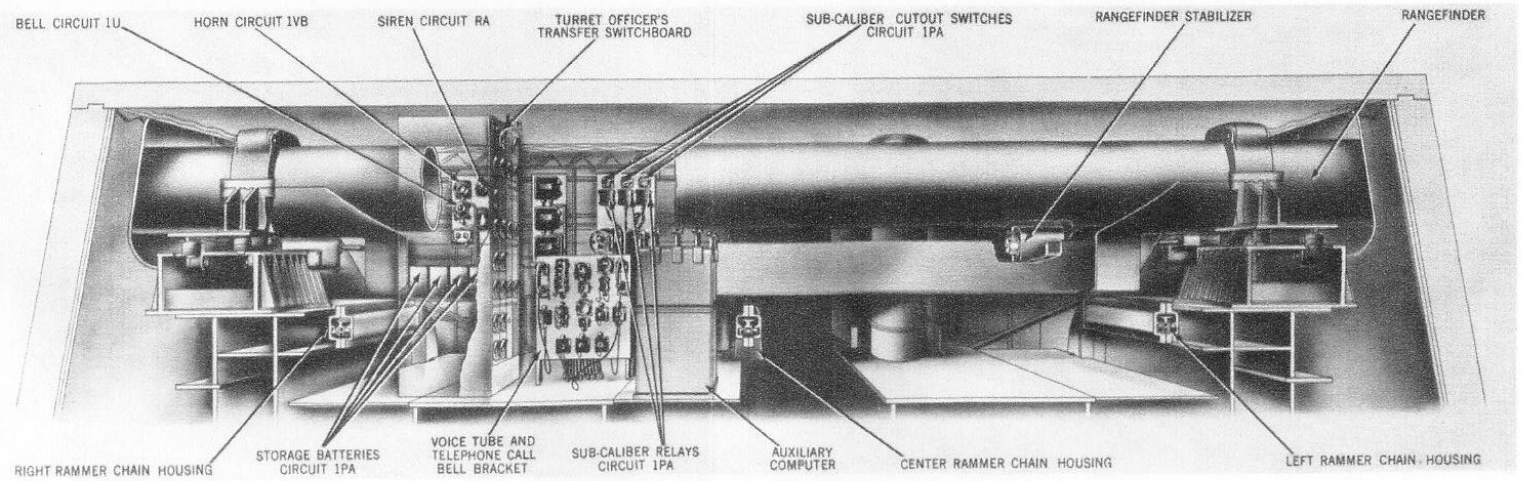


Figure 2-8. Turret Officer's Booth, Looking Aft

2-8A/B

(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)

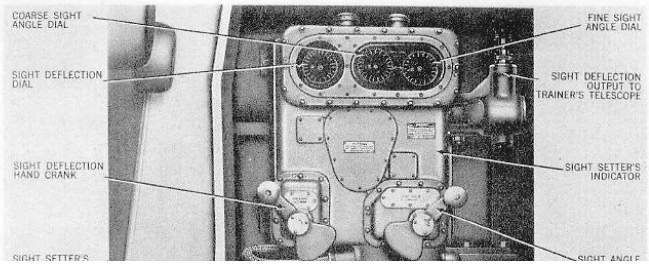
Duties. Each projectile hoist may be filled and used to hoist projectiles from either the uppor or lower projectile flat. The hoist control stations and the hoist operator's duties are identical for each hoist on each level. The hoist operator is responsible for the operation of the projectile hoist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



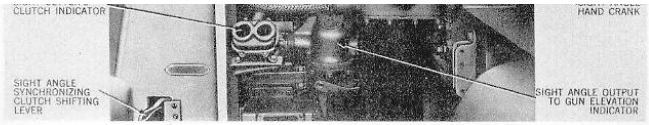


Figure 2-9. Sight Setter's Station, General Arrangement

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.

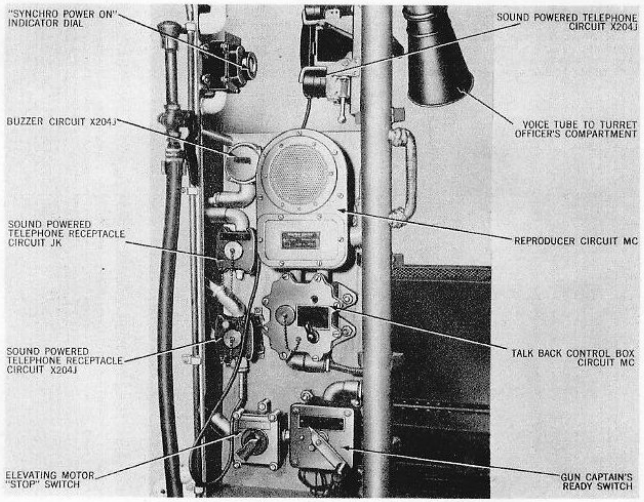


Figure 2-10. Gun Captain's Station, General Arrangement

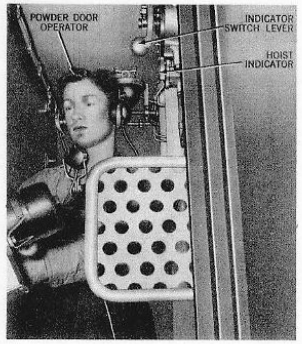


Figure 2-11. Powder Hoist Lower Door Operator's Station, Manned

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.

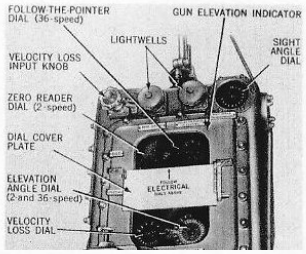
Electrician (each level)

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.

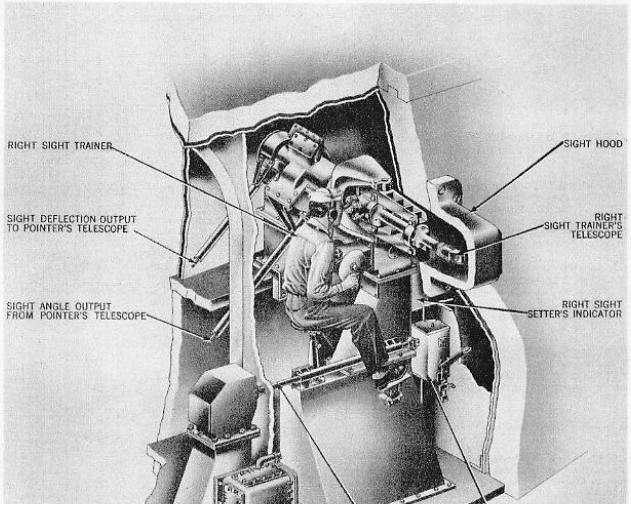


Equipment used. The petty officer in charge (projectile handling deck) uses: communications units located in the projectile flat; the controls of sprinkling station H; and a telephone headset with breastplate-supported and pushbutton-controlled transmitter.

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.



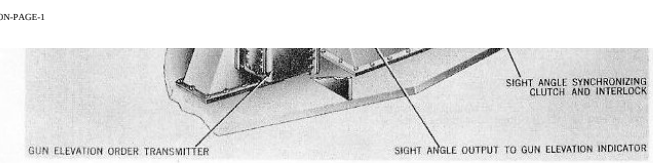


Figure 2-13. Right Sight Trainer's Station, Manned Right Side View

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.

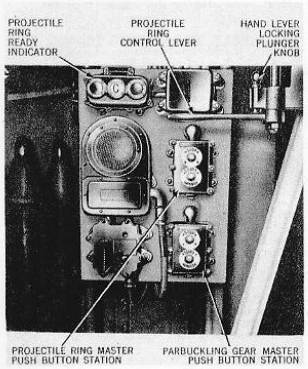


Figure 2-14. Projectile Ring and Parbuckling Gear Control Station

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

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.

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.

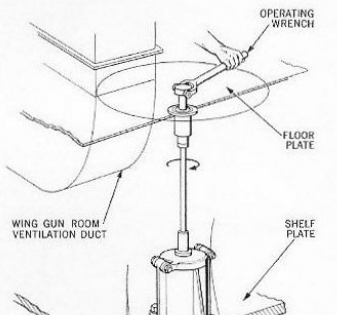
The rangefinder pointer and trainer are each provided with an optic within a sight port and enclosed by a sight hood assembly. Mounted on the gun

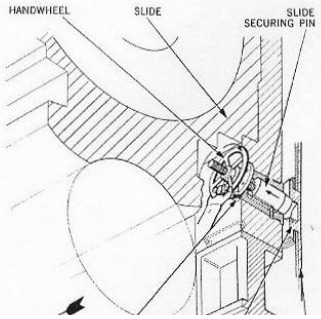
house side armor plate, both sight hoods are similarly arranged with a door similar to that of the sight hood assemblies. This door slides horizontally to open or close and is operated by a shaft and screw mechanism which secures it in either position. The mechanism has an operating handcrank within 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).





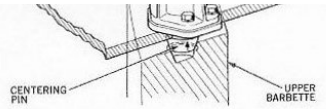


Figure 2-15. Releasing Turret-Centering Pin



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

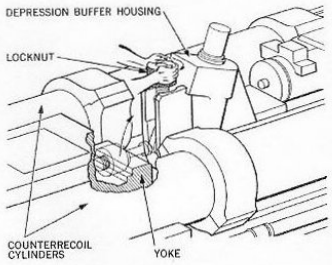


Figure 2-17. Releasing Gun Locking Device

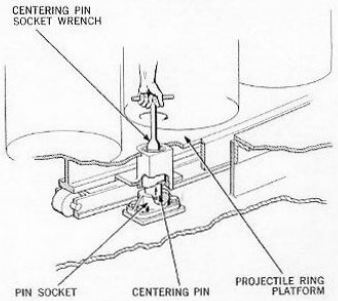


Figure 2-18. Releasing Projectile Ring Centering Pin

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.

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.

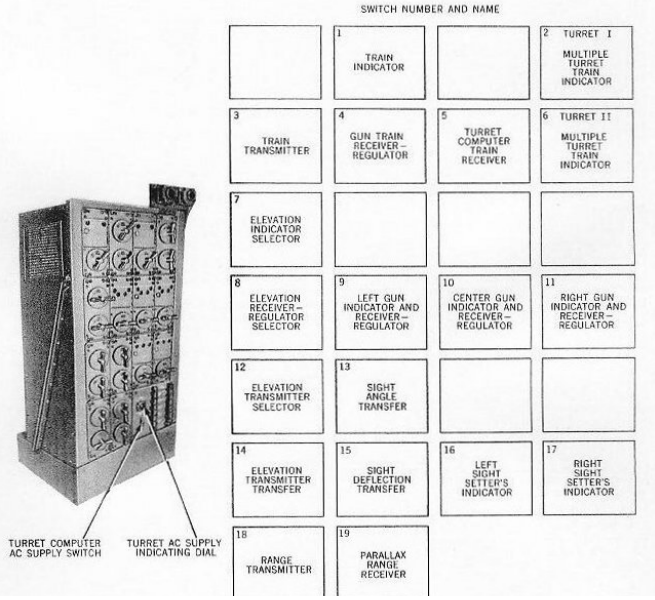
If there is no illumination in the neutral start indicator, either the handwheels or the tilting box are not in their neutral positions. Rotate the handwheels in both directions, counting the turns between limits, and position the handwheels at neutral midway between these limits. The tilting box neutral 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



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		

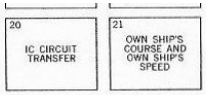


Figure 2-19. Turret Officer's Transfer Switchboard, Turret II. General Arrangement

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.

CHAPTER 2 TURRET OPERATION PAGE 2

GENE SLOVERS
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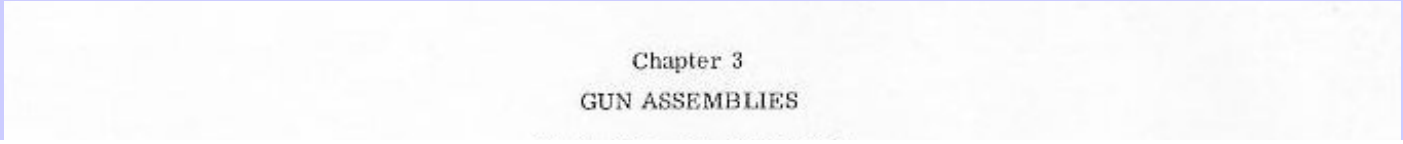
OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

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TITLE AND FORWARD

CHAPTER 3 GUN ASSEMBLIES

CHAPTER 3 GUN ASSEMBLIES PAGE 1
CHAPTER 3 GUN ASSEMBLIES PAGE 2


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 ~~slavo~~ SALVO 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.

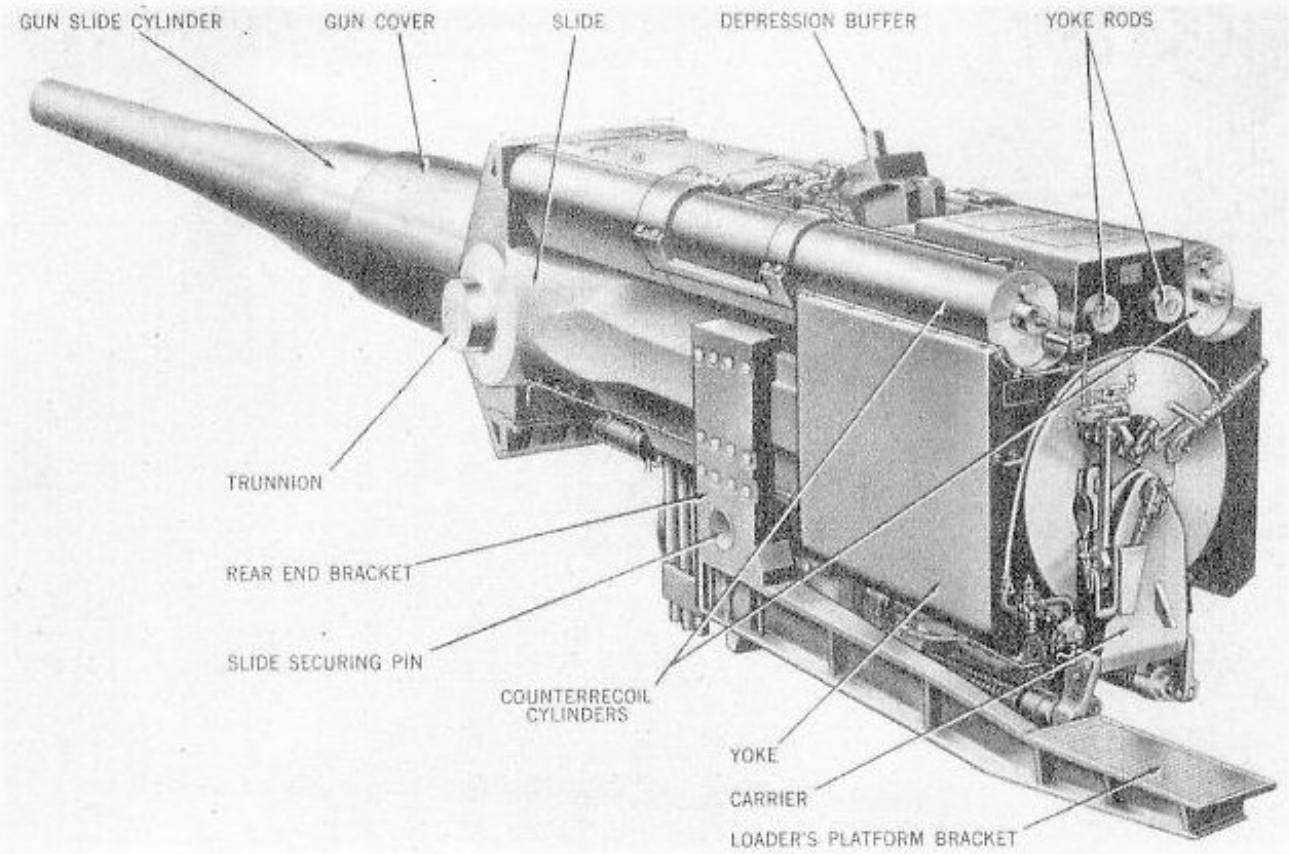


Figure 3-1. 16-inch Gun Mk 7 Mod 0 and 16-inch Slide Mk 6 Mod 0
(Operating Lever Safety Ratchet Mechanism Assembly
Not Shown; See Figure 3-3)

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

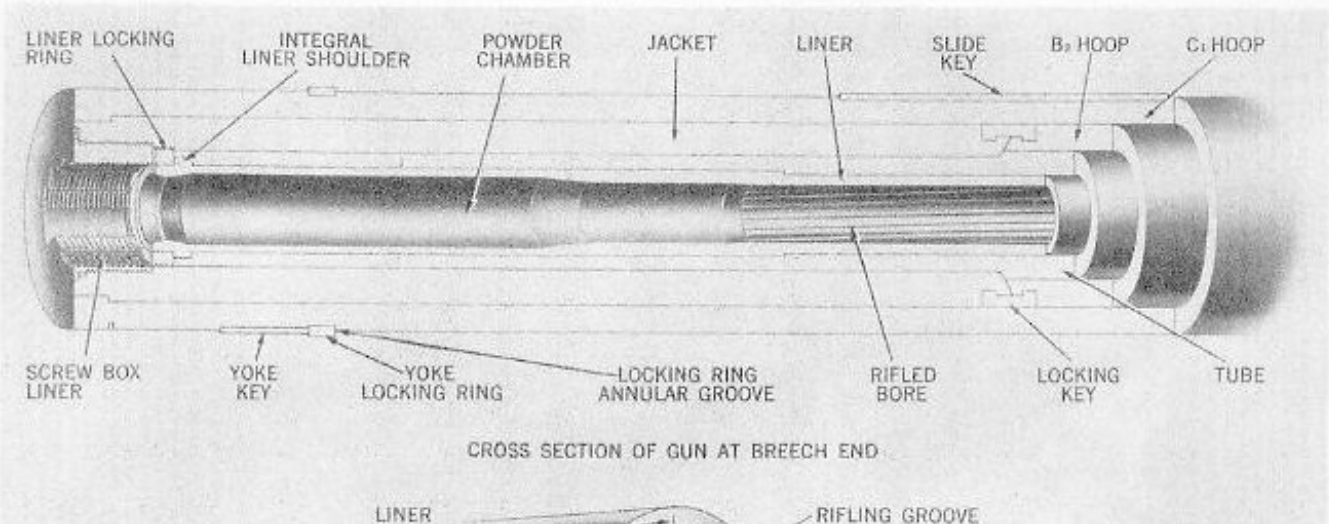
Assembly arrangements

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



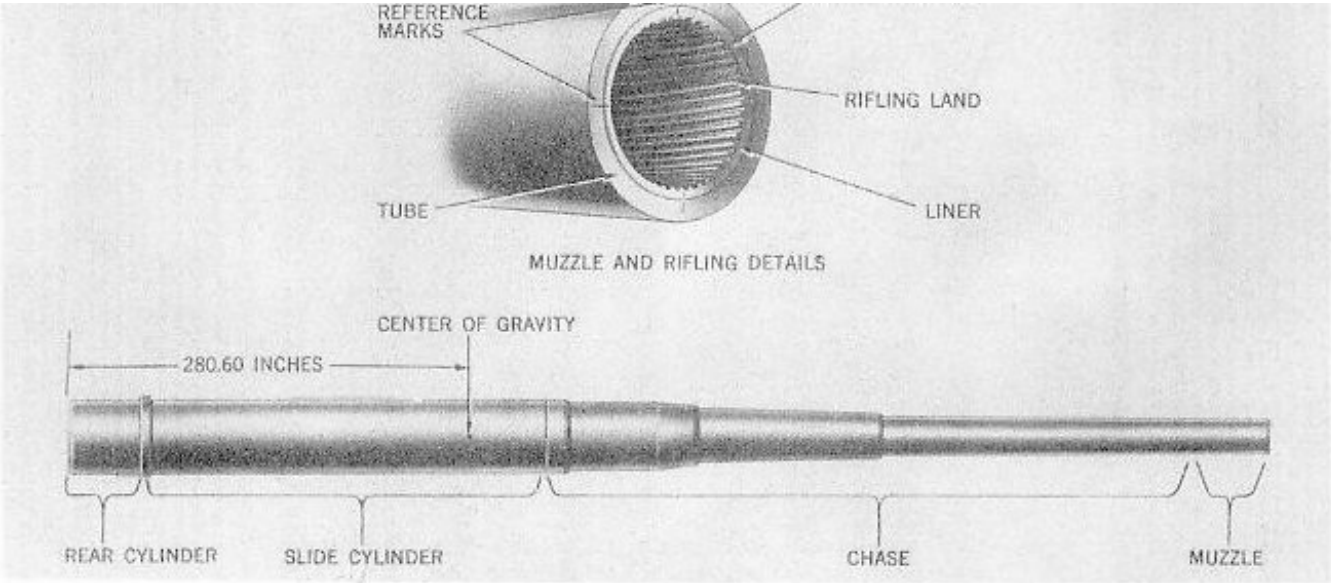


Figure 3-2. 16-inch Gun Mk 7 Mod 0, General Arrangement, Details and Profile

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,	
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	

inches . . . . . 49.0 Projectile Mk 8 Mod 0, fps 2425

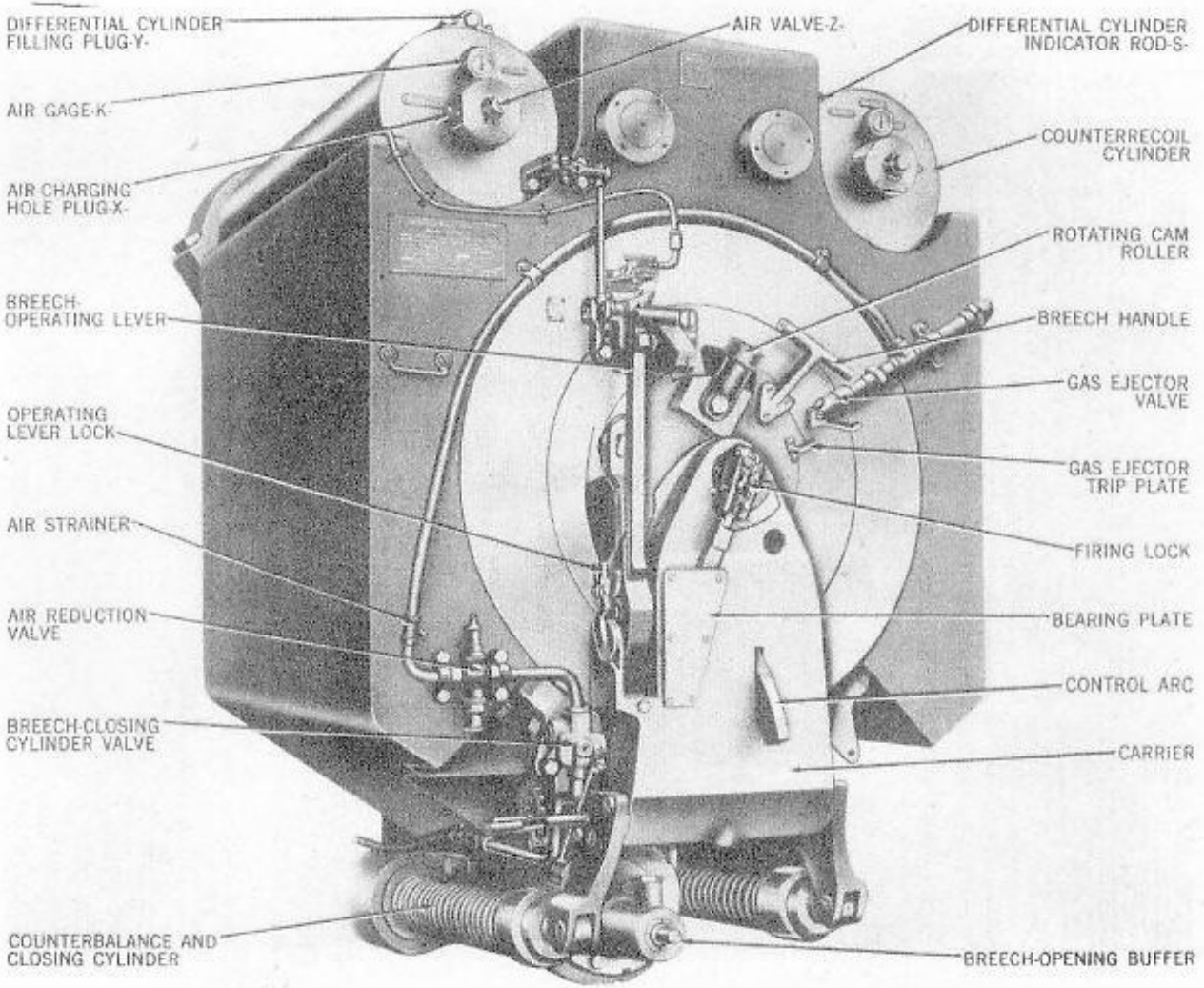


Figure 3-3. 16-inch Breech Mechanism Mk 4 Mod 0 - Breech Closed

3-3

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

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-

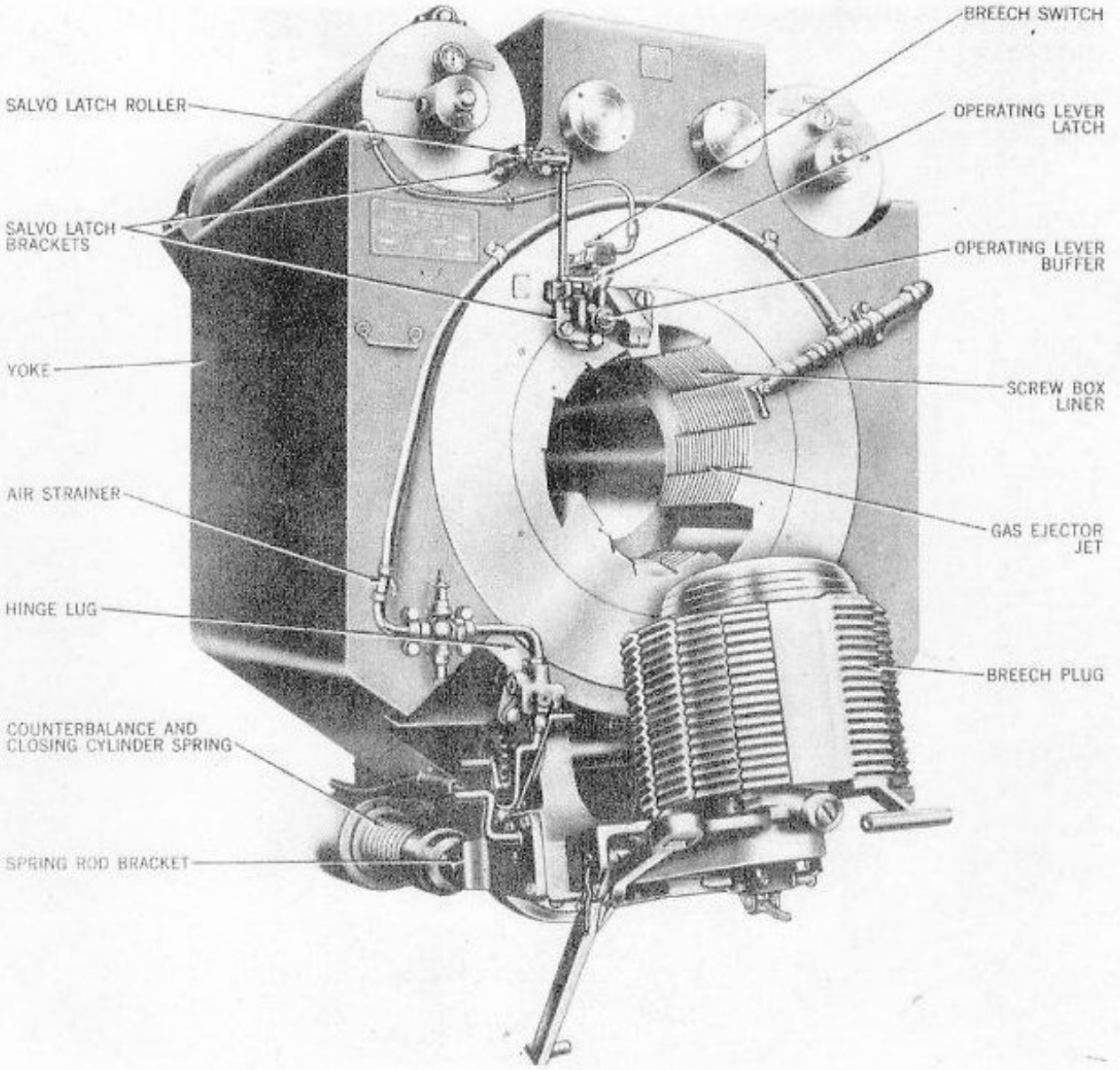


Figure 3-4. 16 inch Breech Mechanism Mk 4 Mod 0 - Breech Open
(Operating Lever Safety Ratchet Mechanism
Assembly Not Shown; See Figure 3-3)

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

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

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

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

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

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 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

SALVO LATCH BRACKET ANNULAR AIR GROOVE PLUG ADJUSTING NUT SPLIT RINGS BAR CLUTCH BAR

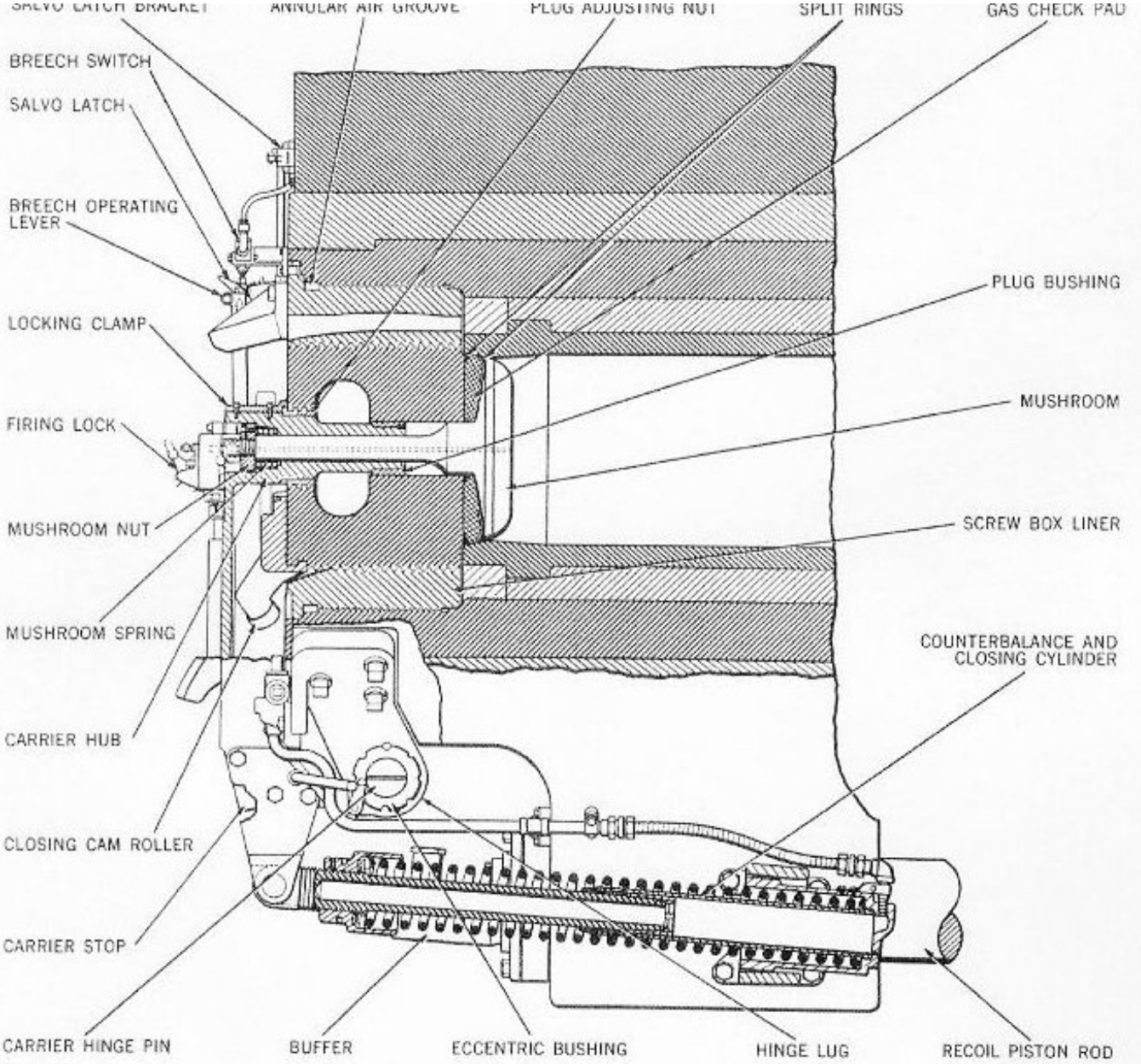
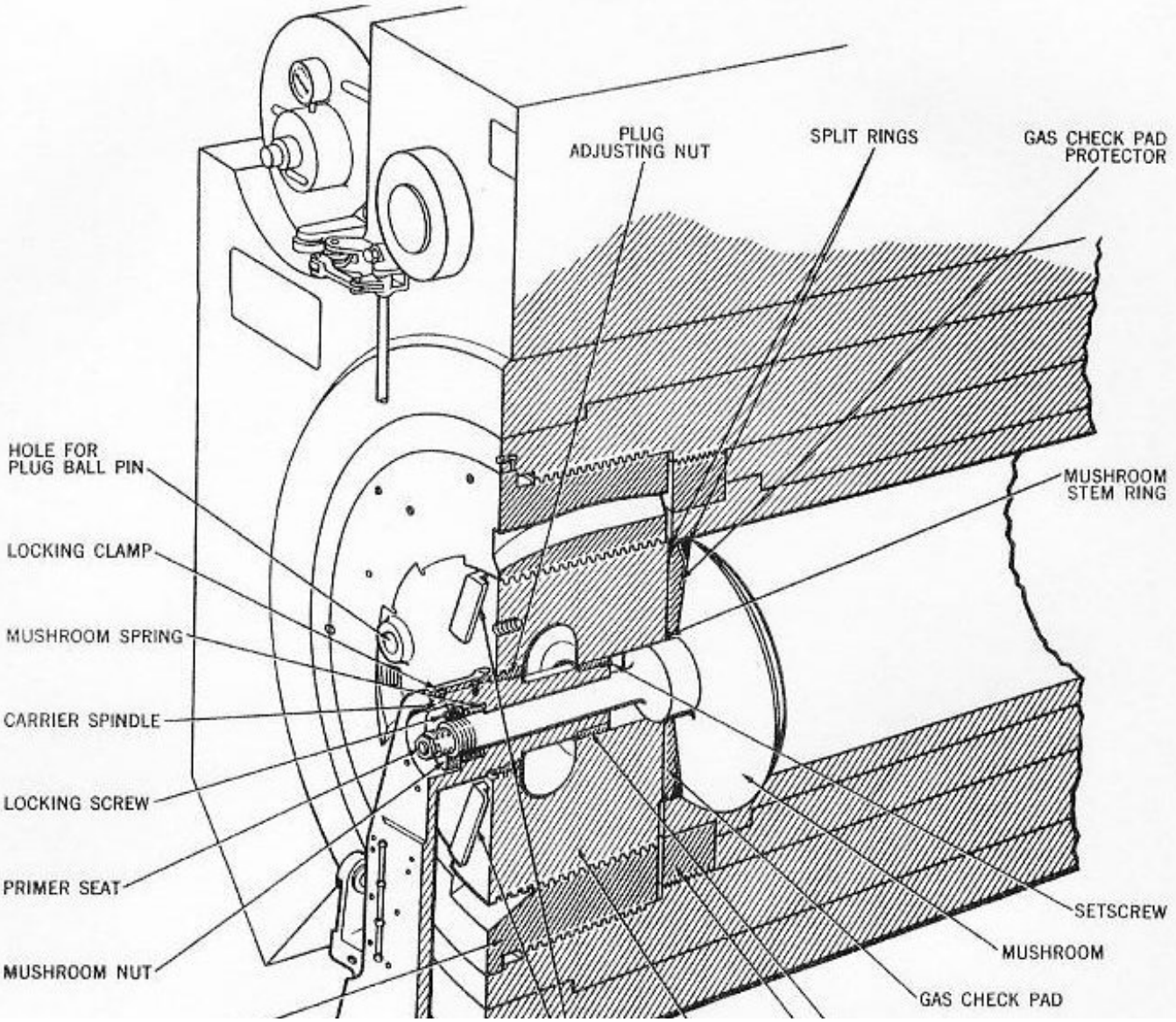


Figure 3-5. 16-inch Breech Mechanism Mk 4 Mod 0 - Sectional View


PLUG ADJUSTING NUT
SPLIT RINGS
GAS CHECK PAD PROTECTOR
HOLE FOR PLUG BALL PIN
LOCKING CLAMP
MUSHROOM SPRING
CARRIER SPINDLE
LOCKING SCREW
PRIMER SEAT
MUSHROOM NUT
MUSHROOM STEM RING
SETSCREW
MUSHROOM
GAS CHECK PAD

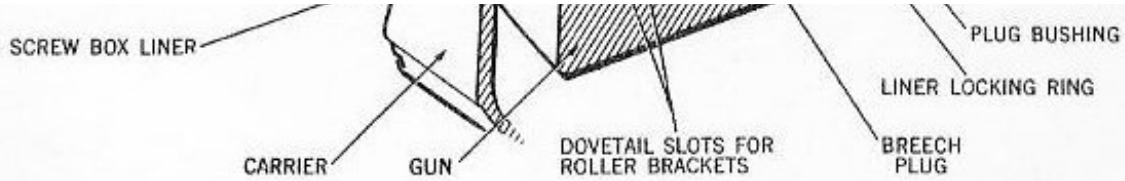


Figure 3-6. Breech Plug Obturator Assembly

3-7

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

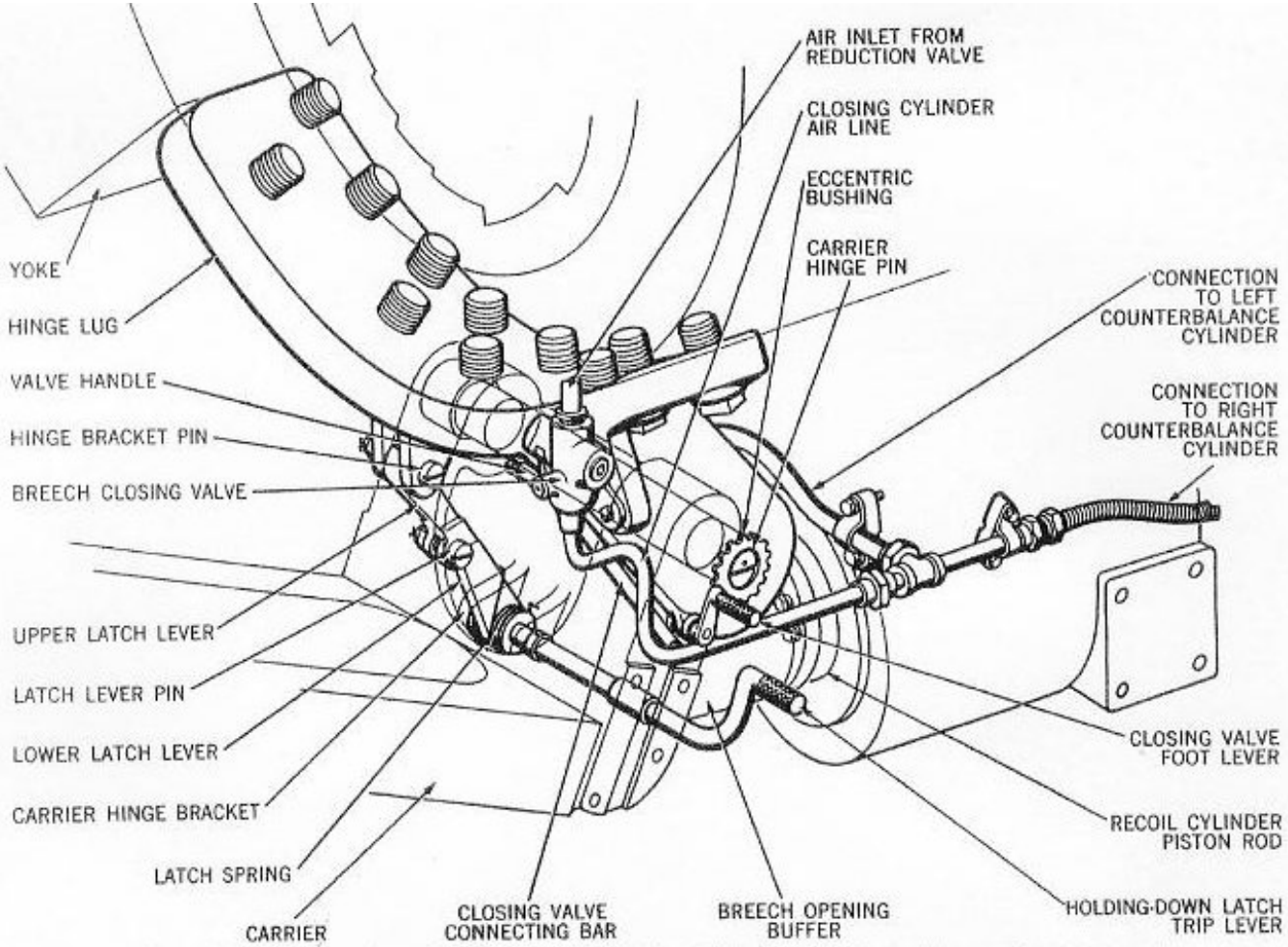


Figure 3-7. Hinge Lug, Holding-down Latch and Closing Controls, General Arrangement

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

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

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

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

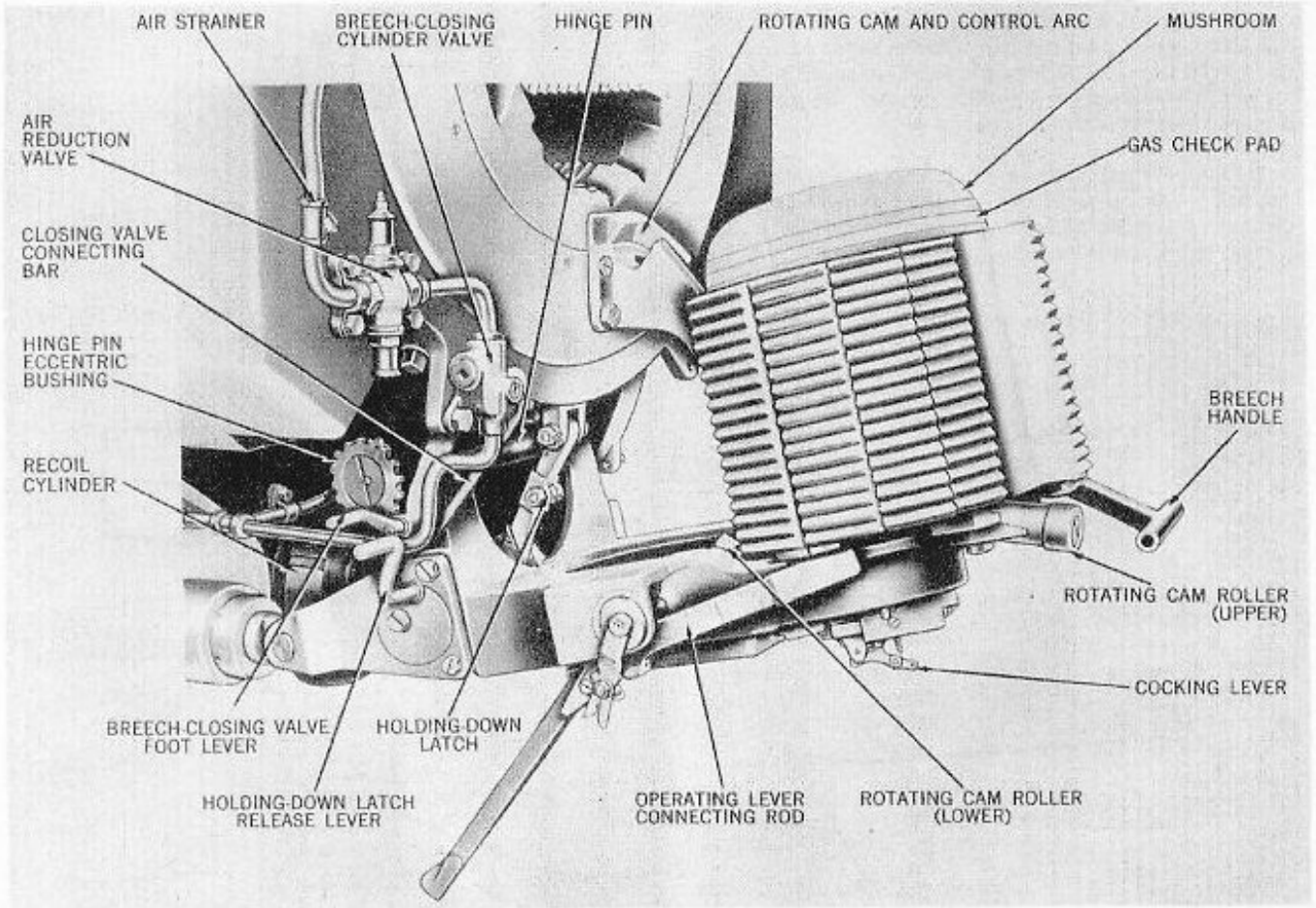


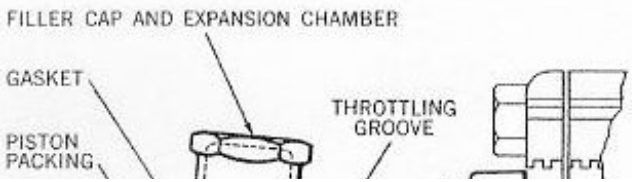
Figure 3-8. 16-inch Breech Mechanism Mk 4 Mod 0 - Breech Open Showing Holding-down Latch (Operating Lever Safety Latch Mechanism Assembly Not Shown; See Figure 3-3)

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.



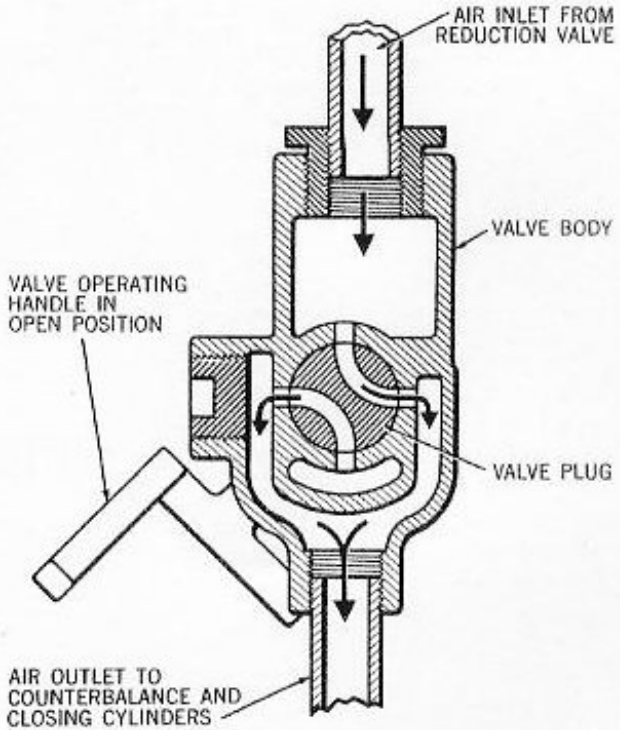
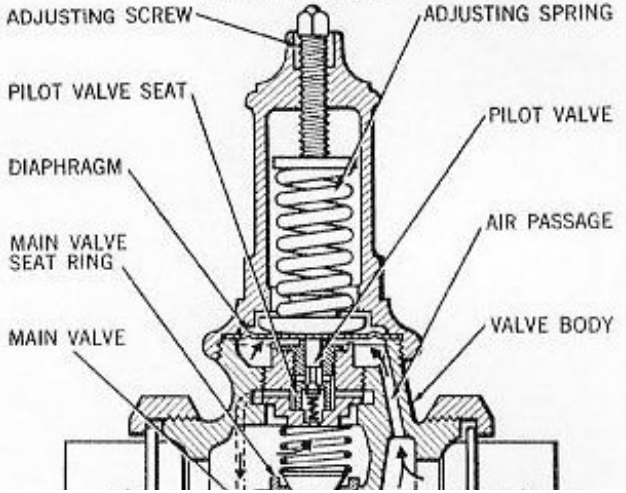


Figure 3-10. Breech-closing Cylinder Valve, Sectional View



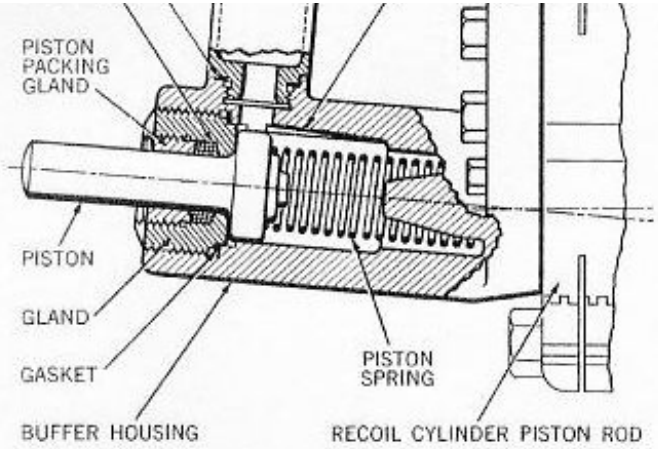


Figure 3-9. Breech-opening Buffer, Sectional View

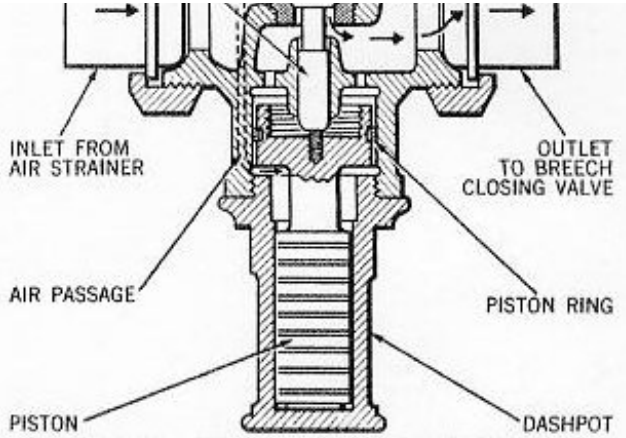


Figure 3-11. Breech Mechanism Air Reduction Valve, Mason Type, Sectional View

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,



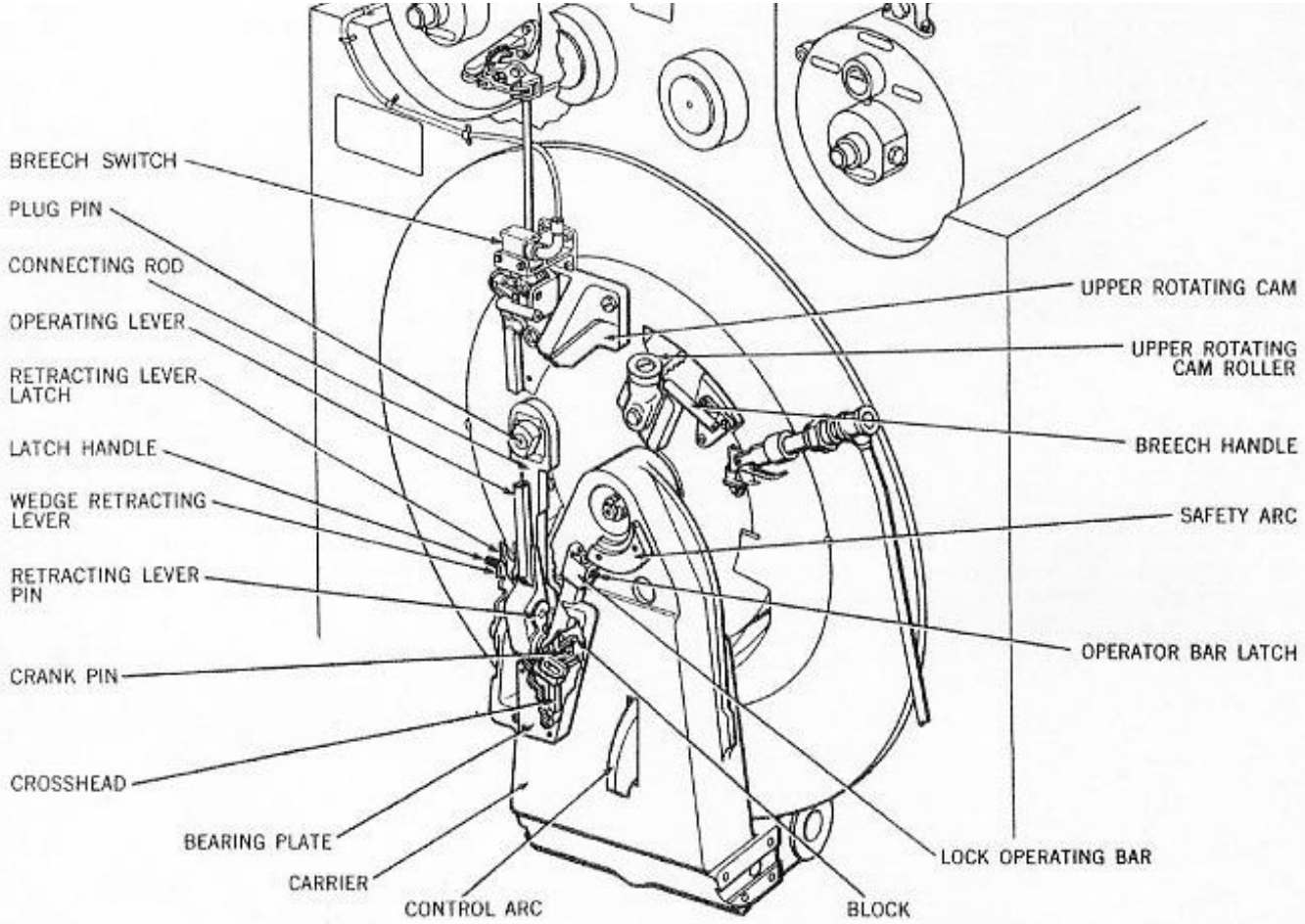


Figure 3-12. Breech Opening Mechanism, General Arrangement

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.

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

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.

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.

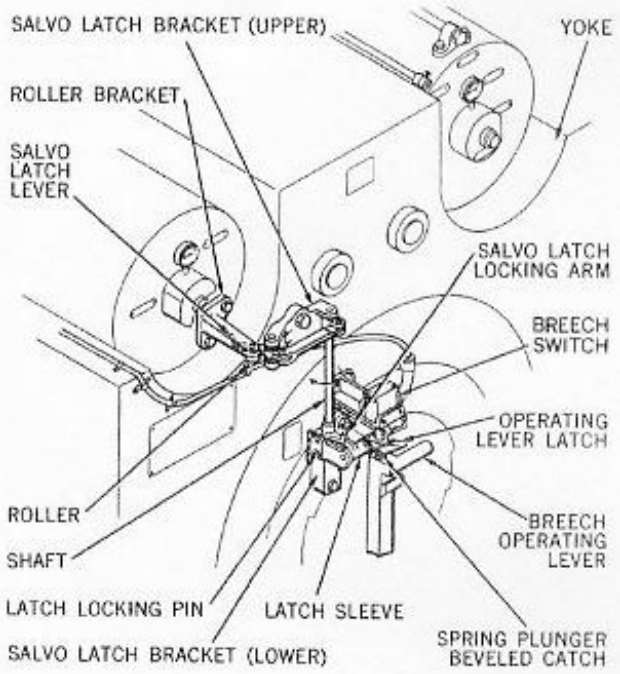


Figure 3-13. Breech Mechanism Salvo Latch

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

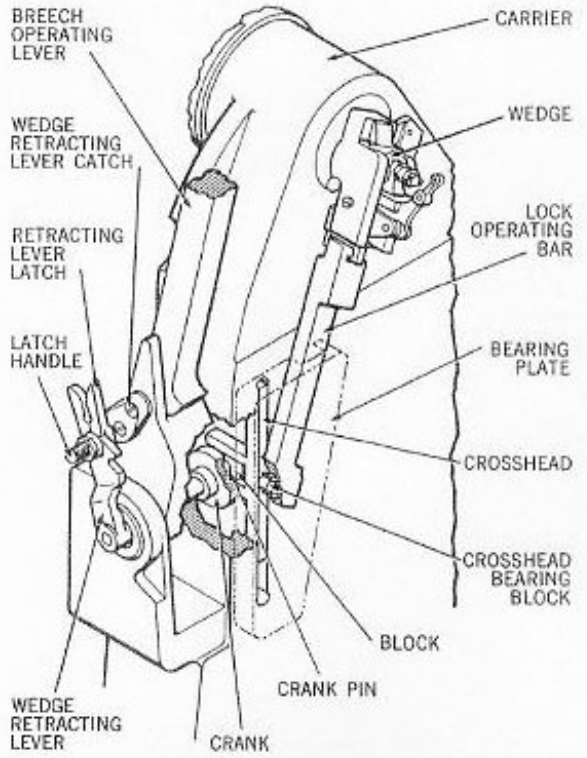
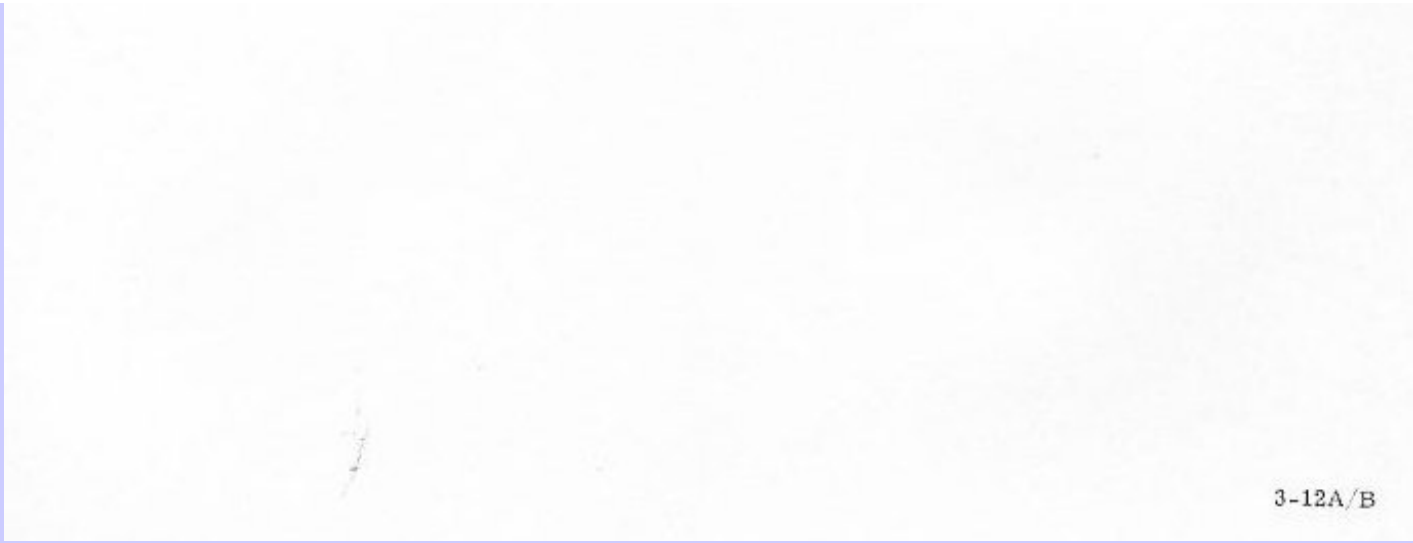


Figure 3-14. Breech Mechanism Firing Mechanism



3-12A/B

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.

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

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

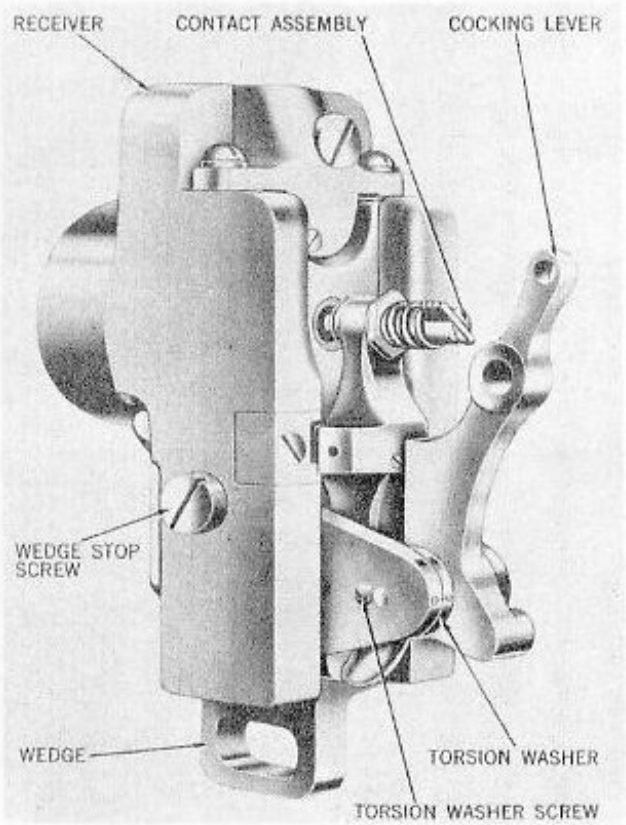


Figure 3-15. Firing Lock Mk 14 Mod 5 - Electrical Firing Position, Left Side

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

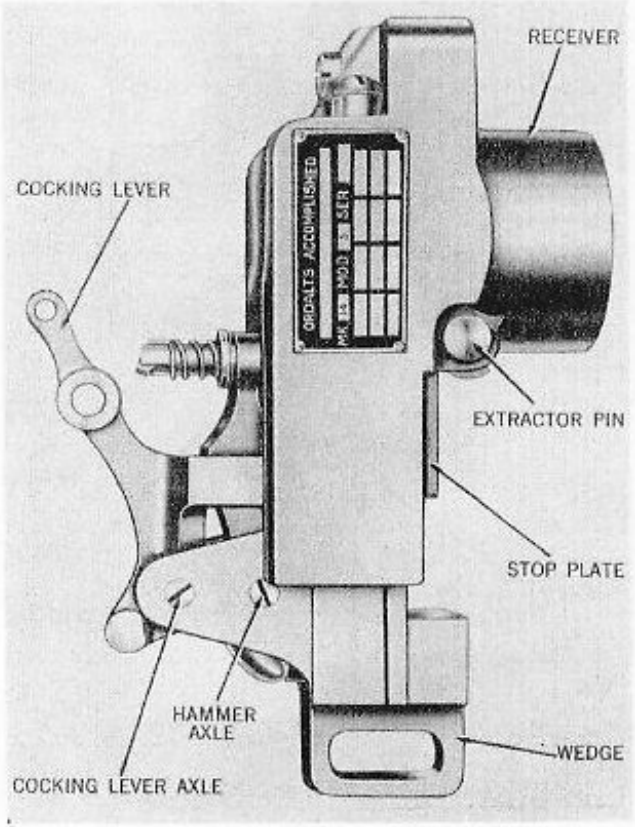
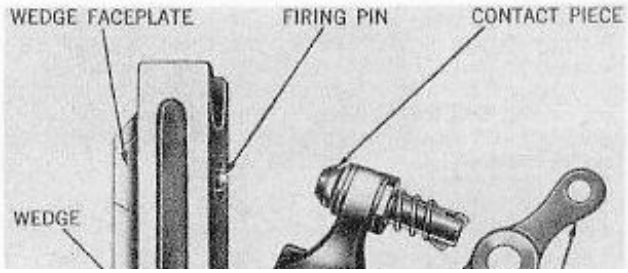


Figure 3-16. Firing Lock Mk 14 Mod 5 - Electrical Firing Position, Right Side

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

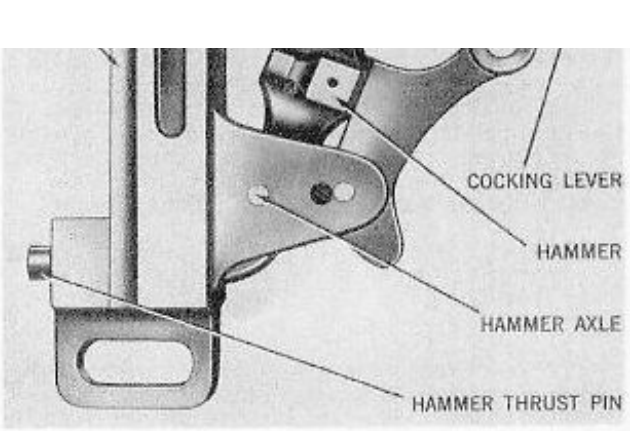
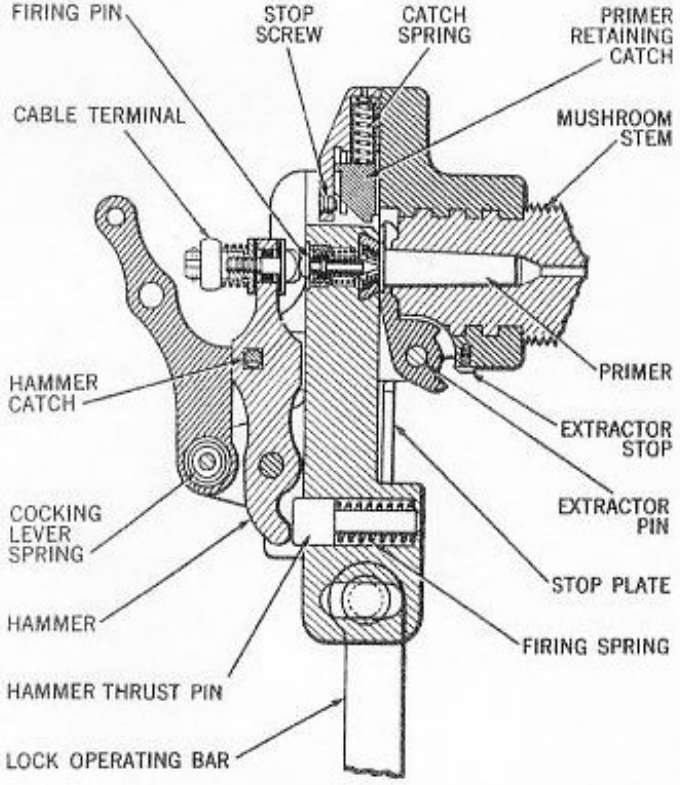


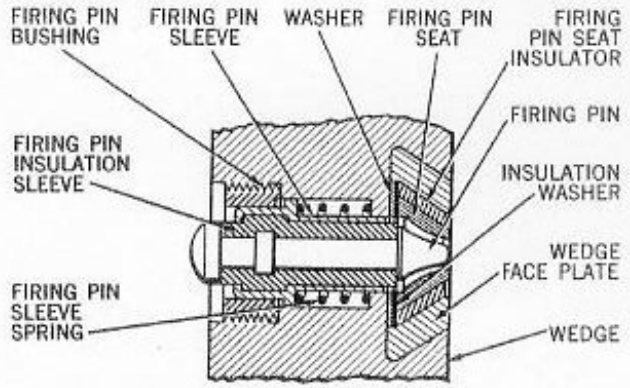
Figure 3-17. Wedge - Cocked Position, Left Side

contact with the primer retaining catch housing.

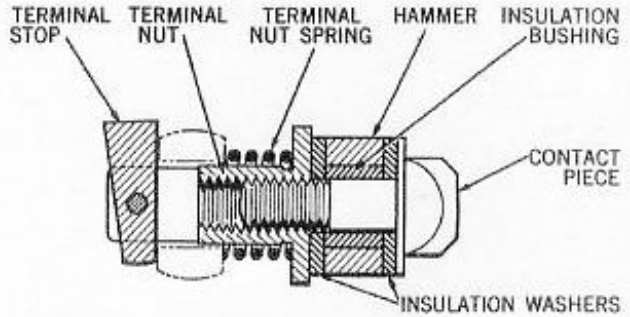
Extractor and extractor cam (figs. 3-19 and 3-20). The extractor and extractor cam are both pivoted on the extractor pin which passes through the receiver. The extractor cam is actuated by a



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.

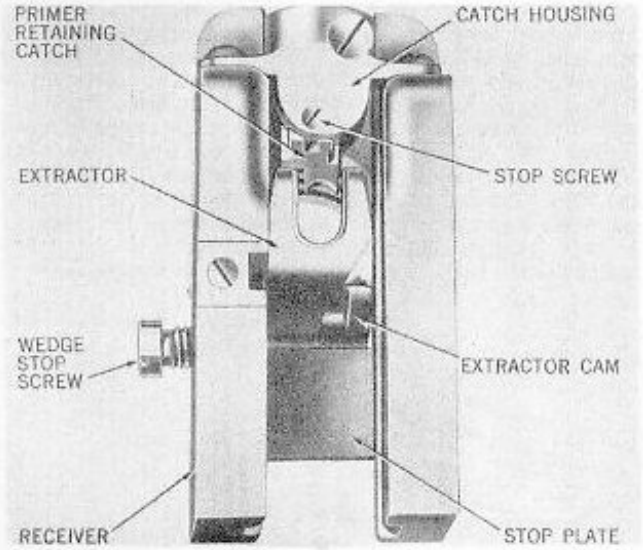
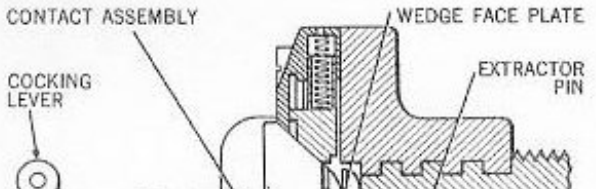


Figure 3-19. Firing Lock Mk 14 Mod 5 - Wedge Removed



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 sys-

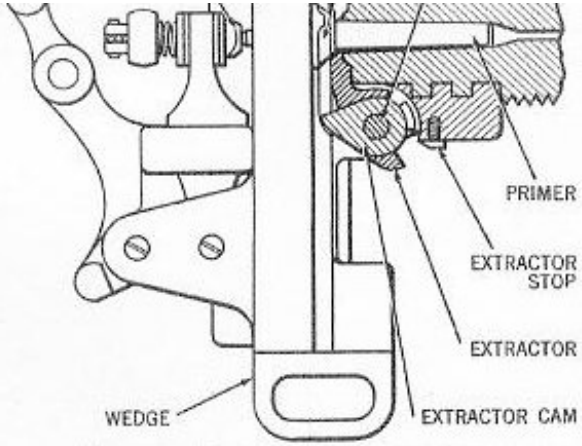


Figure 3-20. Firing Lock, Right Side, Sectional View - Wedge Closed

tems 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

EXPANSION JOINT SLEEVE EXPANSION JOINT BRACKET

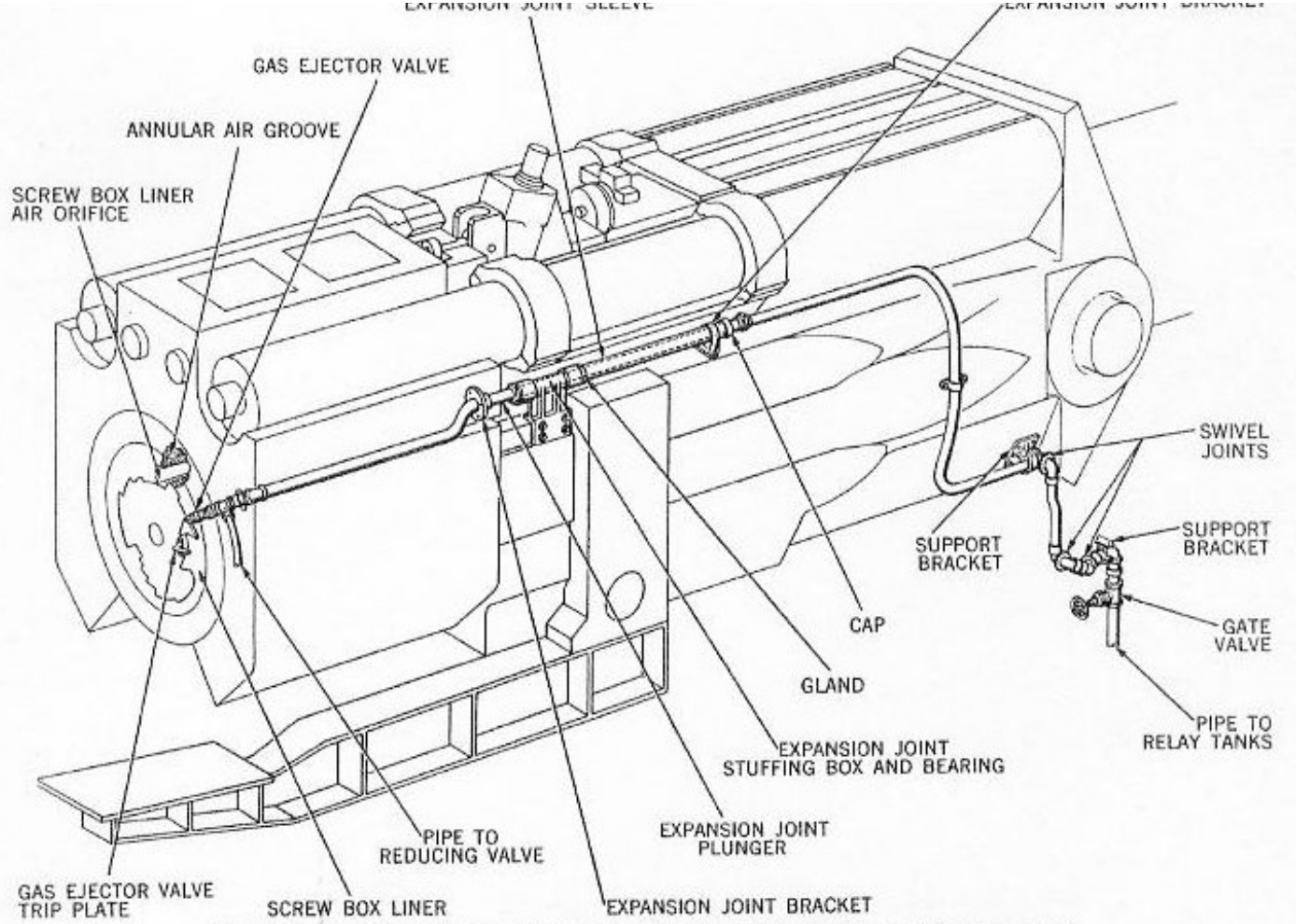


Figure 3-21. 16-inch Gas Ejector System Mk 5 Mod 0, General Arrangement

3-16

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 (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 counterre-

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,

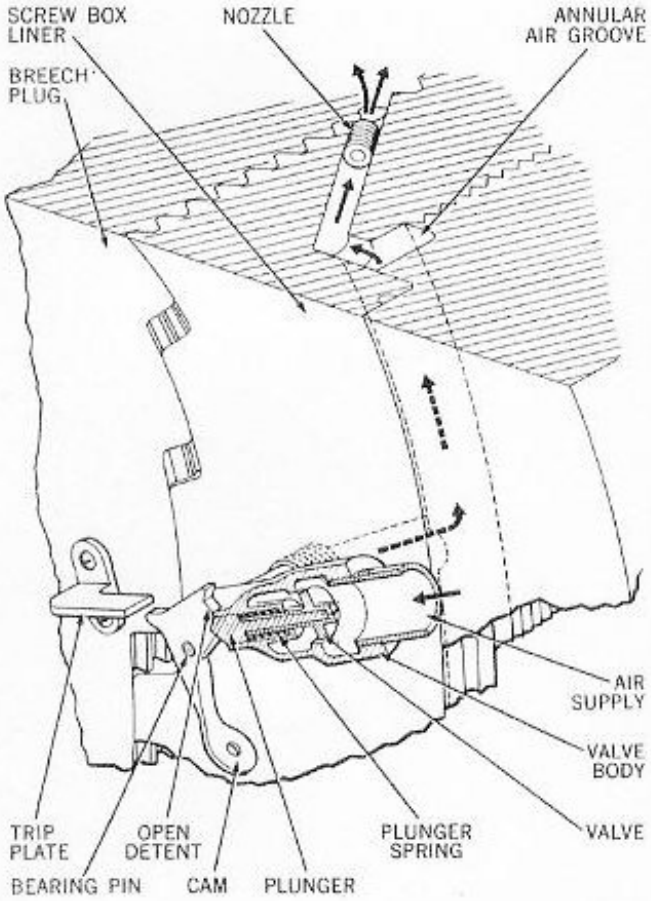


Figure 3-22. Gas Ejector Valve

coil 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 3-23I, 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).

CHAPTER 3 GUN ASSEMBLIES PAGE 2

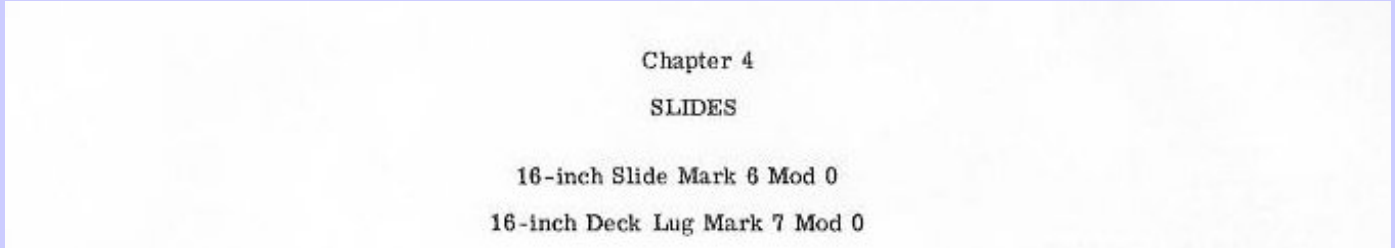
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CHAPTER 4 SLIDES



Chapter 4

SLIDES

16-inch Slide Mark 6 Mod 0

16-inch Deck Lug Mark 7 Mod 0

GENERAL DESCRIPTION

16-inch Slide Mk 6 Mod 0 is a large trunnion-pivoted assembly in which a single gun assembly is mounted (figs. 4-1 and 4-2). Each slide functions as a gun-supporting structure, a gun recoil brake, and a gun counterrecoil mechanism. Included in the gun slide assembly are devices that secure the gun in battery position and the slide in stowed position. The slide pivots on its integral trunnions in vertical rotation. The right and center slides are identical assemblies; the left slide differs in that the loader's platform bracket and slide securing device are mounted in the left rear end bracket, and the elevating screw pivot pin is mounted in the right rear end bracket.

16-inch Deck Lug Mk 7 Mod 0 is a bearing block and roller bearing assembly that provides for frictionless elevating movement of the slide and gun. Each deck lug is arranged with a bearing block and roller bearing assembly on either side of each slide. The deck lugs are virtually identical assemblies; minor structural differences are described later in this chapter.

The deck lugs are located at the front of the turret, within the gun house structure. The common axis of the radial bearings is in a line, 11 feet forward of the turret transverse centerline, parallel to

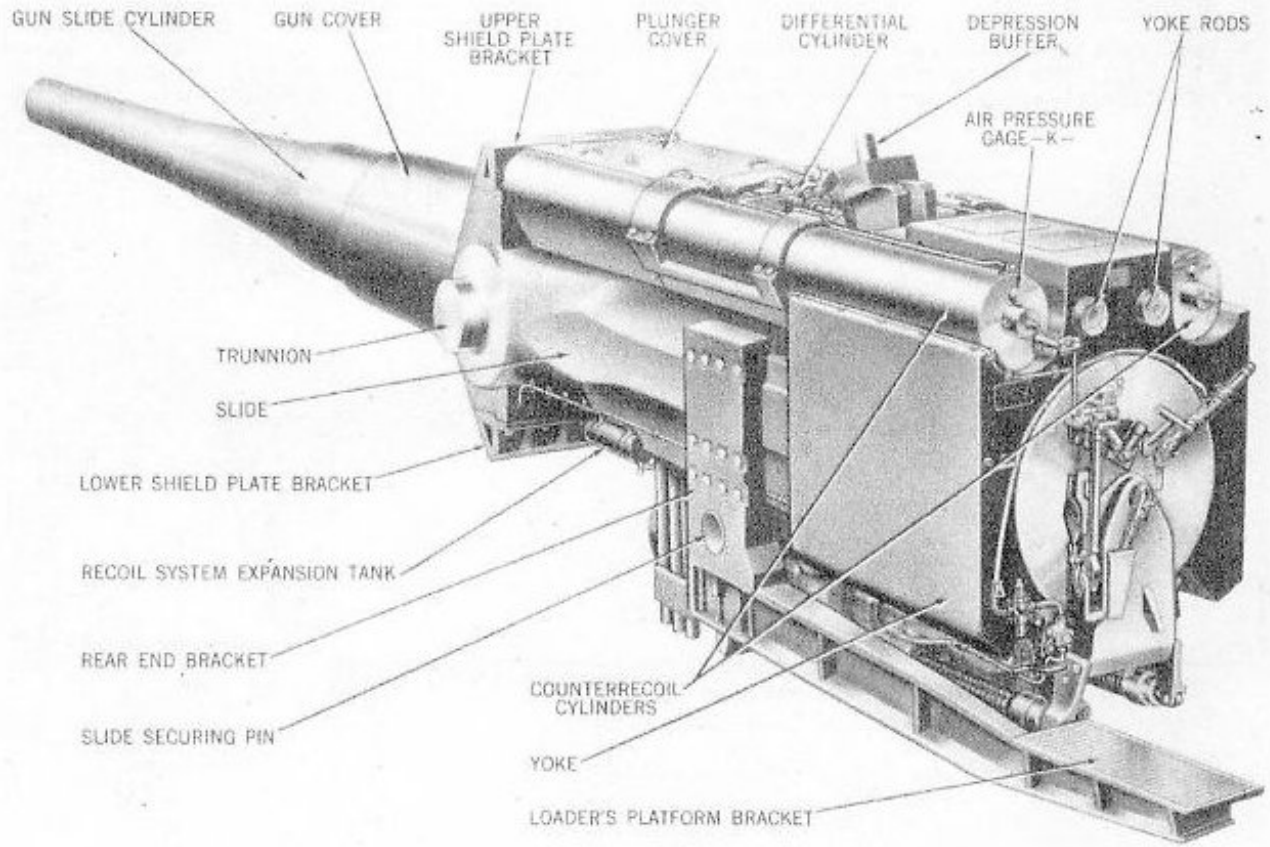


Figure 4-1. 16-inch Gun Mk 7 Mod 0, and 16-inch Slide Mk 6 Mod 0
(Operating Lever Safety Ratchet Mechanism Assembly
Not Shown; See Figure 3-3)

and 16.5 feet above the axes of the rollers of the roller path. Turret structural supports for the lugs are spaced to locate the slides and their guns as follows: The axis of the center gun bore is on the turret centerline. The axes of the right and left gun bores are parallel to that of the center gun and are each spaced 122 inches from it.

Components. The main component of each slide is a large steel forging with integral trunnions that rest in the deck lug bearings. Attached to this forging is a hydraulic-type recoil brake, a hydropneumatic-type counterrecoil system, and the rear end brackets. Other parts attached to the slide structure are the loader's platform, a cylindrical gun cover, the upper and lower shield plates, a yoke locking device, and a slide securing mechanism.

Design features

The deck lugs are identical radial roller bearing assemblies, mounted in a bearing block at the top of the gun girder. Heavy caps, which bolt to the gun girder bearing blocks, prevent vertical displacement of the deck lug bearings. The bearings are secured against horizontal displacement by the rigidity of the gun girder weldment, and by bearing retainers that provide nonadjustable spacing of the bearings of each lug. The bearing retainer design ties the two trunnion bearings together through the integral structure of the slide and its trunnions.

Design differences

The three deck lug assemblies of a turret are virtually identical. The two deck lugs for the outboard slides differ in that the outer bearing blocks extend further forward than do the inner bearing blocks. This is necessary to provide for the difference in shape between the straight, flat turret face plate and the annular gun girder, which forms the outer structural bulkhead within the barbette. In addition, the flat-plate thrust bearings of the outer bearing blocks are rotated to the rear and upward in their assembly positions. Both the bearing blocks and bearing assemblies of the deck lug for the center slide are identical.

Access arrangements

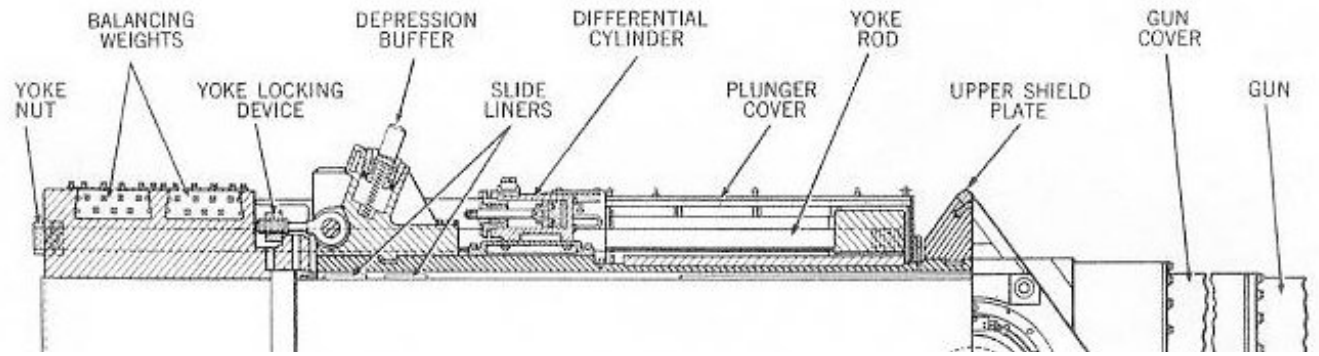
Access to the deck lug bearings is provided for by parallel divisional bulkheads that are formed by the gun girder boxes, and by turret subdivision bulkheads. The two outer trunnion bearings are accessible through the sight station compartments. The remaining trunnion bearings are accessible through the space between the parallel divisional bulkheads. These spaces may be reached from the electric deck.

DETAIL DESCRIPTION

Deck lug

The three deck lugs in each turret are mounted in a transverse row within the gun house structure at the front of the turret.

Each deck lug consists of two trunnion bearings. The common axis for all six trunnion bearings forms a straight line in the forward upper part of the turret gun girder weldments. Each deck lug (fig. 4-3) is composed of two radial roller bearing assemblies and two flat thrust plate bearings arranged with a bearing block and bearing for each trunnion on either



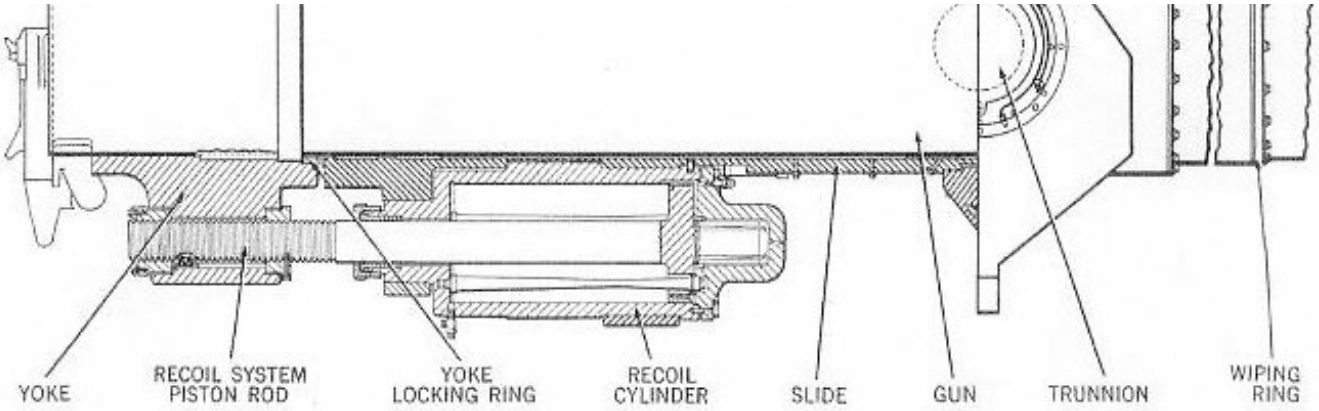


Figure 4-2. 16-inch Gun Mk 7 Mod 0 and Slide Mk 6 Mod 0, General Arrangement, Sectional View

side of the gun slide. The deck lugs are rigidly secured beneath heavy caps that are bolted to the bearing blocks of the gun girder weldment.

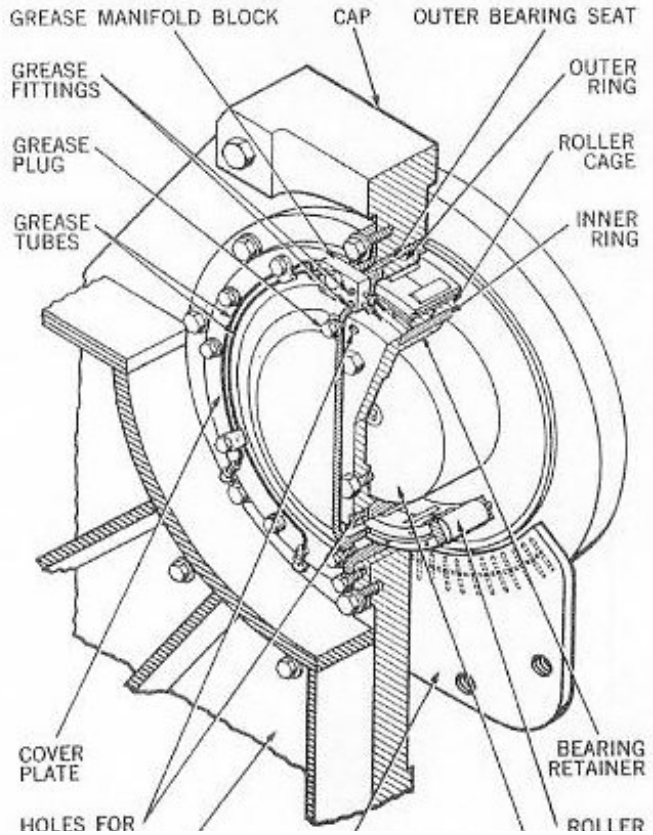
Design features. The turret structural design for gun girders and deck lug seats ties the trunnion bearings together without the use of transverse tie rods. The radial trunnion bearings are of frictionless design. Their rings, rollers, and cages are of noncorrosive materials or are chromium plated. All elements of the six bearing assemblies are fully enclosed and sealed with lubricant retaining devices.

Components. Each trunnion bearing of the deck lug is an assembly of the following parts:

Radial roller bearing
Thrust plate
Bearing retainer
Outer bearing seat
Cover plate

Trunnion bearing assembly (fig. 4-4).

Radial roller bearing. The radial roller bearing unit of each deck lug consists of inner and outer rings, a two-piece bronze cage, 24 cylindrical steel rollers, and 24 cage rivets. Each assembled bearing is 30.0 inches in outer diameter, 5.8 inches wide across the inner ring, and the roller axes form a circular path 25.00 inches in diameter. The rollers are solid true cylinders; each is 3.5 inches long and 2.5 inches in diameter. They are made of special roller bearing steel and are chromium plated. The rollers are equally spaced, loosely fitted in the recesses of the



bronze cage, and retained by the riveted assemblage

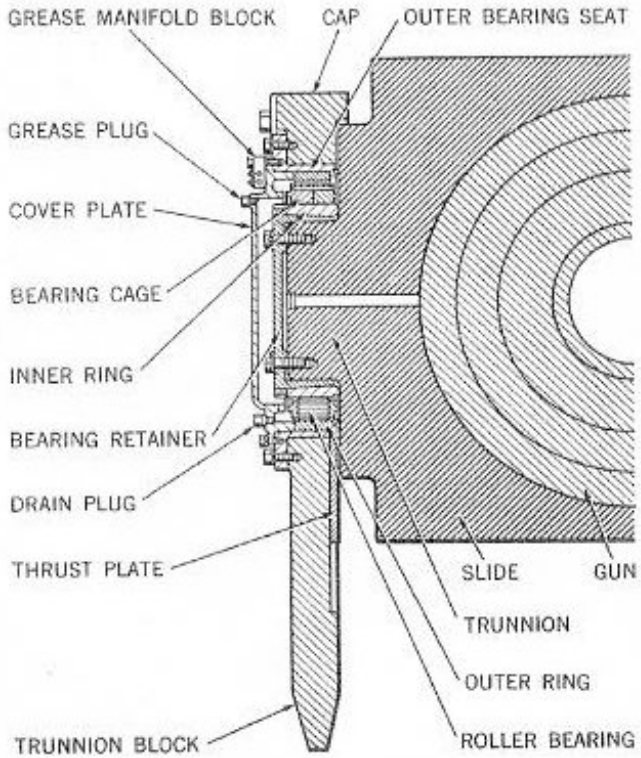


Figure 4-3. Deck Lug Mk 7 Mod 0, Gun Mk 7 Mod 0, and Slide Mk 6 Mod 0, Sectional View



Figure 4-4. Deck Lug and Trunnion Bearing Assembly, General Arrangement

of that unit. The inner and outer rings are special steel, precision ground to provide concentric cylindrical races for the rollers. The inner ring seating area is a 3-degree tapered bore that provides a fixed wedged seat on a matching collar of the retainer. The outer ring is also fixed (cannot rotate) in its seat and is described in a following paragraph.

Thrust plate. The bronze thrust plate is secured by four bolts on the inner side of each gun trunnion block. Centered beneath the trunnion, the plate forms a 120-degree thrust bearing lubricated thrust surface for the side face of the gun slide. The plate has a system of radial grease grooves to distribute lubricant from four grease fittings. With the two bearing plate surfaces parallel to the side face of the slide, the thrust clearance between the slide and each plate is 0.002 inch. The thrust bearing and bearing block design includes provision for maintaining this thrust clearance. Excessive slide thrust clearance, caused by a gun girder spread, can be corrected by installing oversize thrust plates. The installation is made without disturbing the radial bearing assemblies. The bearing block seats for the thrust plates are milled to permit undersized plates to be dropped and new plates to be raised and bolted. This operation can be performed in the limited space beneath the slide.

Bearing retainer. The bearing retainer is a circular plate with an integral cylindrical collar that fits over the slide trunnion. The collar forms the inner ring seat and is machined with a 3-degree tapered slope to match the seat taper of the inner roller race. The inner ring seat of the bearing retainer also provides a shoulder against which the inner ring is wedged. The retainer is secured to the end face of the trunnion with 12 equally spaced bolts that lock when seated. The diameter of the slide trunnion bearing surfaces is 18.5 inches. The assembled bearings and retainers, when fully seated on the trunnions, space the two deck lug radial bearings 73.0 inches

buffers for each slide; one on the left and one on the right gun girder in the gun pocket. Depression movement is buffed by a hydraulic buffer mounted on top of the slide in position to contact a stop mounted in the turret roof.

When the slide is at 0 degrees elevation, a securing pin in one of the rear end brackets aligns with a pin socket in the adjacent gun girder. A yoke locking device (fig. 4-2) locks the gun yoke to the slide for stowage with the gun in battery position.

Components. The gun slide consists of the following components:

apart from center to center.

Outer bearing seat. The outer bearing seat is a flanged ring, 31.5 inches in diameter. It is secured to the bearing block and cap by eight equally spaced bolts. The outer ring of the bearing is fixed and centered by the outer bearing seat. The inner face of the seat has an annular groove for a lubricant seal. This seal is compressed against the side face of the slide. It consists of a wool felt strip, square in cross section, secured in the groove with shellac. The outer flance of the seat is arranged with 12 equally spaced holes that are tapped for the cover plate bolts. In addition, there are six holes for jack screws (so that the seat can be disassembled from the bearing block) and six smaller tapped holes in the lower half of the seat. These holes furnish selective positions for four lubrication fittings for the thrust bearing.

Cover plate. The cover plate is a large recessed disc with a machined integral bolt flange that seals against the outer bearing seat. Completely enclosing the trunnion and bearing, the cover plate provides a lubricant retaining cover with filling and drain plugs for servicing the bearing. There are two accurately machined annular rings within the cover plate and integral with it. These annular rings provide 360-degree contact with the bearing outer ring with the roller cage. When assembled, the plate secures the outer race and the roller cage and prevents thrust displacement of the bearing.

Slide (fig. 4-5)

General arrangement (fig. 4-6). The gun slide forging is the structural foundation for the other components of the slide. The entire assemblage is suspended and pivoted by the integral trunnions of the slide forging. Frictionless vertical rotation in the gun pocket is provided by the deck lugs. The upper and lower shield plates fit within the turret face plate and function to close the gun port in all slide positions.

When fired, the gun slides through the gun port in a 48-inch reciprocating movement (maximum possible stroke). This recoil-counterrecoil motion is controlled by the recoil brake and counterrecoil system of the slide. The gun is held in battery by the counterrecoil system.

The slide is elevated and depressed through the elevating screw mounted in the bottom of the slide rear end bracket. This nonrotating screw is elevated or depressed by the power driven elevating nut (chapter 5).

Elevating movement of the slide is limited by two elevation stops on the bottom of the slide. These stops are positioned in the way of two hydraulic

Slide forging
Gun cover
Recoil system
Counterrecoil system
Yoke locking device
Buffers
Rear end brackets
Loader's platform
Slide securing device
Recoil switch and blade contacts

Slide forging. The gun slide is a large steel forging bored to receive the slide cylinder of the gun. The slide forging, weighing 56,000 pounds, is the major component of the slide assembly. Large trunnions, integral with the slide forging, extend horizontally on either side of it. The common axis of the trunnions forms a straight horizontal line at right angles to the gun axis, 44.0 inches from the forward end of the slide forging. The total length of the forging is 196.0 inches, and it measures 79.0 inches wide from end face to end face of the 18.5-inch diameter trunnions. The gun slide bore of the forging is fitted with four bronze liners at the forward end and two at the rear. Each liner is 10.0 inches wide with a finished diameter of 49.03 inches. (The diameter of the slide cylinder of the gun is 49.0 inches.) Each liner is provided with lubrication grooves that are supplied from fittings on the under side of the slide. There is a 4-inch-wide keyway at the top of the bore to receive the gun slide cylinder key. This keyway is milled through the liners and the entire length of the slide bore. The outer surface of the slide has machined seats for attaching the counterrecoil cylinder mounting brackets and for mounting the recoil cylinder.

Gun cover. The gun cover (fig. 4-6) is a cylindrical subassembly of the slide that extends the slide bore forward and through the gun port. A cylindrical weldment of 0.50-inch steel plate, with an integral diameter of 49.5 inches, the gun cover is secured to the front face of the slide by a steel flange welded to the gun cover plates, 24 equally spaced bolts, and a gasket. A wiping ring at the forward end of the gun cover provides oil and weather seal for the slide cylinder. The gun cover is completely enclosed by a leather buckler, clamped on the outer surface of the wiping ring and mounted on the front face of the armor face plate.

Hydraulic recoil system. The recoil system (fig. 4-7) is a hydraulic throttling device that acts with the counterrecoil system to limit recoil movement. The recoil system also acts as a buffer when the gun is returned to battery position by the counterrecoil mechanism.

Components. The recoil mechanism consists of the following components:

Recoil cylinder
Cylinder head
Cylinder nut
Piston, piston rod, and piston ring
Throttling rods
Piston rod packing, gland, and nuts
Recoil liquid expansion system
Buffer

General arrangement. The recoil cylinder is secured by two straps to the bottom of the slide; the piston rod is secured to the yoke (fig. 4-7). The axis of the piston rod is parallel to the gun bore axis and 43.0 inches vertically below it. Three expansion tanks are mounted on the bottom of the slide, forward of the recoil cylinder. The tanks are connected to the recoil cylinder by a system of pipes that forms a closed system for expansion of recoil liquid. The recoil system is the same in all slide

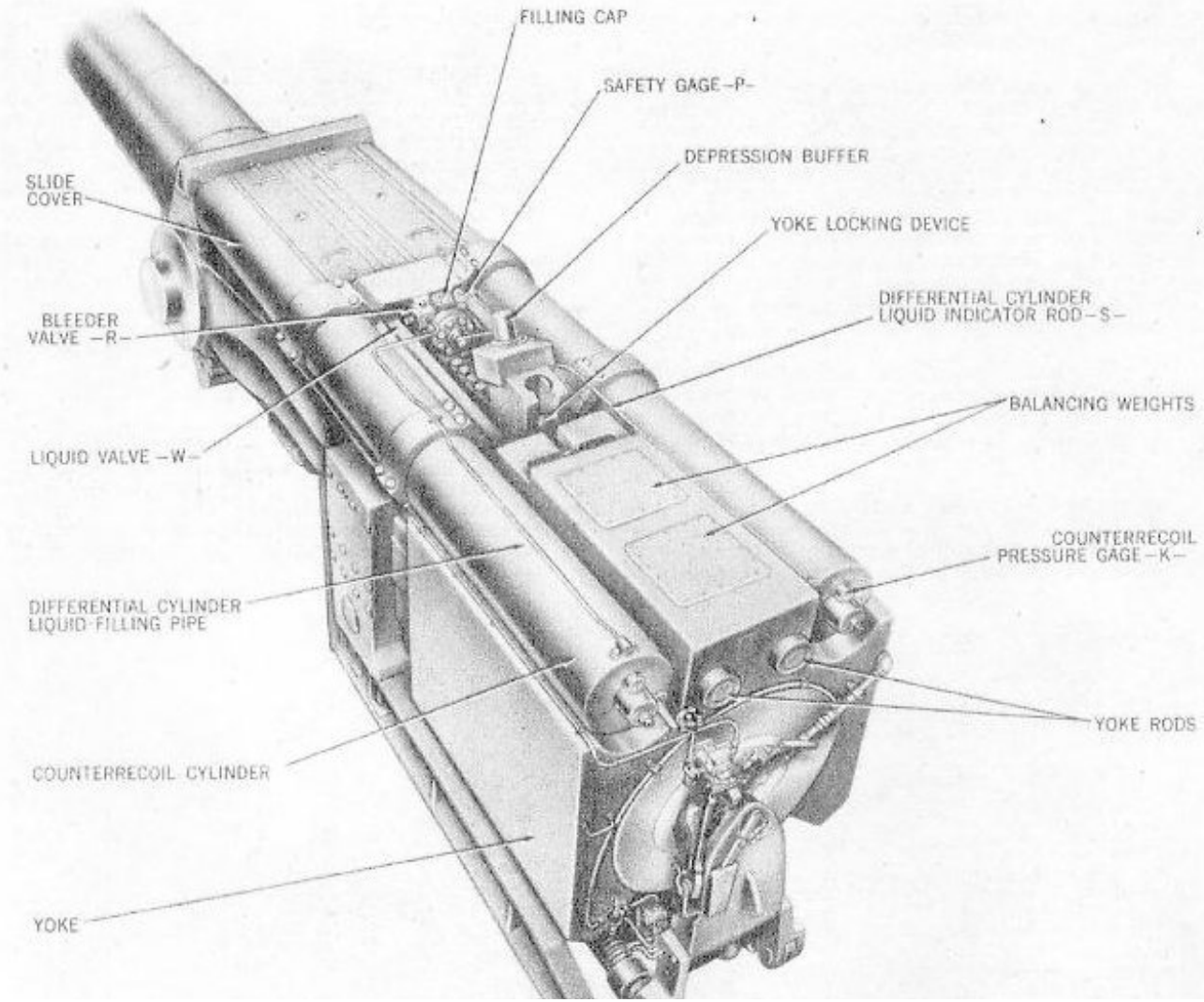




Figure 4-5. 16-inch Gun Mk 7 Mod 0 and 16-inch Slide Mk 6 Mod 0 Assembled
(Operating Lever Safety Ratchet Mechanism Assembly
Not Shown; See Figure 3-3)

assemblies. The cylinder head is designed with an integral dashpot that acts with the piston plunger to buff the return-to-battery of the gun.

Recoil cylinder. The recoil cylinder is secured to the bottom of the slide by two straps. Machined integral shoulders of the cylinder fit into machined seats of the slide to keep the units in alignment. The cylinder is a cylindrical, nickel steel forging, 75.25 inches long, bored for the recoil piston and piston rod. A packing gland nut seals the rear end of the cylinder around the piston rod. The forward end of the cylinder is closed by a forged nickel steel cylinder head with integral dashpot.

Cylinder head. The cylinder head closes the forward end of the recoil cylinder and forms the dashpot for counterrecoil buffing by the recoil piston plunger. A bronze bushing at the cylinder end of the head forms the bearing surface for the piston plunger. The cylinder head is secured to the recoil cylinder with a copper gasket, a dowel pin, and 20 nickel steel bolts. The forward end of the head is drilled and tapped for attaching a pressure gage; however, this hole is normally plugged. Two threaded holes in the flange, 180 degrees apart, provide for jackscrews to disassemble the head.

Cylinder nut. The cylinder nut passes over the piston rod and threads onto the recoil cylinder. When the nut is tightened, it compresses the packing gland and packing to seal the recoil liquid in the recoil cylinder.

Piston and piston rod, and piston ring. The integral piston, piston rod, and piston plunger are machined from one piece of nickel steel. The piston is ring. The piston has three equally placed holes bored through it for the throttling rods. The rear end of the piston rod is threaded into the yoke and secured by two locknuts.

Throttling rods. Three throttling rods, secured in the cylinder and cylinder head, pass through holes in the piston. The varying-diameter rods (fig. 4-7) are spaced at 120 degrees and are aligned parallel to the recoil cylinder axis. The rods, of variable diameter, provide a graduated flow of liquid through the piston holes during the recoil stroke to cause a gradual checking of the recoil motion.

Piston rod packing, gland, and nuts. Coil packing around the piston rod is compressed in the rear end of the recoil cylinder by a packing gland and the cylinder nut to prevent loss of recoil liquid from the cylinder. The piston rod is threaded and is attached to the gun yoke with two piston rod nuts. The nuts thread onto the piston rod and both lock and center the piston rod in the yoke.

Recoil liquid expansion system. The expansion tanks and pipe manifold system keep the recoil cylinder full of liquid and permit the liquid to expand when it heats up during firing. Three tanks, secured by straps and bolts to the bottom of the slide, are connected to each other and to the recoil cylinder head by a pipe manifold system. The system is located on the bottom of the slide, forward and above the recoil cylinder.

Buffer. The forward end of the piston rod is a dashpot plunger that operates in conjunction with the dashpot of the cylinder head to buff the last one-third of counterrecoil movement. The plunger has four variable-depth, longitudinal grooves that gradually restrict the flow of liquid from the dashpot as the gun

threaded for assembly of the bearing-bronze piston

returns to battery.

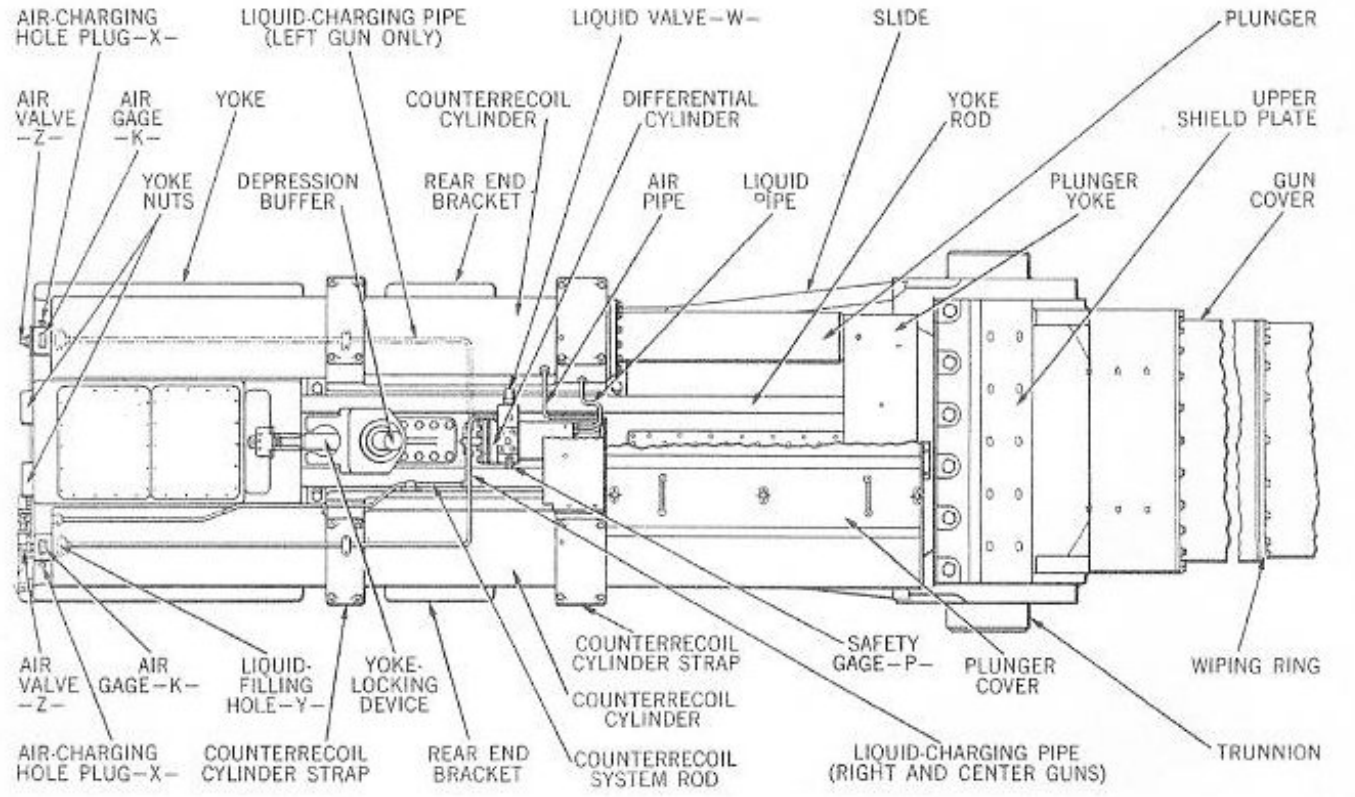


Figure 4-6. 16-inch Slide Mk 6 Mod 0, General Arrangement, Plan View

Counterrecoil system. The counterrecoil system (fig. 4-8) is a hydropneumatic gun recuperator that consists of two air bottles (or counterrecoil cylinders), two plungers and their packings, and a differential cylinder unit. A plunger yoke, yoke rods, gages, valves, and other parts, including a removable cover, complete the assembly. The system absorbs part of the energy at gun recoil to return the gun to battery. The entire assembly is located on top of the slide, as shown in figure 4-6. The axes of the two cylinders are parallel, 43.0 inches apart, and 32.5 inches above the gun centerline. The differential cylinder is centered between the counterrecoil cylinders, 38.0 inches above the gun centerline. In

air side of the differential cylinder by piping. Pipes connect the liquid side of the differential cylinder with the plunger packing seats at the forward ends of the two cylinders. The differential cylinder is so constructed that the pressure of the liquid is always greater than the cylinder air pressure. Distended by the liquid pressure, the packings provide an air-tight seal for the cylinder and plunger assembly. The plungers slide in and out of the open, forward end of the counterrecoil cylinders when the gun recoils and counterrecoils.

Plungers. The plungers are cylindrical monel metal forgings. Each plunger is a hollow cylinder

their installed arrangement in the slide, the chambers of the counterrecoil cylinders are each charged with air to an initial pressure of 1550 pounds per square inch. This stored energy is sufficient to hold the gun in battery at any angle of elevation. Recoil action builds up air pressure in the chambers to a peak of approximately 2150 pounds per square inch (at maximum recoil), and this stored energy thrusts the gun back into battery with sufficient force, at the end of the stroke, to require buffing by the recoil piston plunger. The differential cylinder unit varies liquid pressure on the plunger packings as the air pressure varies to seal in the high air pressures at all times.

Components. The counterrecoil mechanism consists of the following components:

Counterrecoil cylinders
Plungers
Plunger packing
Differential cylinder
Air pressure gage
Plunger yoke and yoke rods

Counterrecoil cylinders. A pair of counterrecoil cylinders, with a plunger in each cylinder, comprise the counterrecoil cylinder assembly (fig. 4-8). The air chambers of both cylinders are connected to the open at the rear and closed at the forward end, assembled as shown in figure 4-8. The outer surface of the plunger is highly finished so that it will slide easily through the plunger packing without disturbing the high-pressure seal of the plunger packing.

Plunger packing. The plunger packing (fig. 4-8) is an assembly of preformed-composition, chevron-type packing rings. These rings are assembled in the bore at the forward end of the counterrecoil cylinder. There are 12 chevron packing rings in this assembly, with 6 rings on either side of a steel ring called the plunger packing follower. The entire assemblage is seated and retained against a shoulder in the bore by a gland. The follower is connected by a drilled passage and pipe line to the oil chamber of the differential cylinder.

Differential cylinder. The differential unit is a cylinder with a floating piston. The cylinder chamber is divided by the piston into air and liquid chambers. One chamber is connected by pipe lines to the air chambers of the counterrecoil cylinders so that it is always charged with the same (varying) pressure that is present in the counterrecoil cylinders. The other chamber is filled with oil and is connected by pipe lines to the plunger packing seats. The area of the piston in the oil chamber is approximately 15 percent

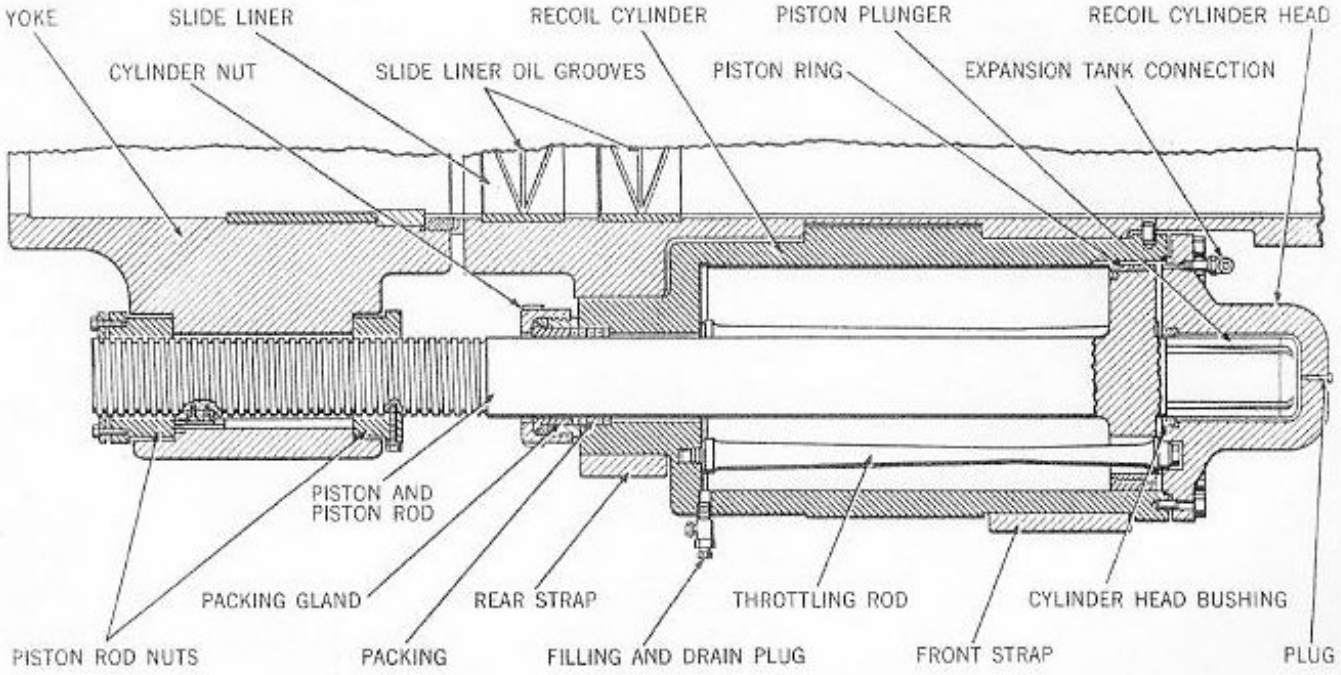
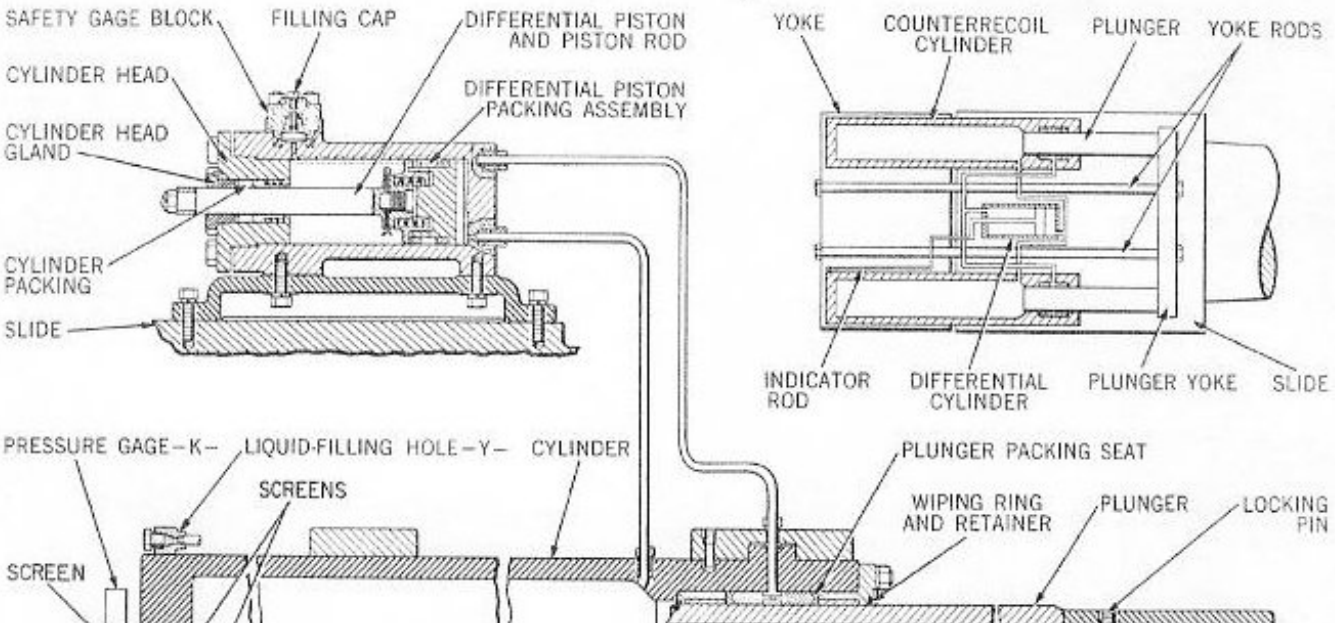


Figure 4-7. Recoil System, General Arrangement, Sectional View

less than the area in the air side because of the piston rod, which passes through a stuffing box to the atmosphere. This results in greater pressure on the liquid side to distend the chevron packing rings. If there is leakage in the system, it will be oil and not air. Leakage is indicated by the amount that the indicator rod (fig. 4-6) attached to the end of the differential piston rod protrudes at the breech. Under no condition should the indicator rod be allowed to project beyond the rear face of the yoke; when it does, the liquid in the differential cylinder must be replenished. A liquid pressure safety gage (P) (figs. 4-9 and 11) is located on top of the differential cylinder; a pipe line connects it to the liquid side of the cylinder so that the liquid pressure on the plunger packing is indicated at all times. This gage is installed with a special safety feature which prevents loss of liquid in the event of gage rupture. The mounting consists of a plate with a screw thread gage seat bolted over a cavity in the differential cylinder forging. A leather diaphragm under the plate separates the pipe line to the plunger packing from the gage lead in the block. For proper functioning, the space above the diaphragm must be filled with liquid before the system is charged.

Air pressure gage. The counterrecoil cylinders are each provided with a gage (fig. 4-1) mounted on the breech end of the cylinder. An adjacent nameplate designates the gage as "Air Gage-K." This gage is connected with the cylinder air chamber by a drilled lead provided with a valve designated "Air Valve-Z." This valve, normally closed and covered by a cap plug, is opened only to obtain a reading on the air gage or when replenishing the air pressure. Filter screens are installed in the leads connecting the gage and valve with the cylinder air chamber as a safety device to reduce the danger of explosion in the event oil leaks into the air cylinder.* Normal air pressure in the system is 1550 pounds per square inch. The pressure should not be permitted to go above 1700 pounds per square inch nor below 1400 pounds per square inch with the gun at battery. This information is included on the instruction plate, adjacent to the valve, on the rear face of the yoke.

Plunger yoke and yoke rods. The counterrecoil plungers are connected to the gun yoke through the plunger yoke and two yoke rods (fig.4-8). The plunger yoke has integral yoke shoes which slide on the plunger yoke guide rails. These rails are mounted lengthwise and parallel to each other, on the top of the slide, between the counterrecoil cylinders. The forward end of each plunger is seated in the plunger yoke and is held there by the recuperator pressure; a locking pin prevents the plunger from turning. The entire assemblage is housed beneath a plunger cover that consists of formed steel plates and flanged frames in a riveted and spot welded assembly that is bolted to the slide. Portable sections may be removed for inspection and maintenance.



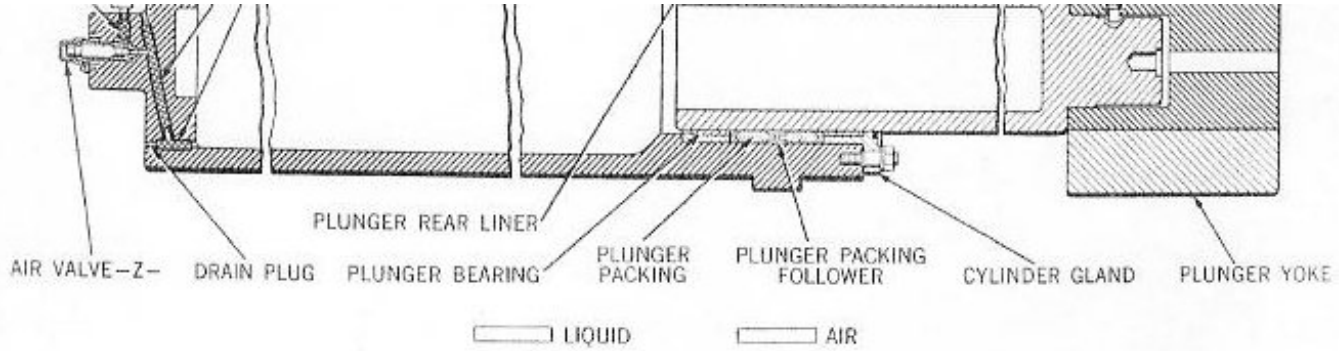


Figure 4-8. Counterrecoil System Schematic, Sectional View

*ORDALT 1324.

Yoke locking device. The yoke locking device (fig. 4-12) is located on top of the slide and is centered between the counterrecoil cylinders. The device is secured in a seat that is aligned with a notched lug on top of the yoke. The device is composed of a safety link, knurled nut, and a link pin. In its locked position, the safety link, with its nut swung down behind the notched lug of the gun yoke, secures the gun in battery. The safety link is strong enough to hold the gun in battery, with the counterrecoil cylinders empty, at any a n gle of elevation. The safety link will fail, without any other casualty, if the gun is fired before stowing the device.

Buffers. In addition to the mechanical automatic elevation and depression limit stops described in chapter 5, each slide is provided with hydraulic elevation and depression buffers. These buffers provide positive limits at a 45-degree angle of elevation for all turrets and a 2-degree angle of depression for turrets I and III. Limit of depression for turret II is 0 degrees elevation.

There are two elevation buffers for each slide. These are mounted on the left and right gun girders, each at the same level above the gun pocket floor. The elevation stops are mounted on the bottom of the slide rear end brackets.

The depression buffer (fig. 4-12) is bolted on top of the slide. Its housing is integral with the yoke locking device bracket. The steel depression stop is bolted to the underside of the turret roof in the way of the buffer.

Both the elevation and depression buffers are of return of the piston following its release.

Rear end brackets. The rear end brackets (fig. 4-13) are mounted at the rear of the gun slide, one on the left and one on the right side. They are similar right and left castings and are bolted to machined seats in the slide. The brackets are designed so that either a slide securing device and a cantilever loader's platform bracket or the elevating screw pin can be mounted to them. When assembled, the symmetrical design and arrangement of the rear end brackets adapt any slide to right, center, or left gun position of any one of the three gun turrets. The right and center guns are arranged with the platform bracket and slide securing device assembled to the right rear end bracket. The elevating screw pin is mounted in the left rear end bracket. This arrangement is reversed for the left gun. Elevation steps are located on the bottom of each bracket.

Loader's platform. The loader's platform extends rearward from the gun breech and spans the gun pocket. The platform is an integral part of the cantilever loader's platform bracket, which is attached to the rear end bracket, as shown in figure 4-1. The bracket is a steel casting. The arrangement illustrated is for the left gun; for the right and center guns the bracket is attached to the right rear end bracket.

(Slide securing device. The slide securing device (fig. 4-13) is a handwheel-operated screw and pin assemblage for stowing the gun slide at 0 degrees gun elevation. A tapered steel pin in the rear end

a self-contained, hydraulic-type, spring-return design. Both have ball check valves to ensure quick

bracket seats in a tapered socket in the adjacent gun girder. When seated, the pin relieves the elevating

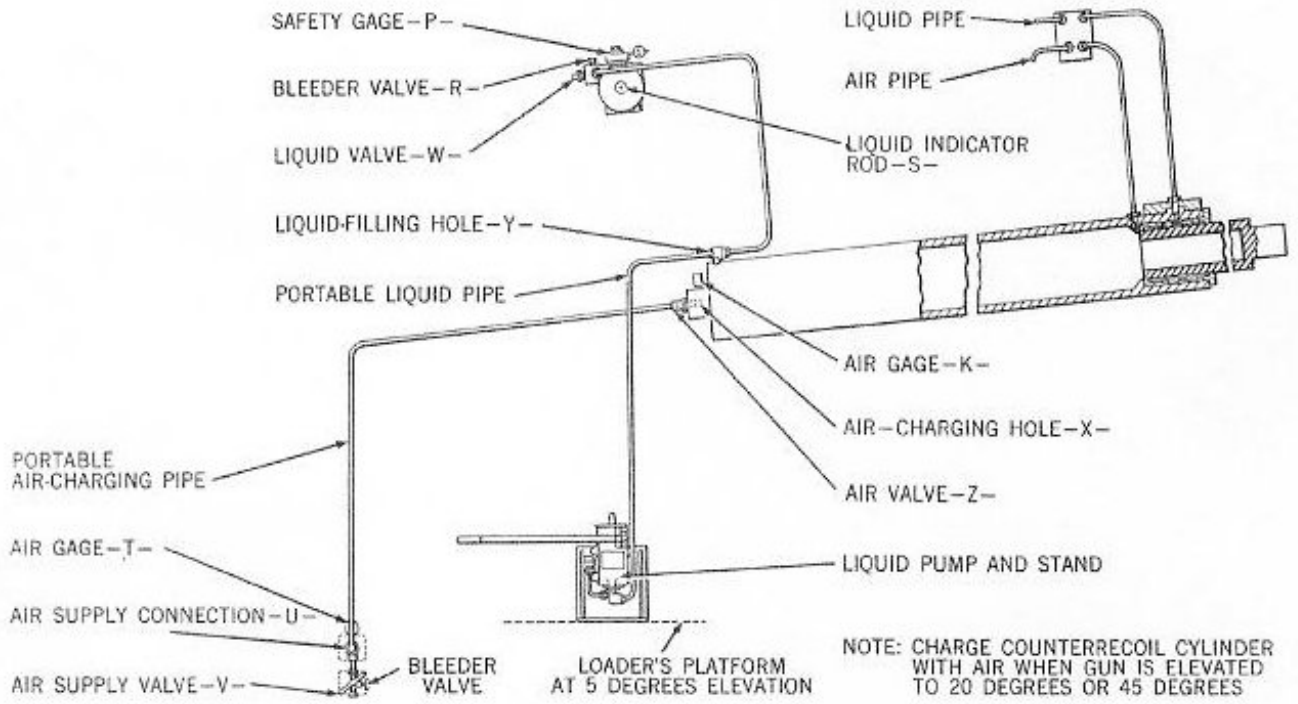


Figure 4-9. Counterrecoil System Air Charging and Liquid Devices

screw and nut assembly from dead load stresses. A securing pin latch locks the device when the pin is either fully seated or fully retracted. A second socket in the gun girder is aligned with the pin when the gun is at 20 degrees elevation. This is used to secure the slide when the portable air charging pipe is installed for replenishing the recuperator air charge (fig. 4-9). Steps and hand grips in the gun girder give access to the securing device. The device can be reached from the gun pocket floor when the gun is at either securing position.

Recoil switch and blade contacts. A lever-

closed position the switch is connected to the coil circuit of the recoil relay, Relay Mk 5 Mod 1, and to the GUN IN RECOIL indicator lights circuit. The blade contacts are in series with the breech switch (ch. 3) and are closed when the gun is in battery. When closed, they energize a solenoid to unlock and permit the positioning of the gun captain's ready switch to READY and illuminate a BREECH CLOSED indicator light. When the gun leaves battery in recoil, the recoil switch closes, thus switching from one circuit to the other as described above. This action de-energizes the gun captain's ready switch solenoid and illuminates the recoil indicator lights.

actuated recoil switch and a set of blade contacts are mounted on each gun slide as shown in figure 4-10. The switch is a two-circuit switch that is normally open when the gun is in battery and normally closed during recoil. In the normally open position the switch is part of a circuit containing the slide contacts and the breech closed switch; in the normally

The sequence of events is so arranged that the recoil switch opens the circuit containing the breech closed switch before the slide contacts can open, thus eliminating any possible arcing of the slide contacts. The recoil switch and blade contacts are part of the interlock portion of Ready Light circuit 1R (ch. 15).

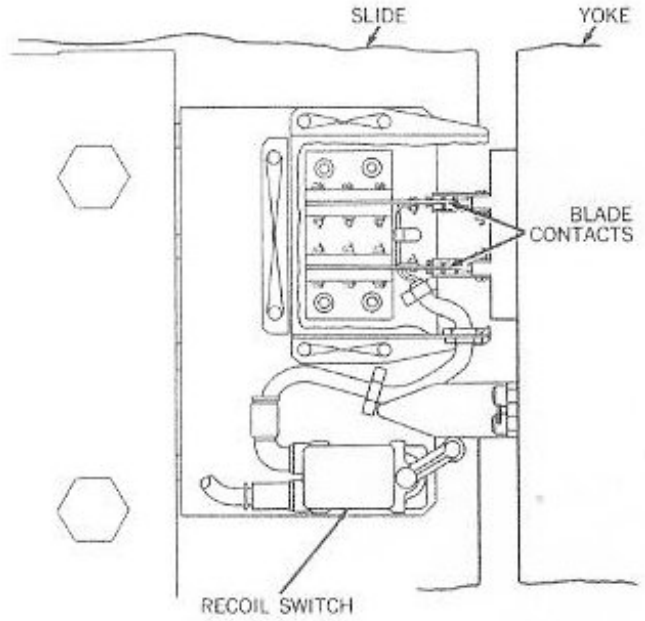


Figure 4-10. Recoil Switch and Blade Contacts

OPERATION

Slide operation when gun is fired.

Slide operation is controlled at all times by its self-contained recoil and counterrecoil systems. Before the gun is to be fired, the recoil system must be filled and the counterrecoil cylinders charged to the operating pressure.

When the gun fires and recoils, the recoil piston and the two counterrecoil plungers are drawn to the rear. The liquid in back of the recoil piston is throttled through the holes in the piston at a rate that is regulated by the varying diameter of the throttling rods. At the same time, the plungers are drawn to the rear within the counterrecoil cylinders. The initial high air pressure within these cylinders is raised by compression to a maximum pressure of 2150 pounds per square inch. The recoil is stopped within 48 inches (1/3-second) by the combined actions of the recoil and counterrecoil systems. The stored energy in the recuperator (counterrecoil cylinders) thrusts the gun back toward battery position. Return flow of liquid around the throttling rods buffs the counterrecoil to some extent; however, the major buffing action is provided by the recoil piston plunger. During the last 16 inches of return to battery movement, the recoil piston plunger displaces liquid from the dashpot in the recoil cylinder head. The liquid is forced from the dashpot through four grooves of variable depth in the plunger and through the fine clearance between the plunger and the cylinder head bushing. This action slows the return-to-battery movement and brings the oscillating gun assembly to a gentle stop as the gun reaches its battery position.

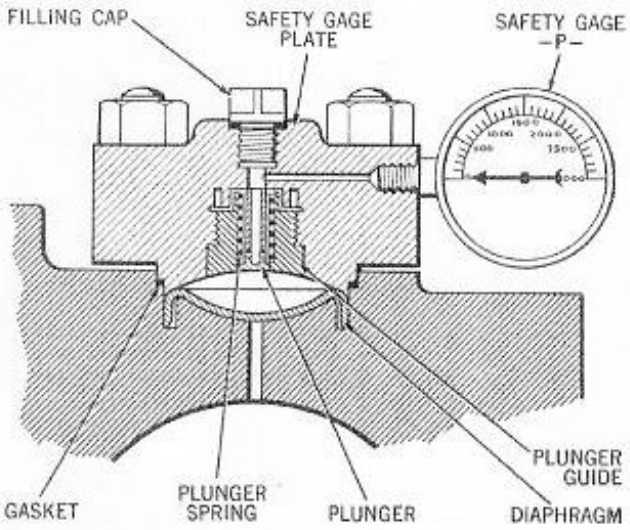


Figure 4-11. Counterrecoil System Differential Cylinder Safety Gage, Sectional View



INSTRUCTIONS

General instructions

The importance of proper care and frequent thorough inspection of the slides and deck lugs cannot be overstressed. Indifferent servicing of slide bearing surfaces and mechanisms, and of the other attached units, will result in improper functioning and serious damage. Observe the general regulations for maintenance of slides and deck lugs in the Bureau of Ordnance Manual, chapter V, the instructions on the instruction plates attached to the various assemblies, and the specific directions that follow in this chapter.

The slide assembly, particularly the hydropneumatic counterrecoil system, requires periodic exercise to keep it in good operating condition. Exercise serves the extremely important function of exercising the plunger packing chevrons, deflating and again distending them. This prevents their taking a permanent set or seizing. By keeping them pliant, their sealing capacity is retained.

To prevent unnecessary wear and consequent needless mechanical failure, keep all elements of the slide properly lubricated at all times. See the "Lubrication" paragraph following and the lubrication charts provided.

To prevent formation of rust or corrosion, all metal surfaces of the slide should have a preservative coating at all times. This coating may be paint or an oil film or other lubricant. Renew paint on painted surfaces whenever the coating is scratched, damaged, or deteriorated. Keep all bright work coated with a film of light oil except for the counterrecoil plungers, which should not be coated. Perform all lubrication as prescribed so that no bearing surface will be left unprotected.

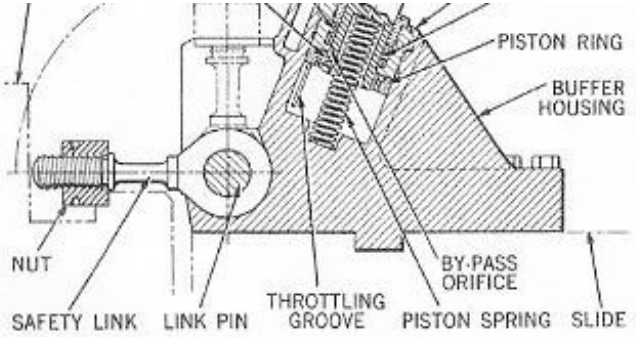


Figure 4-12. Depression Buffer and Yoke-Locking Device, Sectional View

Lubrication. Lubricate the deck lug, the slide, and all slide-mounted units according to the frequency and with the lubricants specified on the lubrication charts provided. Lubrication of the trunnion radial bearing is primarily for preservation. Keep the voids of the bearing and coverplate full of the corrosion inhibiting grease specified. Check the adequacy of lubricant at frequent intervals and observe the condition of the lubricant seals.

Gage the loss of lubricant from the bearings by regular cleaning and inspection of the bearing block surfaces. Observe whether an excessive quantity of grease has dripped from the bearings. Seepage that exceeds normal grease loss from the bearings indicates that lubricant must be replaced without delay.

4-10A/B

Always lubricate the gun slide liner, the plunger yoke, and plunger yoke guide rails before and after firing. Do not use excessive amounts of grease; remove all spilled or exuding grease. Check the various parts for galling after firing. Refer to chapter 18 for information on the substitution of lubricants.

Routine preparation for firing. When preparing the slide assembly for firing, perform the following checks and operations:

1. Be sure that the slide is properly lubricated; perform the "before firing" lubrication.

2. Read and record the air pressure indicated on the counterrecoil air pressure gage. Recharge if at or below the minimum prescribed (1400 pounds per square inch).

3. Measure and record the projection of the counterrecoil system indicator rod S. Replenish liquid if necessary.

4. Retract and latch the pin of the slide securing device.

5. See that the recoil system liquid is at the proper level with the gun at 0 degrees elevation. Replenish, if necessary, until liquid appears at thecap plug on the expansion line.

6. Disconnect and stow the yoke locking device.

7. See that there is enough liquid in the elevating and depression stop buffers.

8. Make certain that the plunger covers are secure.

Instructions for stowing the slide after firing. Perform the following checks and operations after firing:

1. Connect the yoke locking device and draw it up tight.

2. Read and record the indicated air pressure on the counterrecoil cylinder air gage. Compare with previous reading. If an unusual loss is noted, determine and correct the cause.

3. Measure and record the projection of the counterrecoil system indicator rod S. If a loss of oil occurred during firing, determine the cause, correct it, and recharge the system with both oil and air.

4. Make an external inspection of the recoil system for evidence of loss of liquid.

5. Perform the recoil cylinder alkalinity tests prescribed by MIL-G-18694.

6. Remove the plunger covers and examine the plungers, yoke shoes, and guide rails for galling or other indications of misalignment.



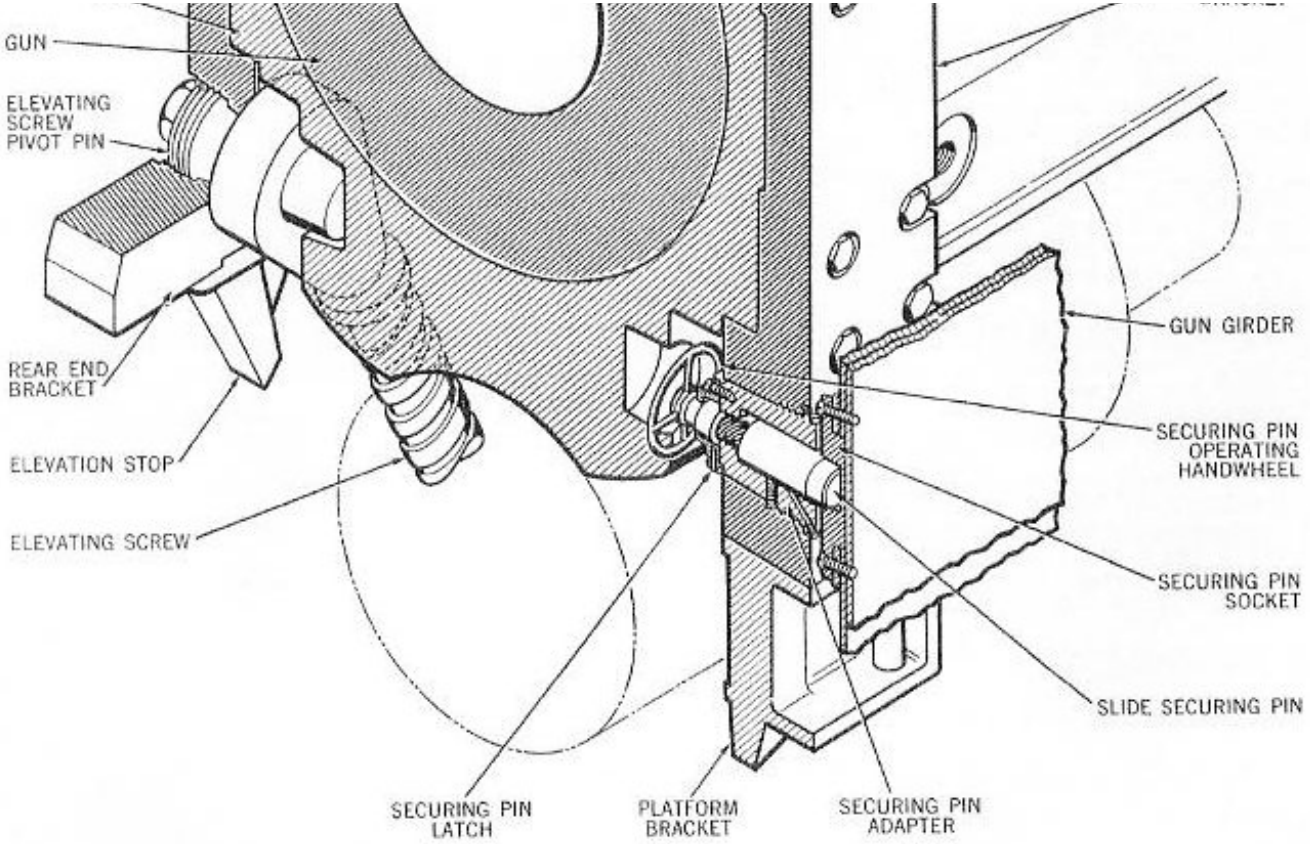


Figure 4-13. **Slide Rear End Brackets, Slide Securing Device and Elevating Screw Pin, Sectional View**

7. Inspect the differential cylinder leads, the gage, and the gage safety block for leakage.

8. Bring the gun to 0 degrees elevation; and latch the slide securing pin.

9. Replenish the slide liner lubricant and check the gun cover wiping ring.

General slide servicing instructions

The following instructions must be strictly observed to avoid casualties to personnel or equipment.

Recoil liquid. Never charge the recoil system

air charging pipe lines and fittings, and a liquid charging pump are provided for servicing the slide assembly. These tools and accessories, and no others, are to be used when working on the equipment.

Servicing instructions for slide recoil and counter-recoil systems

Servicing the recoil system. When filling or draining the recoil system, perform the operations listed below:

Filling routine.

1. Prepare an adequate quantity of recoil liquid

Recoil liquid. Never charge the recoil system with any other liquid than that prescribed by OS 1914, latest revision. When filling, strain through a fine mesh screen (at least 120 wires to the square inch, finer if possible). Whenever the system is drained, follow the instructions given in MIL-G-18694 as to care, preservation, and test.

Recuperator differential liquid. Never charge the differential cylinder with any liquid other than ice machine oil, Navy Symbol 2075. Replenish when necessary to maintain indicator rod S flush with the rear face of the indicator rear end bracket located on the counterrecoil cylinder. Always check the position of indicator rod S before firing the gun.

Air pressure. Never let the counterrecoil air pressure fall below the minimum of 1400 pounds per square inch except when making prescribed tests. Always check the air pressure before firing the gun. Recharge to 1550 pounds per square inch if below the safe minimum.

Recoil system liquid level. Maintain liquid level in the recoil system at the level of the cap plugs in the expansion line with the gun at 0 degrees elevation. Always check before firing the gun. If low, fill as directed under servicing instructions.

Recoil system valves and plugs. The drain valve, cylinder head plug, and cap plug must be securely seated at all times except when servicing the unit. Always see that they are properly secured and tight after the mechanism has been serviced.

Recuperator valves and plugs. Keep all air and liquid valves and plugs tight at all times except when performing necessary service to the mechanism. Air valve cap Z must be securely seated except when reading the air pressure. Always check the tightness of all valves and plugs before firing the gun.

Care of the recuperator plunger. Never wipe the plungers with dirty, greasy, or harsh rags. These highly finished cylindrical surfaces must be free from scars and scratches; they do not require a film of oil. Keep the plunger covers latched in place at all times except when inspecting or servicing the unit.

Thrust bearing clearance. Maintain a trunnion thrust plate clearance of 0.002 inch on each side. To correct for excessive thrust play, see the adjustment instructions on page 4-16 (deck lug adjustment).

Legibility of instruction plates. Do not deface, alter, or paint over the name and instruction plates; they must be kept clearly legible.

Tools and accessories. Special tools, spanner wrenches, open end wrenches, portable liquid and

1. Prepare an adequate quantity of recoil liquid in accordance with MIL-G-18694. Use no other liquid.

2. See that the yoke locking device is connected, and that the slide securing pin is seated with the gun at 0 degrees elevation.

3. Connect the standard funnel and filling hose to the filling and drain valve.

4. Support the funnel above the level of the cap plug aperture.

5. Remove one cap plug from the expansion line manifold.

6. Open the filling and drain valve.

7. Run liquid into the funnel until it flows from the cap plug opening. The last portion must be run in slowly to allow the recoil cylinder dashpot to fill.

8. Close the filling and drain valve.

9. Remove hose and replace cap.

10. Replace the cap plug.

Draining routine.

1. Connect the yoke locking device and secure the slide at 0 degrees elevation.

2. Connect the filling hose to the filling and drain valve.

3. Provide adequate containers on the gun pocket floor to catch the liquid.

4. Remove one cap plug from the expansion line manifold.

5. Open the drain valve and run the liquid into the containers.

Recoil piston rod packing replacement. Worn recoil piston rod packings that can not be set up enough to stop leakage must be replaced with new packings of the specification designated on the detail drawing. Replace as follows:

1. Drain the recoil system as outlined above.

2. Bring the gun to 0 degrees elevation and seat the slide securing pin.

3. Uncouple the yoke locking device.

4. Bleed the counterrecoil air pressure. (Do not completely exhaust the system.)

5. Jack the gun out of battery (approximately 12 inches).

6. Back off the cylinder nut with spanner wrench.

7. Slide the packing gland out.

8. Remove the split rings of worn packings.

9. Carefully clean the packing seat.

10. Position the new packing (OS 687) around the piston rod in the packing seat.

11. Install the packing gland and reseat the cylinder nut.

12. Jack the gun back into battery position; couple the yoke locking device and run the nut up tight.

13. Fill the recoil system as outlined above.

14. Retract the slide securing pin.

15. Bring the gun to 20 degrees elevation and recharge the counterrecoil air system to the required air pressure.

Servicing the counterrecoil system. The mechanisms of this system are provided with special portable pipe and pump facilities and with permanently located high-pressure air-line arrangements (in the gun pocket, turret pan floor) for the purpose of replenishing air and liquid and to permit service tests. All openings, valves, and gages are precisely designated by nameplates and the parts labeled have cross-reference instructions and diagrams compiled on drawing 232190. For convenient reference, the diagrams, servicing connections, and accessories are shown in figure 4-9, and the instructions are repeated below. These instructions are specific routines, both for initial charging of liquid and air, and for subsequent replenishment of one or both.

Part identity. The labeled parts and their symbols are:

1. On turret structure

Instruction plates. Instruction plates, secured to the rear face of the yoke, carry the legends reproduced below:

INSTRUCTION PLATE

AIR GAGE

AIR GAGE -K- LOCATED ON THE REAR OF EACH COUNTERRECOIL CYLINDER, PROVIDES A MEANS OF CHECKING THE AIR PRESSURE IN THE COUNTERRECOIL SYSTEM. THE AIR PRESSURE READING IS OBTAINED BY OPENING AIR VALVE -Z-. CAUTION: THE AIR VALVE -Z- SHOULD BE OPENED ONLY LONG ENOUGH TO OBTAIN AIR PRESSURE READING AND MUST BE CLOSED AT ALL OTHER TIMES. THE SERVICE PRESSURE SHOULD READ 1550 POUNDS ON AIR GAGE -K-. UNDER NO CONDITION SHOULD AIR PRESSURE BE ALLOWED TO DROP BELOW 1400 POUNDS, OR RISE ABOVE 1700 POUNDS ON AIR GAGE -K-. DO NOT ATTEMPT TO REPLENISH OR BLEED THE AIR SYSTEM WITHOUT CONSULTING ORDNANCE DRAWING NO. 232190.

INSTRUCTION PLATE

LIQUID INDICATOR

THE AMOUNT OF PROJECTION OF LIQUID INDICATOR -S- BEYOND THE REAR FACE OF ITS REAR BRACKET INDICATES THE LOSS OF LIQUID FROM THE COUNTERRECOIL SYSTEM. UNDER NO CONDITION SHOULD THE INDICATOR BE ALLOWED TO PROJECT BEYOND THE REAR FACE OF THE YOKE WITHOUT REPLENISHING THE LIQUID IN THE DIFFERENTIAL CYLINDER. DO NOT REMOVE LIQUID VALVE CAP -W-, LIQUID FILLING HOLE PLUG -Y-, NOR ATTEMPT TO REPLENISH THE LIQUID IN THE DIFFERENTIAL CYLINDER WITHOUT CONSULTING ORDNANCE DRAWING NO. 232190.

The servicing instructions and warnings quoted from drawing 232190 are:

WARNING

YOKE LOCKING DEVICE MUST

1. On turret structure

Air supply valve	V
Air supply connection	U
Air gage	T
Bleeder valve	R

2. On each mechanism

Air valve	Z
Liquid valve	W
Liquid filling hole	Y
Air charging hole	X
Air gage	K
Safety gage	P
Indicator rod	S

BE CONNECTED AT ALL TIMES EXCEPT WHEN THE GUNS ARE TO BE FIRED OR OPERATING TESTS ARE TO BE CONDUCTED.

COUNTERRECOIL SYSTEM

THE COUNTERRECOIL SYSTEM IS LOCATED ON TOP OF THE SLIDE AND CONSISTS OF AN AIR AND LIQUID SYSTEM HOUSED IN TWO AIR CYLINDERS AND ONE DIFFERENTIAL CYLINDER. THE AIR CYLINDERS AND DIFFERENTIAL CYLINDER ARE INTERCONNECTED WITH PIPING. THE AIR SYSTEM IS FILLED WITH AIR TO A PRESSURE OF 1550 POUNDS PER SQUARE INCH.

THE LIQUID SYSTEM IS FILLED WITH ICE MACHINE OIL (NAVY SYMBOL NO. 2075). THE LIQUID SYSTEM HOLDS APPROXIMATELY 1-1/2 GALLONS. WHEN THE AIR AND LIQUID SYSTEMS ARE BOTH EMPTY, THE LIQUID SYSTEM MUST BE FILLED FIRST.

LIQUID SYSTEM

TO FILL WHEN BOTH AIR AND LIQUID SYSTEMS ARE EMPTY:

1. SET GUNS TO FIVE DEGREES ELEVATION.

2. DISASSEMBLE SAFETY GAGE PLATE.

3. DISASSEMBLE SAFETY GAGE LEATHER DIAPHRAGM.

4. REMOVE PLUG FROM LIQUID FILLING HOLE -Y-.

5. REMOVE CAP FROM LIQUID VALVE -W- AND BACK OFF VALVE STEM 3 TURNS.

6. OPEN BLEEDER VALVE -R-.

7. SECURE LIQUID PUMP TO LOADER'S PLATFORM.

8. CONNECT LIQUID PORTABLE PIPE FROM LIQUID PUMP TO LIQUID FILLING HOLE -Y-.

9. PUMP LIQUID INTO SYSTEM.

10. CLOSE BLEEDER VALVE -R- WHEN

19. DISCONNECT LIQUID PORTABLE PIPE FROM LIQUID PUMP AND LIQUID FILLING HOLE -Y-.

20. REPLACE PLUG IN LIQUID FILLING HOLE -Y-.

TO REPLENISH UNDER AIR PRESSURE

NOTE: DUE TO LUBRICATION OF COUNTERRECOIL PLUNGER, DIFFERENTIAL PISTON AND PISTON ROD, THE LIQUID WILL IN TIME NEED REPLENISHING. THIS REPLENISHING SHOULD BE DONE BEFORE THE LIQUID INDICATOR ROD -S- PROJECTS FLUSH WITH THE REAR FACE OF THE YOKE.

21. SET GUNS TO FIVE DEGREES ELEVATION.

22. REMOVE PLUG FROM LIQUID FILLING HOLE -Y-.

23. PERFORM OPERATIONS 6, 7, 8, 9, 10, 5, 17, 18, 19, and 20.

SAFETY GAGE P

THERE IS A SAFETY GAGE LOCATED ON THE TOP ON EACH DIFFERENTIAL CYLINDER. THE SAFETY GAGE SHOWS THE LIQUID PRESSURE ON THE SYSTEM AT ALL TIMES. IF THE GAGE IS BROKEN OFF OR DAMAGED, THE LEATHER DIAPHRAGM PREVENTS THE IMMEDIATE LOSS OF LIQUID FROM THE SYSTEM. THE SPACE ABOVE THE LEATHER DIAPHRAGM CANNOT BE FILLED IF AIR PRESSURE IS ON THE SYSTEM. THE FOLLOWING CONDITIONS MAY CAUSE THE SAFETY GAGE TO CEASE FUNC-

LIQUID APPEARS AT THE VALVE.

11. CONTINUE TO PUMP LIQUID UNTIL LIQUID APPEARS FLUSH WITH THE SAFETY GAGE DIAPHRAGM SEAT.

12. REPLACE LEATHER DIAPHRAGM, PRESSING IT FIRMLY AGAINST ITS SEAT.

13. ASSEMBLE SAFETY GAGE PLATE.

14. REMOVE SAFETY GAGE FILLING CAP AND GASKET.

15. WITH SMALL ROD, PUSH DOWN SAFETY GAGE PLUNGER AS FAR AS IT WILL GO: HOLDING PLUNGER DOWN, FILL SLOWLY WITH LIQUID THE SPACE ABOVE THE LEATHER DIAPHRAGM. THE SAFETY GAGE PLUNGER SHOULD BE WORKED UP AND DOWN DURING FILLING TO MAKE SURE ALL THE AIR HAS PASSED OUT OF THE SAFETY GAGE. (THE SAFETY GAGE HOLDS ABOUT 2 OZS OF THE SAME LIQUID USED IN THE LIQUID SYSTEM.)

16. WHEN THE LIQUID IN THE SAFETY GAGE IS FLUSH WITH THE FILLING CAP HOLE, REPLACE FILLING CAP AND GASKET.

17. CONTINUE TO PUMP LIQUID INTO SYSTEM UNTIL LIQUID INDICATOR ROD -S- IS FLUSH WITH REAR FACE OF THE REAR END BRACKET.

18. SCREW IN LIQUID VALVE -W- FIRMLY AGAINST ITS SEAT AND REPLACE VALVE CAP.

MAY CAUSE THE SAFETY GAGE TO CEASE FUNCTIONING:

A. LOSS OF LIQUID FROM ABOVE THE LEATHER DIAPHRAGM.

B. THE END OF THE INDICATOR ROD -S- HAS BEEN ALLOWED TO EXTEND BEYOND THE REAR FACE OF THE YOKE, DUE TO LOSS OF LIQUID FROM THE COUNTERRECOIL SYSTEM.

C. INSUFFICIENT AIR PRESSURE ON THE SYSTEM.

D. DEFECTIVE SAFETY GAGE.

TO FILL OR REPLENISH

SAFETY GAGE P

24. BLEED AIR SYSTEM (OPERATIONS 27 AND 29).

25. PERFORM OPERATIONS 14, 15, AND 16.

AIR SYSTEM

TO CHARGE WHEN EMPTY

CAUTION: MAKE SURE YOKE LOCKING DEVICE HAS BEEN CONNECTED AND LIQUID SYSTEM HAS BEEN FILLED.

26. ELEVATE GUNS TO 20 DEGREES ELEVATION.

27. REMOVE PLUG FROM AIR CHARGING HOLE -X-.

28. CONNECT PORTABLE AIR PIPE FROM AIR SUPPLY CONNECTION -U- TO AIR CHARGING HOLE -X-.

29. REMOVE CAP FROM AIR CHARGING VALVE -Z- AND BACK OFF VALVE STEM 3 TURNS.

30. OPEN AIR SUPPLY VALVE -V- VERY SLOWLY AND CHARGE TO 500 POUNDS PER SQUARE INCH AS INDICATED ON AIR GAGE -K-.

31. CLOSE AIR VALVES -V- AND -Z-.

32. BLEED PRESSURE FROM PORTABLE AIR PIPE AT BLEEDER VALVE IN AIR SUPPLY VALVE -V- AND DISCONNECT AT AIR CHARGING HOLE -X-.

33. OPEN AIR VALVE -Z- VERY SLOWLY AND EXAMINE ESCAPING AIR AND AIR CHARGING HOLE -X- TO DETECT THE PRESENCE OF OIL.

34. IF NO OIL IS DETECTED IN OPERATION 33, PROCEED AS FOLLOWS:

A. RECONNECT PORTABLE AIR PIPE TO AIR CHARGING HOLE -X-.

B. CHARGE SYSTEM VERY SLOWLY UNTIL

41. OPEN AIR VALVE -Z- ONE TURN.

42. READ PRESSURE ON AIR GAGE -K-.

43. CLOSE AIR VALVE -Z-.

44. BACK OFF AIR CHARGING HOLE PLUG -X- TO BLEED PRESSURE OFF AIR GAGE -K-; THEN RETIGHTEN AIR CHARGING HOLE PLUG -X-.

General note

1. For daily, monthly, and annual inspection of the counterrecoil system, see instructions issued by the Bureau of Ordnance.

2. Caution: In closing air or liquid valves, use proper tool with no extension. Excessive force on valve may damage valve parts or seat.

3. Caution: Air valves should be opened very slowly, to prevent possible explosion or damage to air gage.

AIR GAGE -K- INDICATES A PRESSURE OF 1700 POUNDS PER SQUARE INCH. ALLOW THIS PRESSURE TO STAND FOR SEVERAL HOURS, THEN BLEED TO SERVICE PRESSURE OF 1550 POUNDS PER SQUARE INCH.

C. CLOSE AIR VALVES -V- AND -Z-, AND REPLACE CAP ON AIR VALVE -Z-.

D. BLEED PRESSURE FROM PORTABLE AIR PIPE AT BLEEDER VALVE IN AIR SUPPLY VALVE -V-, DISCONNECT AIR PIPE AT BOTH ENDS AND REPLACE PLUGS IN AIR CHARGING HOLE -X- AND AIR SUPPLY CONNECTION -U-.

35. IF OIL IS DETECTED IN OPERATION 33, REPEAT OPERATIONS 28 TO 33, USING A PRESSURE OF 800 POUNDS PER SQUARE INCH.

36. IF OIL IS PRESENT AFTER OPERATIONS 33 AND 35, PROCEED AS FOLLOWS:

A. DRAIN LIQUID SYSTEM, DISASSEMBLE AND EXAMINE COUNTERRECOIL AND DIFFERENTIAL CYLINDER PACKINGS.

B. DISASSEMBLE ALL PARTS OF AIR SYSTEM AS ARE NECESSARY TO INSURE REMOVAL OF ALL OIL.

C. REASSEMBLE AND PERFORM OPERATIONS 1 TO 20.

D. PERFORM OPERATIONS 26 TO 36.

TO REPLENISH

NOTE: WHEN AIR PRESSURE ON GAGE -K- DENOTES 1400 POUNDS PER SQUARE INCH OR LESS, THE AIR SYSTEM SHOULD BE REPLENISHED.

CAUTION: MAKE SURE YOKE LOCKING DEVICE IS CONNECTED.

37. CHECK AIR SUPPLY LINE BY OPENING AIR VALVE -V- AND CHECK PRESSURE ON LINE BY AIR GAGE - T-.

38. CLOSE AIR VALVE -V- AND BLEED PRESSURE OFF AIR GAGE -T- BY BLEEDER VALVE IN AIR VALVE -V-.

39. PERFORM OPERATIONS 26 TO 29 AND 34B TO D TO OBTAIN READING OF AIR PRESSURE ON SYSTEM

NOTE: THE AIR PRESSURE IN THE SYSTEM SHOULD BE CHECKED DAILY AND THE PRESSURE SHOULD BE KEPT AT THE SERVICE PRESSURE OF 1550 POUNDS PER SQUARE INCH ON AIR GAGE -K-

40. MAKE SURE AIR CHARGING HOLE PLUG -X- IS TIGHT IN ITS SEAT.

4. In no case should the counterrecoil system be charged with air if oil is in the air portion of the counterrecoil system. This would result in an explosive mixture of air and oil vapor.

5. Extreme care should be taken that the counterrecoil system is not inadvertently charged with oxygen instead of air. An oxygen and oil vapor mixture is highly explosive.

Counterrecoil plunger packing replacement. Worn counterrecoil plunger packing must be replaced to prevent formation of an explosive oil or air mixture, and to prevent loss of air or oil.

Packing specifications. The plunger packing is a chevron-type preformed composition packing ring identified by Ordnance Specification 749.

Packing replacement routine. For plunger packing replacement routine, see "Counterrecoil plunger and packing assembly and disassembly," this chapter.

Routine tests of the slide

General instructions. The slide assembly, and particularly the hydropneumatic counterrecoil mechanism, requires frequent inspection and regular exercise tests in order to assure normal performance when the gun is fired. These tests and inspections are required by instructions contained in the Bureau of Ordnance Manual. Such tests furnish exercise for the plungers and differential chevrons, deflecting and distending them, thus preventing their taking a set or seizing the plungers. By keeping the packings pliant, their sealing capacity is retained. Daily, monthly, and overhaul tests and inspections are separately listed below.

Daily inspection. Daily and immediately after firing, inspect the counterrecoil system for evidence of air or liquid leakage. Observe carefully the exposed cylindrical surface of each recuperator plunger. Proceed as follows:

1. See that the yoke locking device is connected and that the nut is drawn tight against the shoulder of the yoke.

2. Read and record the recuperator system pressures as indicated on both the safety gage and the air pressure gages. If air pressure has dropped to 1400 pounds per square inch or below, recharge the system.

3. Measure and record the protrusion of indicator rod S. If rod end projects near or beyond the rear face of the yoke, replenish the liquid.

Monthly test. Once monthly after completing the inspection prescribed above, perform the following test routine:

CAUTION: Do not elevate the gun after air has been bled from the counterrecoil system with the gun at or near horizontal position. The gun will move toward its recoil position and the plunger yoke shoe will strike the studs in the face of the counterrecoil cylinder. This will stop the gun but the inertia of the counterrecoil plunger may be sufficient to shear or damage the locking pin.

1. Check the level of the recoil system liquid with the gun at 0 degrees elevation. Replenish if necessary until liquid flows from the cap plug vent.

2. Disconnect the yoke locking device, elevate the gun to 20 degrees elevation, secure the slide and perform the following counterrecoil exercise.
* Connect the portable air-charging pipe between U and X. Verify that bleeder valve V is closed. Open air valve Z three turns. Bleed air at V until the gun slides out of battery. Close bleeder in valve V and open air-supply valve until gun returns to battery. Repeat the exercise two more times and give final charge in accordance with routine outlined under "Daily inspection." Retract the slide securing pin.

3. Depress the gun to loading position. Connect the yoke locking device and perform the following differential piston exercise. Remove plug Y and valve cap W. Connect the portable liquid filling pipe to Y and place the lower end in a bracket. Open valve W and bleed off the liquid until indicator rod S is one inch from the rear face of the yoke. Mount the liquid charging pump with oil-pressure gage installed in the line, and restore the liquid. Repeat the exercise two more times and give the final charge in accordance with the routine outlined under "Daily inspection."
* The 45-degree-elevation position shown in figure 4-8 and the portable pipe indicated for that position are not intended for the sliding out exercises. The arrangement shown for 45 degrees elevation is for purpose of service operation in order to get an unbalanced gun assembly back into battery after losing air charge. Under such conditions the elevating gear must not be used to raise the gun to the 20-degree air-charging position.

4. With the liquid pump connected as above, and with the yoke locking device connected, bleed the counterrecoil air charge to zero. Pump liquid until the differential piston moves beyond its fully charged position, and until the liquid pressure gage (safety gage) reading indicates 1000 pounds per square inch. Observe that the plunger packings hold this pressure. Then recharge the air pressure to 1550 pounds per square inch. Bleed liquid until the indicator rod S is at normal full-charge position. Secure the counterrecoil system and mount.

Overhaul inspection. Supplement the above inspections and tests by overhaul inspection of the counterrecoil system at intervals designated by the Bureau of Ordnance Manual. Perform the disassembly at the home yard with the assistance of the yard force. The of sediment present in each. If the amount is unusually large, forward samples (properly designated) to the Bureau of Ordnance.

4. Test the air and liquid gages by comparison with a standard gage.

5. Renew all parts which are in an unsatisfactory condition and reassemble the mechanism. Use Naval Gun Factory chevrons only.

Adjustments

Adjustments are to be performed by personnel familiar with the procedure and only when found to be necessary. Non-adjustable units include the deck lug radial bearing and the gun slide with all its components including the slide forging, the gun cover, the slide liners and wiping ring, the yoke locking device, the buffers, the rear end brackets and loader's platform, and the slide securing device. Adjustments pertaining to the gun assembly, which includes the breech mechanism and gas ejector, are covered in chapter 3. Adjustable elements of the deck lugs and the procedure for making the adjustments are given in the following paragraph.

Deck lug adjustment. The deck lug is designed for fixed nonadjustable arrangement. The deck lug thrust plates are installed with a thrust clearance of 0.002 inch between the slide and each of the two plates. Check the thrust clearance, and if the clearance is excessive, correct by installing oversized thrust plates. This operation is described on page 4-3.

DISASSEMBLY AND ASSEMBLY

General instructions

Operations of dismantling, disassembly and assembly of the components are to be performed by personnel familiar with the procedure who are equipped with standard and special tools required for the job at hand. Reassembly and reinstallation of components is facilitated by precise fitting of the parts at the time of initial installation at the Naval Gun Factory. Design is such that once this initial fitting is made, a minimum of adjustment or fitting is necessary on subsequent reassembly. When disassembling or assembling components of the slide, refer to applicable general arrangement and detail design drawings for information not readily apparent from an examination of the assembly or from the instructions.

Counterrecoil plunger packing replacement. Defective chevron packing rings or other components of the plunger packings should be removed and reassembled as prescribed below. In these operations the plunger rear liner and plunger bearing must not be withdrawn. If the rear liner is to be removed (for replacement of the bearing or other reason) the counterrecoil cylinder must be disassembled intact from the slide and the plunger must be withdrawn

procedure is as follows:

1. Open the counterrecoil and differential cylinders.

2. Examine the condition of packings, glands, liners, followers, packing seats, wiping rings, working surfaces, and cylinder walls.

NOTE: Extreme care shall be exercised to prevent foreign matter entering air passages. It is not necessary to remove filter screens.

3. Clean out the cylinders and note the amount

before disassembling the packing. The operations which follow should be performed preferably with the gun at 0 degrees elevation. If the operations are performed at 20 degrees elevation (access is more convenient at this position), extreme care must be exercised to prevent the plunger from slipping into the cylinder. To disassemble and assemble the plunger packing refer to (see paragraph 4C OS5321) drawings 232376 and 236064. Proceed as follows:

1. Secure the yoke locking device.

2. Seat the slide securing pin in its socket.

3. Remove the plunger cover.

4. Secure C-clamps to the guide rails just to the rear of the plunger yoke.

5. Remove air valve cap Z and plug X.

6. Open air valve Z and completely bleed the recuperator air pressure.

NOTE: It is not necessary to drain the liquid from the differential cylinder. The position of the packing lead is such that only the liquid in the packing will be lost.

7. Remove the locking pin from the yoke, one plunger only.

8. Remove the 12 stud nuts and lock washers from the cylinder gland and slide the gland forward.

9. Place a wood block and pad beneath the plunger in front of the cylinder.

10. Loosen the plunger from the yoke and withdraw it sufficiently to remove the gland.

11. Refer to drawing 236064. Slide the plunger rearward sufficiently to assemble the connecting rod (236064-4) and the rail fixture (236064-2), with the eye nut (236064-7) on the forward end of the connecting rod, and with the stop rod (236064-6) and nut seated in the rail fixture. Attach a sheave to the yoke (use eye bolt in the plunger yoke seat). Reeve a line through the sheave and attach to the eye nut. Snub the line at the projectile hoist cradle.

12. Slide the plunger into the cylinder until the stop rod contacts the cylinder face.

13. Remove packing elements to a position on the connecting rod.

14. Draw the plunger forward until the eye nut is at the sheave.

15. Install a wood block under the forward end of the plunger.

16. Remove the eye nut and rail fixture.

17. Remove the old packing from the connecting rod and replace with new packing chevrons and gland.

18. Reassemble rail fixture and eye nut and remove the wood block.

19. Install the packing in the cylinder and secure the gland. Do not move the plunger.

20. Remove rail fixture, connecting rod, sheave, and line. Support the plunger forward end until it is seated and secured in the plunger yoke.

21. Recharge the recuperator air pressure and replenish the differential cylinder liquid in accordance with the routines outlined in "Servicing the counterrecoil system" of this chapter.

22. Remove the C-clamps and replace the plunger cover.



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OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

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TITLE AND FORWARD

CHAPTER 5 ELEVATING GEAR

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Chapter 5

ELEVATING GEAR

16-inch Elevating Gear Mark 5, Mods 0, 1, and 2

16-inch Elevating Receiver Regulator Mark 10 Mod 0

GENERAL DESCRIPTION

The gun elevating equipments installed in each turret are three independent elevating gear assemblies. They are designated 16-inch Elevating Gear Mk 5 Mod 0 for the right gun, 16-inch Elevating Gear Mk 5 Mod 1 for the center gun, and 16-inch Elevating Gear Mk 5 Mod 2 for the left gun. The three assemblies are identically powered and controlled and differ only as to position and arrangement of components. A typical elevating gear installation is illustrated in figure 5-1.

The elevating gear assemblies control and operate the gun laying movements of the three gun slides. These assemblies elevate and depress the guns through 47-degree arco in turrets I and III, and 45-degree arcs in turret II. The arcs are limited by stops at 45 degrees elevation in all turrets, at 2 degrees depression in turrets I and III, and zero degrees depression in turret II.

16-inch Elevating Gear Mk 5 is an electric-hydraulic machine with an elevating-screw and oscillating-bearing type of final drive. The independent selector for each gun permits selection of control of gun laying from a remote control station or hand control of gun laying from a local pointer's station. The method of gun elevation control is selected by the gun layer by positioning a control selector that is mounted on the bulkhead adjacent to his station. Automatic positioning of the gun at five degrees elevation for loading and return of the gun to automatic control is provided by a switch at the gun captain's station.

Each elevating gear comprises a power drive, an elevating screw and oscillating bearing, and control mechanisms which include 16-inch Receiver-Regulator Mk 10 Mod 0. Component locations (fig. 5-1) are similar for the three turret assemblies; all are located forward and below the respective gun pockets, in the pan floor and electric deck spaces, except for certain controls. The motor controllers are located in the upper projectile handling deck machinery space. The ON-OFF push-button control is at the gun layer's station.

The power drive is an electrically driven hydraulic transmission that drives the elevating screw through the oscillating bearing to elevate and depress the gun at maximum average rate of 12 degrees per second. The arrangement of the mechanical components of the elevating gear with respect to the power drive is shown in figure 5-2.

In automatic control, the receiver-regulator receives gun elevation order electrically from the through a mechanical response gear. A difference between elevation order and actual elevation results in movement of the A-end tilting box (fig. 5-2), through a hydraulic control valve and the servo piston. The amount of tilt, determined by the gun position "error," regulates the speed of the B-end as it drives the elevating screw. "Follow-up" control is provided by shafting and gearing that feed B-end response back to the receiver-regulator and to the A-end tilting box to return it to neutral. Control is entirely automatic; no action by turret personnel is required.

In hand control, the gun layer's handwheels are mechanically connected (through shafts, gears, and a clutch) to a hydraulic directional valve, which ports servo pressure to the servo piston. Movement of the handwheels moves the A-end tilting box through the directional valve and the servo piston. The B-end elevates or depresses the gun at a rate corresponding to the direction and speed of handwheel motion. Response is mechanically fed back to the A-end tilting box to return it to neutral. Because of this follow-up action, the gun will continue to move (within its limits) only as long as the handwheels are turned.

In automatic loading control, a loading valve in the receiver-regulator controls hydraulic flow to the servo cylinder to bring the gun automatically to five degrees elevation for loading.

Design differences

The right- and center-gun elevating gears are identical, with the exception of some hydraulic pipes and the positions of certain parts. In the center gun installation, the electric motor is located farther away from the A-end. The response gear shafting is rearranged to conform to the offset-from-center installation of the center-gun elevating gear.

The left-gun elevating gear differs from the right and center installations as follows: The B-end is mounted in the opposite way from the like units of the right and center installations; the hydraulic pipes are rearranged to conform to this mounting. The arrangement of the response gear is similar to that of the right gun.

Elevating gear data.

Gun movement limits
- Maximum elevation, deg..... 45
- Maximum depression, deg..... -2
- Maximum depression (turret II), deg..... 0
- Loading position, deg..... 5

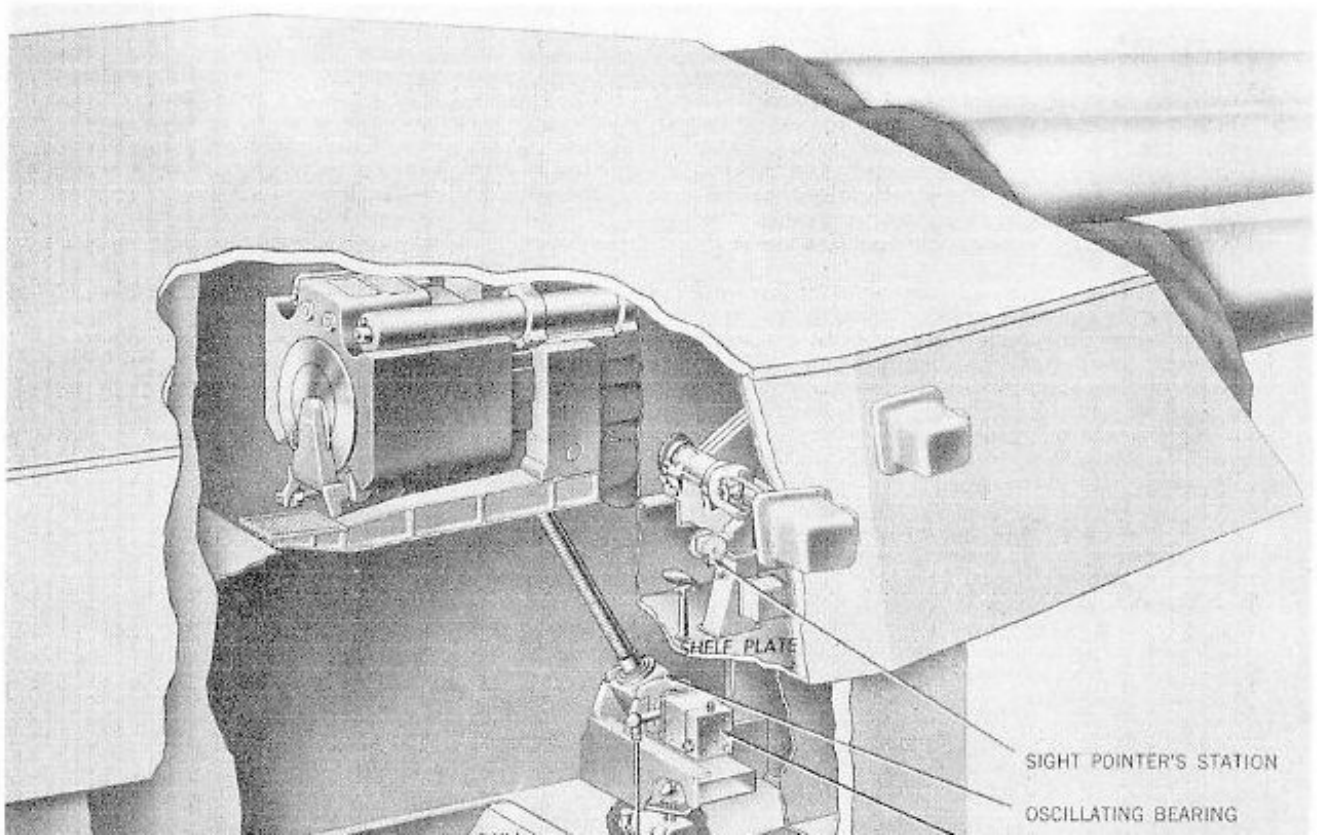
remote control station. Actual gun elevation is automatically transmitted to the receiver-regulator

Loading position, deg.....
Speed, maximum gun laying, deg per sec. 12

Power drive

Components. The components of each elevating-gear power drive are:

Electric motor
Controller
Speed reducer
Auxiliary pumps
Motor to A-end couplings
Hydraulic pump (A-end)
Hydraulic motor (B-end)
B-end coupling
Servo and supercharge filters
Servo and supercharge relief valves
Expansion tank



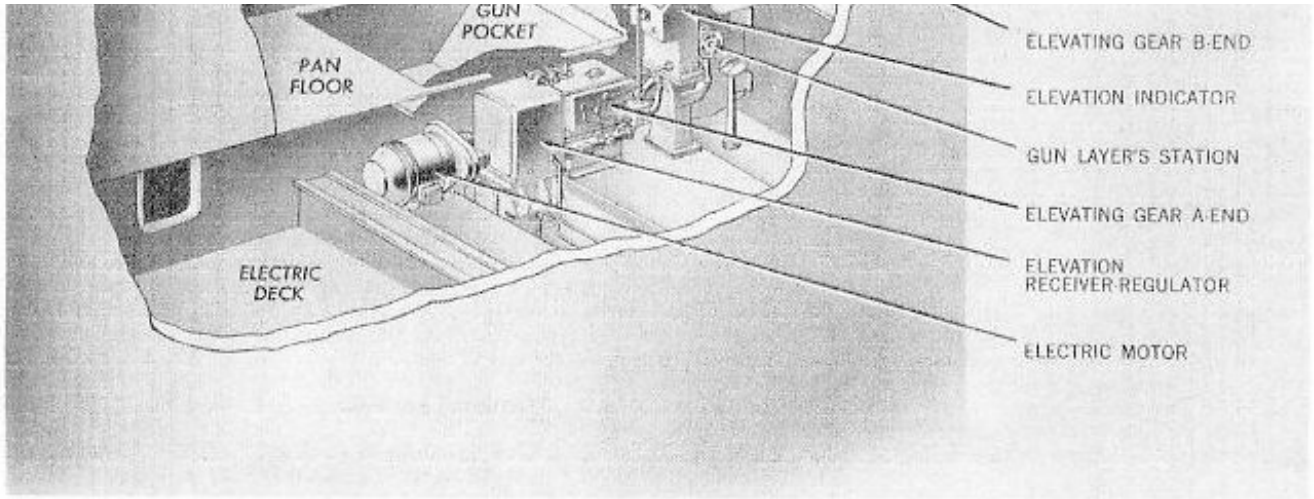
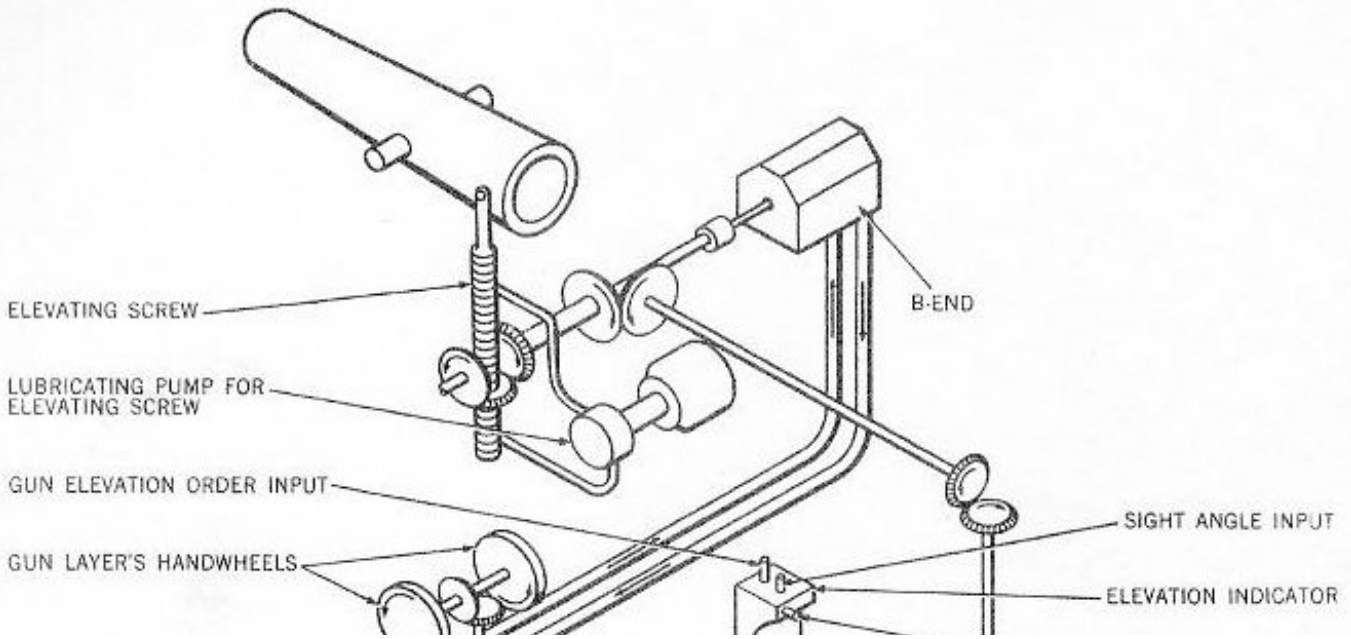


Figure 5-1. 16-inch Elevating Gear Mk 5 Mod 0, General Arrangement



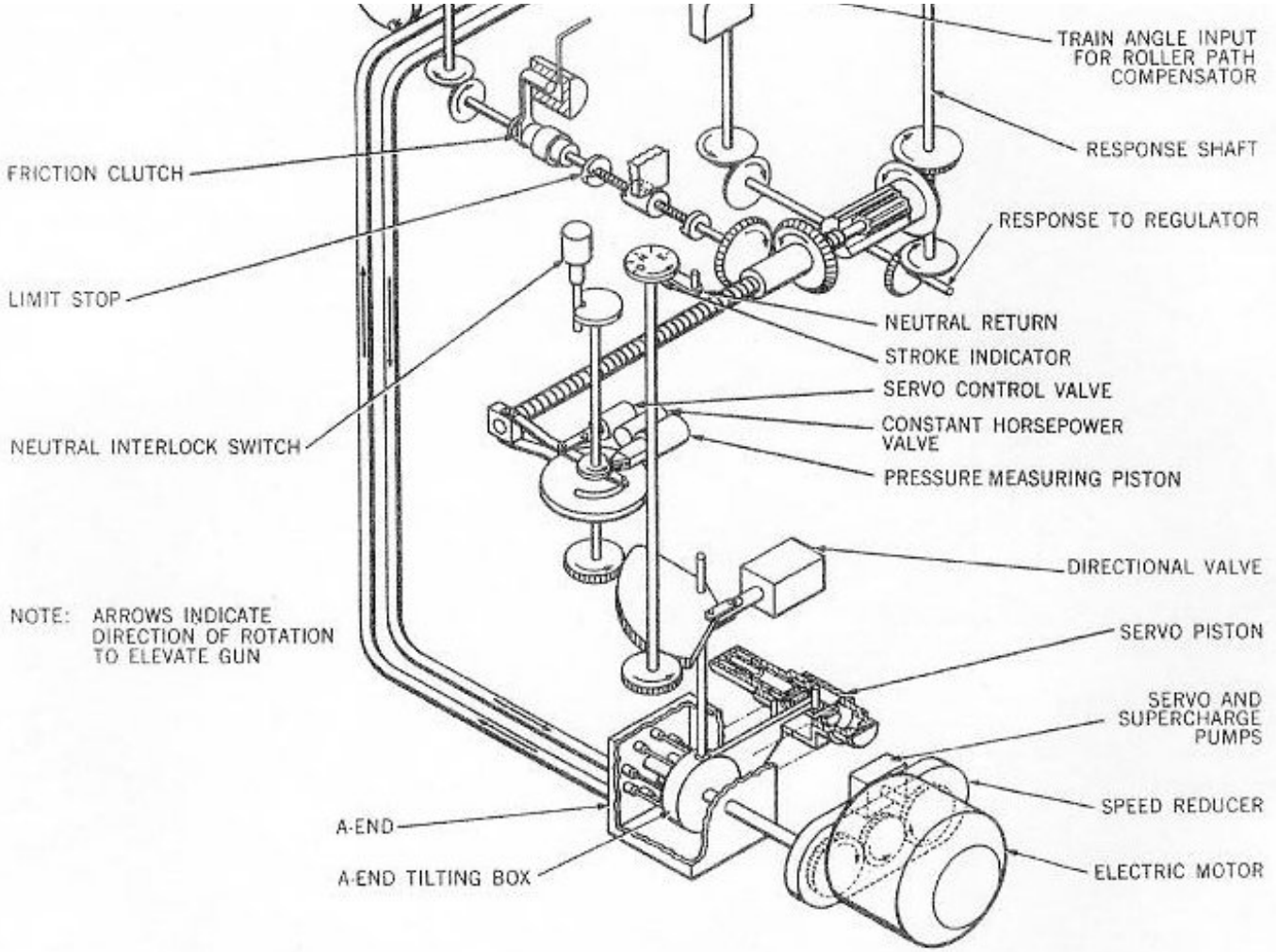


Figure 5-2. 16-inch Elevating Gear Mk 5 Mod 0, Schematic Arrangement

Electric motor. The electric motor is a squirrel-cage induction type. It is mounted on a structural foundation (fig. 5-1) that raises it slightly above the electric deck. The motor has its output shaft at the forward end, with direct drive coupling to the speed reducer (fig. 5-3).

Controller. Each electric motor is powered and controlled through an across-the-line magnetic-type controller. Each controller contains a main contactor, overload relays, reset relays, and a hand-operated circuit breaker. The controller is controlled from a master push button at the gun layer's station. This switch is normally open and is closed by press-

Motor data.

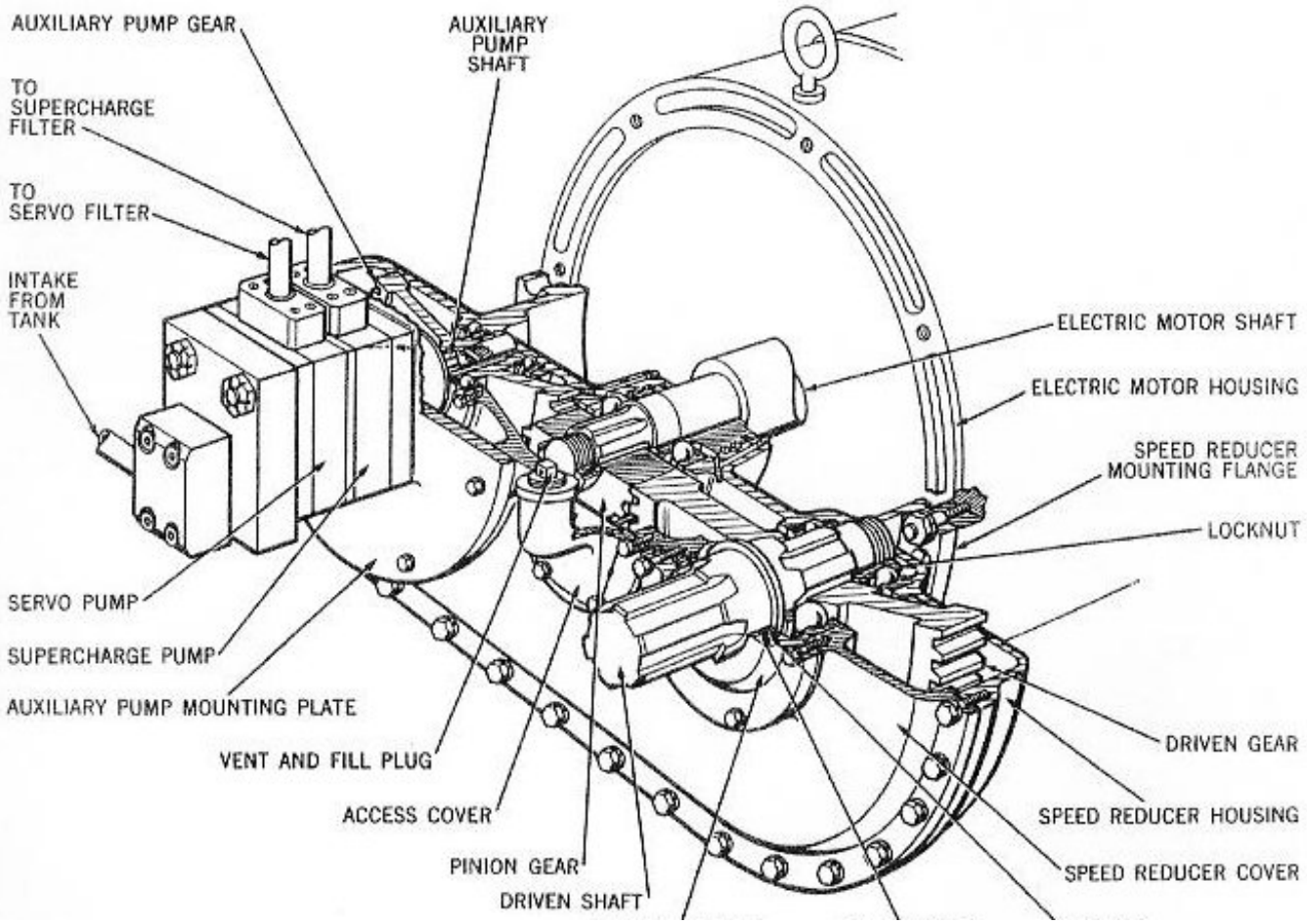
Type	squirrel cage, induction
Design features	waterproof, fan cooling, horizontally mounted, reduction gear drive
Horsepower	60
Revolutions per minute, synchronous	1800
Revolutions per minute, full load	1750
Rotation (viewed at fan end)	counterclockwise
Speed class	constant
Voltage	440
Amperes, full load	81.8
Amperes, locked rotor	560.0
Phases	3
Cycles	60
Ambient temperature, C	75
Torque class	normal, low starting current
Weight (including speed reducer, lb)	1880
Manufacturer	Reliance Electric Engineering Co.
Manufacturer's designation	Type AA
Drawing	265472

ing the START-EMERG push button. The switch is opened by pressing the STOP push button.

Controller data.

Type	across the line magnetic starter
Horsepower rating full load	60
Protection	
Overload	thermal type
Adjustable range, amps	80-95
Normal setting, amps	90
Short circuit, circuit breaker, amps.	675
Under Voltage	
Drop-out voltage	44
Sealing voltage	374
Shock rating	50
Weight lbs	165
Manufacture	Cutler - Hammer
Drawing	365736

Speed reducer. The speed reducer (fig. 5-3) is driven by the electric motor and is bolted directly to the motor case by means of an integral flange



RETAINER COVER OIL RETAINER PACKING

Figure 5-3. Speed Reducer Assembly, Cutaway View

of the speed reducer housing. The pinion gear, directly driven by the electric motor, drives both the driven shaft (output shaft for the A-end pump) and the auxiliary pump shaft for the servo and supercharge pumps.

Speed reducer data.

Type	enclosed spur gear train
Output shaft (ratio 3.342 to 1.00), rpm	500
Auxiliary shaft (ratio 2.085 to 1.00), rpm	835
Rotation (viewed from output end):	
Output shaft	counterclockwise
Auxiliary shaft	counterclockwise
Lubrication	oil bath
Manufacturer	Northern Pump Company
Drawing	268473

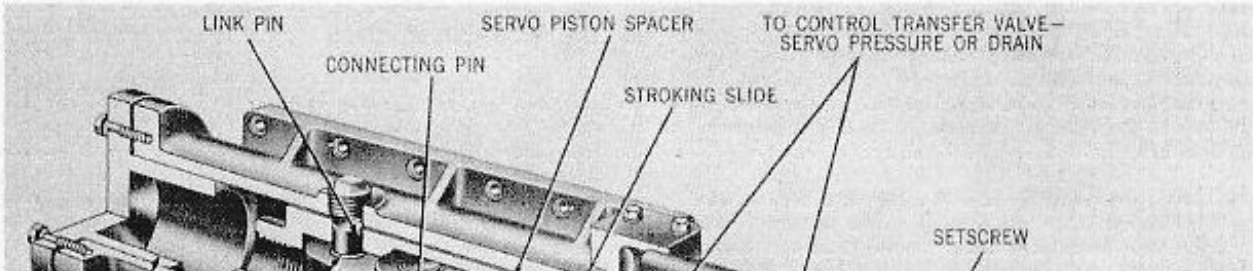
The speed reducer illustrated in figure 5-3 is for the right- or center-gun elevating gear. The speed reducer for the left gun is rotated 180 degrees.

Auxiliary pumps. The auxiliary pumps (fig. 5-3) are bolted on the speed reducer housing. They are arranged as a tandem-driven assemblage of functionally independent pumps. Both are rotary-gear-type pumps of identical design but of different capacities. The larger one is a servo pump that supplies the servo piston housing (fig. 5-4). The other is a supercharge pump that supplies hydraulic fluid to the main system relief valves and replenishing valves located in the valve block attached to the A-end valve plate.

Servo pump. The intake of the servo pump (fig. 5-3) is connected to the main system supply tank. The pump discharges through a duplex filter into the control selector and stroking systems. Pump capacity is 11.5 gallons per minute at approximately 400 pounds per square inch pressure.

Supercharge pump. The intake of the supercharge pump (fig. 5-3) connects to the main system supply tank through a common connection with the servo pump. The supercharge pump discharges through a duplex filter into the main system relief valves and replenishing valves. The valve block for these valves is mounted on the A-end valve plate. Pump capacity is 8.5 gallons per minute at approximately 50 pounds per square inch pressure.

Motor to A-end couplings. The connecting drive shaft, between the output shaft of the speed reducer to the main shaft of the A-end, is coupled to these units by flexible couplings. These couplings are commercial units which provide floating compensation for slight misalignment. Each is an assembly of splined hubs, which seat on respective shaft ends, and flanged sleeves which enclose the hubs.



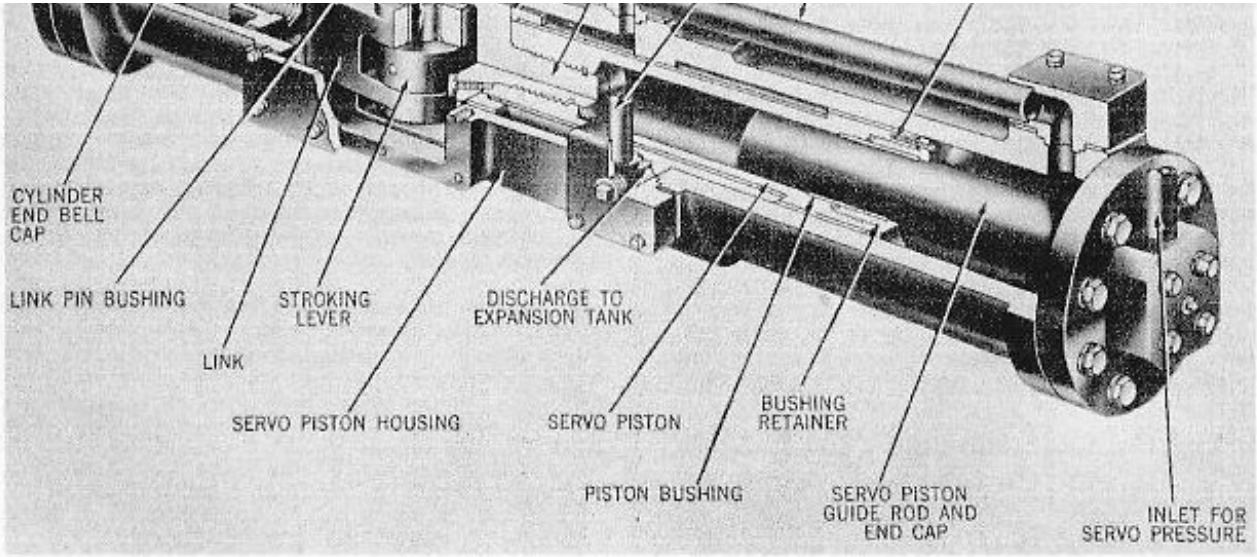


Figure 5-4. Servo Piston Assembly, Cutaway View

The sleeves have gears that mesh with gear teeth on the hubs. When installed, each coupling is partially filled with oil to provide lubrication for the gearing.

Hydraulic pump (A-end). The A-end is a type K, variable-displacement hydraulic pump of modified commercial design. It is mounted on a foundation weldment of the electric deck with its input shaft connected to the driven shaft of the speed reducer. Proper alignment of these shafts is provided by the special gear-type coupling described in the previous paragraph.

Pressure and tank connections. In addition to the pipe connections of the main system, the A-end assembly has drain, circulating, servo, and supercharge connections. The drain connections direct hydraulic fluid vented from the servo piston assembly and control box mechanism back to the expansion tank. The servo pump (delivers servo pressure to the control box mechanism) and the supercharge pump (delivers supercharge pressure to the valve block of the A-end valve plate) are supplied with fluid through a common connection with the expansion tank. The A-end and B-end and the A-end and expansion tank are interconnected by flanged fittings for fluid circulation, which aids in cooling the mech-

A drilled hole in the center of the front face of each piston admits hydraulic fluid to lubricate the ball-shaped ends of the connecting rods.

Nine connecting rods connect the nine pistons with the socket ring. Each connecting rod has two ball-shaped ends. One end seats in a socket in the piston and is held in place by a split cap, cap nut, and nut lock. Shims are placed between the cap and piston surface to obtain proper clearance for the ball end. Each connecting rod has two ball-shaped ends. One end seats in a socket in the piston and is held in place by a split cap, cap nut, and nut lock. Shims are placed between the cap and piston surface to obtain proper clearance for the ball end. Each connecting rod is drilled throughout its entire length to provide for lubrication of the ball end sockets.

The socket ring is a circular piece that contains the nine sockets for the other ends of the nine connecting rods. Each rod is retained in its socket by a socket cap, socket cap nut, and socket cap nut lock. The socket cap is split to facilitate installation and removal. The socket ring has two ball bearing assemblies, one at the back and the other at the piston side of the socket ring. Two slots, located about the center of the socket ring and 180 degrees apart

anism.

The pipes indicated above are connected by flanged fittings that are bolted in position.

Case. A square, oiltight case encloses the A-end. The case assembly consists of valve plate, case head, servo piston assembly, control box mechanism, trunnion cap, trunnion bearing assembly, and retainer. A storage tank for hydraulic fluid in which the active parts rotate, the case has attached mounting feet that are bolted to the A-end foundation weldments. The receiver-regulator is mounted on similar foundation weldments adjacent to the A-end. The general arrangement of parts within the A-end case is the same as the training gear A-end shown in figure 6-5.

The main shaft of the A-end supports the rotating parts of the pump. At a point near the center of the A-end case, the main shaft is made in the form of a closed yoke to support the universal-joint trunnion and pin. Ahead of the closed yoke is a section provided with two keys 180 degrees apart which supports the cylinder barrel. The forward end of the main shaft is supported by a ball bearing in the valve plate. The splined end of the main shaft is similarly supported by a ball bearing in the case head.

The open center of the cylinder barrel has two keyways 180 degrees apart throughout its length to mate with the two keys in the main shaft. The barrel, retained on the main shaft by a nut, is held against the valve plate by a spring which backs up against a flange on the main shaft. The cylinder barrel contains nine cylinder bores, which are of the same diameter throughout the length of piston travel. They taper sharply at the end to a small cylinder port outlet.

Each cylinder bore is fitted with a piston, ground and lapped to a smooth-working fit. When the A-end is transmitting hydraulic power, the fluid being discharged by the pistons presses against the ends of the cylinder bores and forces the barrel against the valve plate to reduce internal leakage between barrel and valve plate. This sealing effect increases as hydraulic pressure in the system increases.

center of the socket ring and 180 degrees apart, carry the mainshaft trunnion bearing blocks of the universal joint.

Main shaft rotation is transmitted to the socket ring by a universal joint formed by a trunnion in the shaft yoke. The attached socket ring is free to rotate about the axis of the trunnion, giving a controlled variation in the length of piston stroke.

Tilting box. The tilting box varies the angle of the socket ring with relation to the main shaft, changing the length of piston stroke from zero to maximum.

The tilting box is a trunnion-mounted casting located inside the A-end case. It contains two groups of ball bearings which take the radial and axial thrusts of the socket ring. An arm of the tilting box extends through a hole of the A-end case and connects with the servo stroking piston. A shaft extends vertically from the tilting box trunnion and connects with the follow-up mechanism mounted on top of the A-end. The function of the follow-up is described on page 5-13 of this chapter.

Valve plate. The valve plate is stationary and forms one end of the A-end case. The inner, or rear, surface of the plate is a finished surface against which the cylinder barrel rotates. This surface has two semiannular grooves, called valved-plate ports, through which hydraulic liquid flows when power is being transmitted. These ports connect with the power transmission pipes between the A- and B-ends.

Between the valve ports are flat surfaces called lands. As the cylinder barrel rotates, the cylinder bores pass in succession over the lands. The lands are positioned so that they coincide with the end-of-stroke of each of the nine reciprocating pistons; there is no pumping action when the cylinder bores pass over the lands. At the center of the valve plate are the bearings for the end of the main shaft. The valve plate includes an attached valve block which houses the two main valves, a pilot valve, a cutout valve, and a directional flow shuttle valve.

Main valves. Each main valve is connected with a semiannular port of the valve plate, and each acts in two ways:

1. As a main system replenishing valve operating under supercharge pressure.

2. As a relief by-pass valve.

Pressure and tank connections. In addition to the pipe connections of the main system, the B-end assembly has circulating and servo pressure connections. The servo pump delivers servo pressure to the valve block of the B-end valve plate. There is

When power is being transmitted, a small amount of hydraulic fluid is constantly being lost from the main system. Hydraulic fluid is purposely directed from the cylinders to the socket caps for lubrication of the connecting rods. Slight leakage around the pistons and between the barrel and valve plate ensures lubrication of the bearing surfaces. The leakage must be replaced as fast as it occurs; this replacement is furnished by the main valves acting as replenishing valves. As relief valves, the main valves protect the A-end from overload by limiting the pressure in the system.

The two main valves operate through differential loading of pressure and intake (return from the B-end end). The pressure is ported through cutout and pilot valves. Positioned by servo pump pressure, the cut-out valve ports main system high pressure to the top of the main valve in the high-pressure line. The top of the other main valve is now opened to low-pressure return. Centered by a spring at each end, the pilot valve moves only when main system pressure exceeds 1850 pounds per square inch in either valve plate port. When it moves, it unloads excessive high pressure in the main system from the top of the main valve and permits that valve to lift and by-pass pressure into the low-pressure side. Hydraulic fluid, delivered by the supercharge pump, enters the main system through the main valve opened to low-pressure return.

A-end data.

Driven speed, revolutions per minute	500
Oil temperatures	
Normal operating range, F	120 to 175
Maximum permitted, F.	185
Displacement, cubic inches	134.82
Manufacturer	Northern Pump Company
Manufacturers designation, size..frame	7043
Drawing	268458

Servo piston assembly. The servo piston assembly (fig. 5-4) is a high-pressure piston and cylinder assembly, flange-mounted on the side of the A-end case. This assembly acts to change the position of the A-end tilting box to vary the volume delivered by the A-end to the B-end. The servo piston assembly is described in full detail on page 5-11 of this chapter.

Follow-up control. The follow-up control consists of response shafting from the oscillating bearing to the elevation indicator, the receiver regulator, and the control box mechanism. The follow-up mechanism. The follow-up mechanism (fig. 5-6) within the control box consists of a follow-up response gear, a control screw, and a control nut. This mechanism uses B-end response to return the A-end tilting box to its neutral stroke position. A complete description will be found on page 5-13 of this chapter.

Hydraulic motor (B-end).

also a servo pressure connection between this valve block and the A-end valve assembly. The A-end and B-end units, and the A-end and expansion tank are interconnected by flanged fittings for fluid circulation, which cools the mechanism.

Case. The valve plate and angle box of the B-end are enclosed within a square case. Case, valve plate, and angle box are bolted together to form an oiltight assembly in which the torque-producing members rotate. The case has attached mounting feet that are bolted to the B-end foundation.

Main shaft. The B-end shaft differs from the A-end shaft only in dimensions. An inter-shaft disc is located in the main-shaft bearing recess formed in the valve plate. This disc compensates for any end-play that results from allowable tolerances in the manufacture of other parts.

Rotating group. The rotating group of the B-end is basically the same as the rotating group of the A-end. It consists of the main shaft and universal joint, the cylinder barrel with its pistons and connecting rods, and the socket ring.

Angle box. The angle box, in which the socket ring rotates, is permanently tilted at an angle of 20 degrees. The pistons and connecting rods therefore reciprocate through one full stroke each time the main shaft makes one revolution. The socket ring rotates in radial-thrust roller bearings.

Valve plate. The valve plate forms one end-plate cover for the B-end. The valve plate contains hydraulic liquid passages (semiannular valve plate ports) which connect with the two power transmission pipes from the A-end. The valve plate also holds the ball bearing assembly in which one end of the main shaft rotates. The cylinder barrel is held against the valve plate by a spring which backs up against a flange on the main shaft. Hydraulic liquid is drawn into, or discharged from each cylinder through the two semi-annular valve plate ports which connect with the two power transmission pipes.

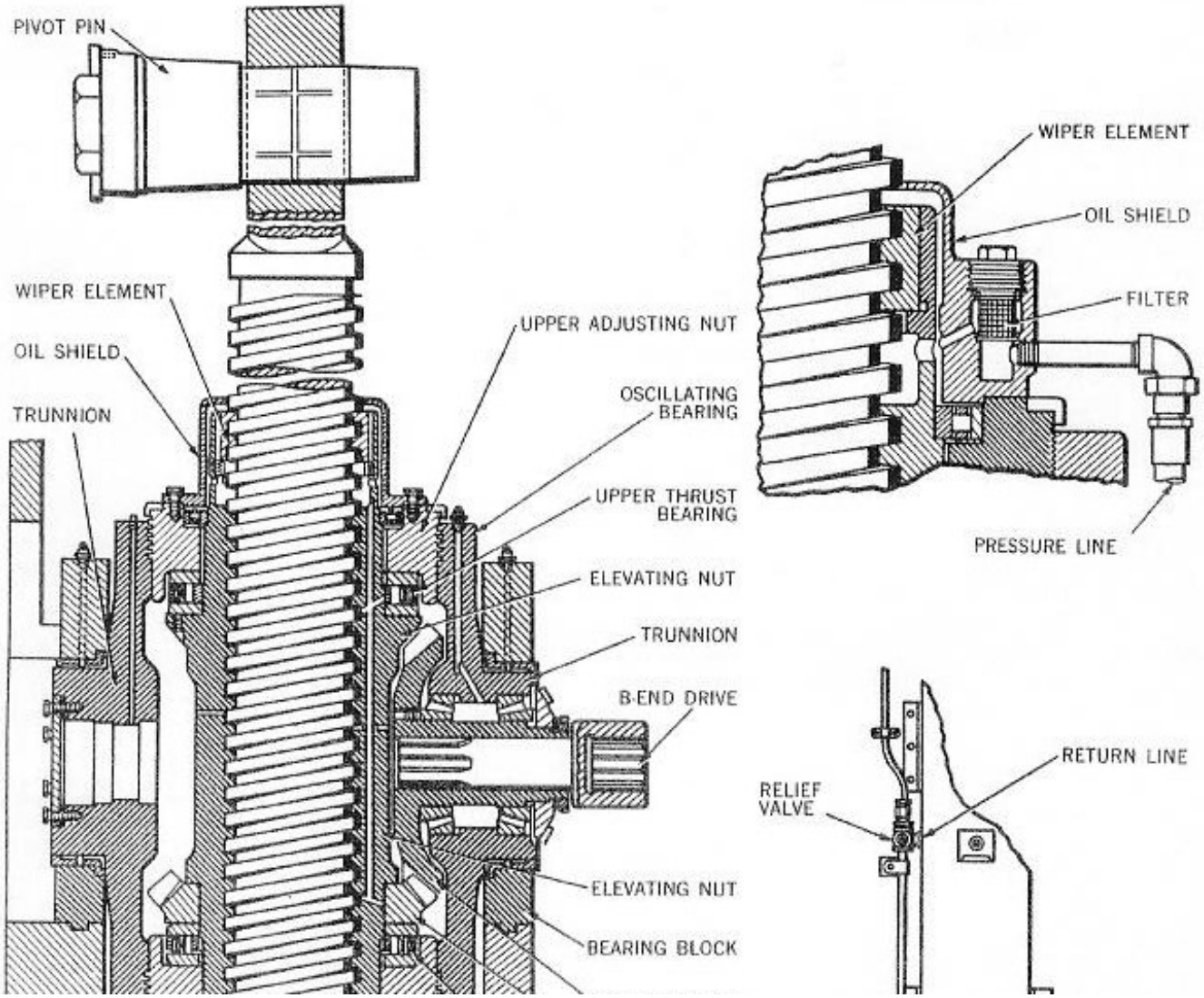
Valves. The B-end valve plate includes a relief valve (by-pass arrangement), a power-off valve, and two replenishing valves.

Relief bypass valve. The B-end relief bypass valve (fig. 5-34) is a pressure safety relief valve to relieve the system in event of servo pressure failure while the gun is moving. If servo pressure fails, the spring-loaded power-off valve will close both main transmission pipes; any overhauling will build up excessive pressure in the B-end. The B-end relief valve is adjusted to relieve at a pressure slightly above the A-end pilot valve adjustment.

Power-off valve. The power-off valve is a spool-type shuttle valve, spring-loaded at one end. It functions as a blocking valve and closes both main transmission pipes when the power is off. It acts as a brake valve that provides a block in the B-end against a settling of the gun slide. The power-off valve is moved to operating position under servo pressure. This

The B-end is a type K, fixed-displacement hydraulic motor of modified commercial design. It is mounted on a foundation weldment of the pan floor, with its drive shaft coupled to the adjacent oscillating bearing that it drives.

pressure is ported to the power-off valve through the adjacent power-off control valve that is positioned by a solenoid. In its operating position, the power-off valve ports servo pressure to the cutoff valve of the A-end valve plate assembly.



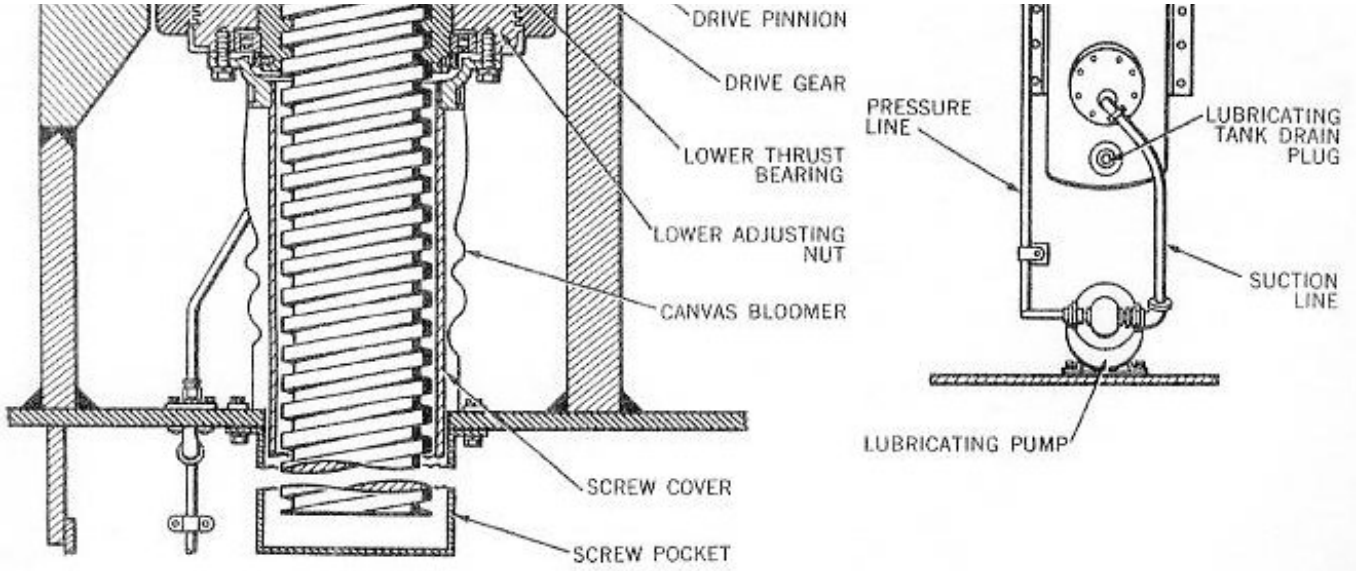


Figure 5-5. Elevating Gear Oscillating Bearing, Sectional Views

Replenishing valves. The B-end replenishing valves are plunger type with drilled leads from each valve connecting to the valve plate ports. The replenishing valves deliver hydraulic liquid to the low-pressure side of the main system. The valves are located on the rear face of the B-end valve plate.

B-end data.

Speed (maximum), rpm.	500
Torque load.	
Normal, rated, ft-lb	2000
Maximum, rated, ft-lb	2200
Oil temperatures	
Normal operating range, F . . .	120 to 175
Maximum permitted, F	185
Displacement, cubic inches	134. 82
Manufacturer . . .	Northern Pump Company
Manufacturer's designation, size. .	frame 71 43
Drawing	2684599

B-end coupling. The B-end output shaft is coupled to the oscillating bearing by a short drive shaft. The B-end shaft is splined and fits into a splined female hub of the drive shaft. The other end of the drive shaft is a splined male fitting and is secured in the drive pinion gear of the oscillating bearing.

Servo and supercharge filters. The duplex filters used in both the servo and supercharge systems are of modified commercial design. They keep the hydraulic fluid free of solid matter which would damage the system. Each filter assembly consists of two sumps, each sump containing a disc-type filter cartridge. A dual valve, controlled by selector handle, permits the use of either or both of the sumps.

Servo and supercharge relief valves. The servo and supercharge relief valves, connected to the discharge lines of the servo and supercharge filters,



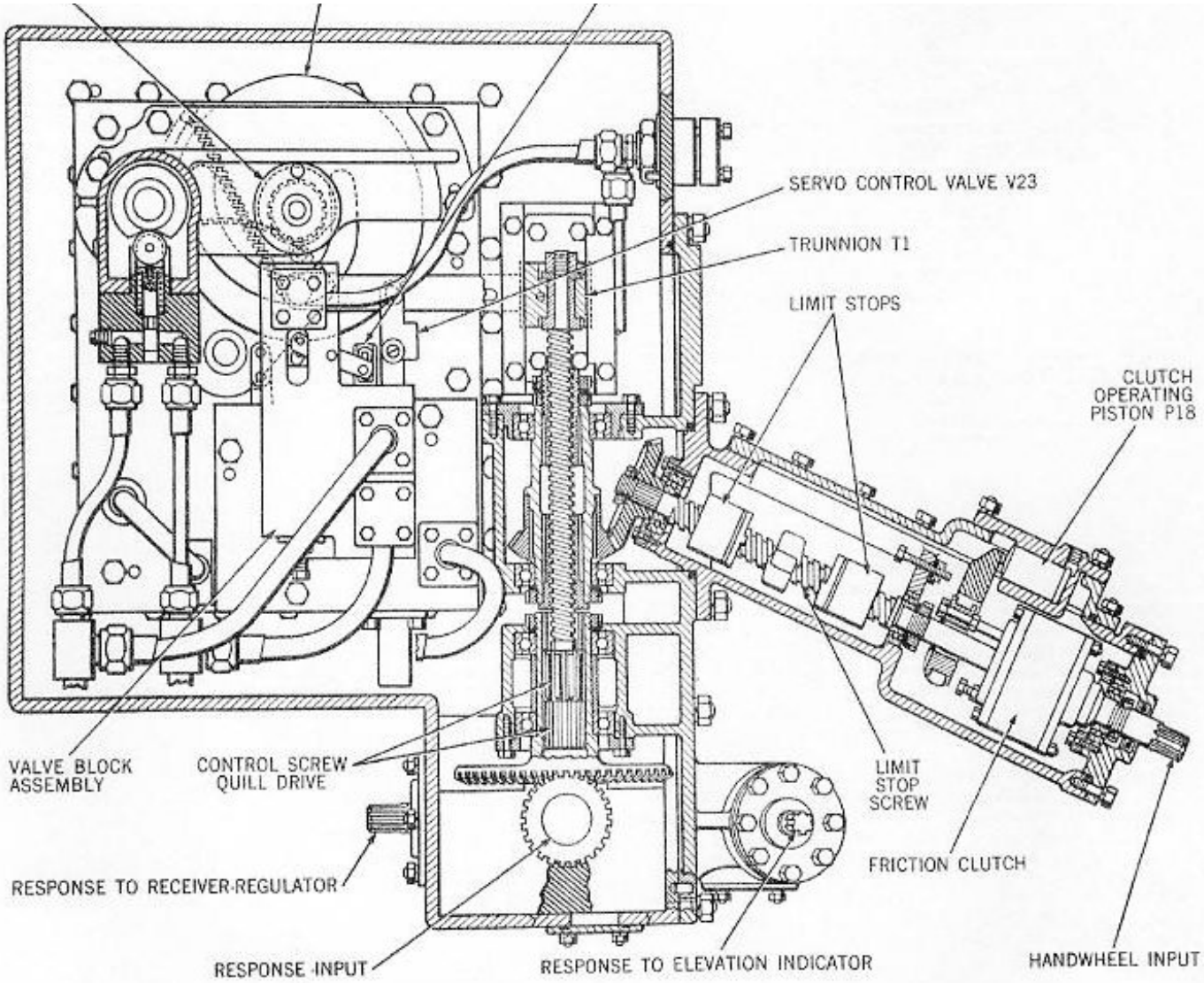


Figure 5-6. Control Box Mechanism, Sectional View

5-9

are mounted in a common valve block near the A-end. They are spring-operated, plunger-type, safety relief valves. The valves open and bypass excess pressure flow to the expansion tank when the servo

threads of 1.50-inch pitch. It is 153 inches long overall, with 133 inches threaded, and with a lead of 3 inches. The elevating screw is secured to a rear end bracket (fig. 5-36) of the gun slide by a

and supercharge discharge lines are overloaded. The servo relief valve is farthest from the valve block mounting plate and the supercharge relief valve is nearest the mounting plate.

Expansion tank. The 28.5-gallon expansion tank for each elevating gear assembly is a vented type with gravity feed connection to the servo and supercharge pumps. Return lines lead to the tank from the A-end, the B-end, and the servo and supercharge relief valves. Located at the highest point of the hydraulic system, the tank body is box-shaped, 30.0 inches high, 20.0 inches wide, and 10.0 inches deep. It is equipped with a cover, high- and low-level trycocks, filler cap, and an oil strainer inside the tank. The tank dissipates heat from the oil returned by the recirculating system.

Oscillating bearing assembly

The oscillating bearing (fig. 5-5) is an enclosed elevating-nut pinion-drive-type assembly. The drive pinion engages the drive gear, which is keyed to the elevating nut. The elevating screw is threaded through the elevating nut and is attached to the gun slide with a pivot pin. The elevating screw is fixed and cannot rotate. The elevating nut is rotated by the drive pinion, and causes vertical movement of the elevating screw to elevate or depress the gun.

The trunnion-pivoted oscillating bearing (fig. 5-35) is aligned with the B-end with the axis of the elevating screw offset 21.0 inches from the vertical plane of the gun bore axis. The trunnion bearing blocks of the bearing form a foundation weldment above the pan floor in the forward part of the gun pockets.

Components. The oscillating bearing assembly comprises the following:

Bearing and elevating nut
Elevating screw
Oil shield
Lubrication pump
Lubrication tank

Bearing and elevating nut. The oscillating bearing assembly is enclosed within a hollow cast steel block with integral trunnions (fig. 5-5). The oscillating bearing houses roller-type thrust bearings at each end that seat in the upper and lower adjusting nuts. The oscillating bearing trunnion adjacent to the B-end is bored to receive the drive pinion with its two tapered radial bearings. The drive pinion and drive gear are also enclosed within the bearing housing, together with the elevating nut.

The drive gear is keyed to the radially split elevating nut. The two halves of the elevating nut lock together for rotation but have adjustable axial motion to eliminate end play of the elevating screw. The lower half of the elevating nut is driven by the concentrically mounted drive gear, which is meshed with the drive pinion, as shown in figure 5-5. These

bronze pivot pin at its upper end (chapter 4).

Oil shield. A cylindrical oil shield (fig. 5-5) fits around the elevating screw and is attached to the upper adjusting nut by 10 screws. The adjusting nut has 20 equally spaced and threaded holes to permit the oil shield and the lubrication pump oil lead to be attached in approximately the same position with any setting of the adjusting nut.

Three wiper elements within the oil shield are threaded to mesh with the elevating screw. The wiper elements are secured to and rotate with the elevating nut to remove oil from the emerging elevating screw threads. The oil drains downward through the bearing assembly to a cylindrical screw cover bolted to a flange of the lower adjusting nut. Oil drains from the cover into the screw pocket.

Lubrication pump. The lubrication pump (figs. 5-5 and 5-37) is an independent unit mounted on the electric deck adjacent to the gun layer's station immediately below the elevating screw pocket and lubrication tank. The pump provides circulating lubrication for the elevating screw and oscillating bearing assembly. The pump is a rotary gear-type unit, attached to and driven by a horizontally mounted 1/4-horsepower electric motor at the rate of 600 revolutions per minute. Pump delivery, at the rate of 3 gallons per minute under an operating pressure of 50 pounds per square inch, is controlled by a spring-loaded relief valve.

Lubrication tank. The lubrication tank (elevating screw pocket) is a flanged steel assembly attached to the underside of the pan floor that extends downward to the electric deck, as shown in figure 5-37. In addition to furnishing storage for the lubricant, the tank weldment also forms a pocket for the elevating screw. An oil pipe connects the tank storage space with the inlet of the pump. The pressure outlet of the pump is connected by an oil pipe to a fitting in the oil shield.

Elevating gear controls

The independent elevating gear control arrangements for each of the three guns of the turret consist of:

Start-stop control
Power-drive transmission control
Control selector
Servo stroking system
Control gear hand gear
Control gear response gear
Control box mechanism
Receiver-regulator

Start-stop control. Each elevating gear power drive is started and stopped through its electric-power motor controller (described on page 5-4). The controller is remotely operated by two push buttons adjacent to the gun layer's station. One push button is labeled START-EMERG and the other STOP.

parts are adjusted by means of adjusting nuts that thread into the top and bottom ends of the bearing housing.

Elevating screw. The elevating screw has a 7.75-inch outside diameter with right-hand double

Pressing the START-EMERG button closes a normally open, three-pole switch and energizes the coil of the main contactor to connect power to the electric motor. Holding contacts on the relays keep the power circuit closed when the START-EMERG

button is released until the STOP button is pressed. In the event of a power failure, the main contactor opens and remains open until the START-EMERG button is depressed. An overlodd relay opens the circuit when current demand is too great. The main contactor may be kept closed to keep the electric motor running in an emergency by holding the START-EMERG button closed. The electric motor is stopped by pressing the STOP button.

Transmission controls. The transmission controls are the A-end control mechanisms and hydraulic-system devices that position the A-end tilting box and control the main system hydraulic pressure. They are:

Hand control elements
Automatic control elements
Loading control elements
Control screw centering mechanism

Hand control elements. The elements of the hand control system are:

1. Control selector
2. Servo stroking system
3. Control gear hand gear
4. Control gear response gear
5. Control box mechanism

The units function together so that, when the control selector is moved to HAND, the gun is elevated or depressed by manually turning the handwheels. The response gear and the control box devices provide follow-up control and limit stop control.

Automatic control elements. The elements of the automatic control system are:

1. Control selector
2. Servo stroking system
3. Receiver-regulator

Loading control is automatic control action by the receiver-regulator which moves the gun from any angle of elevation to the loading position when the control selector is positioned at LOAD or when the gun captain's switch is turned to SAFE.

Control screw centering mechanism. A control screw centering mechanism prevents shifting from hand control to automatic control except when the hand control screw and the servo pilot valve are in neutral. The mechanism also keeps the control screw and the servo pilot valve in neutral while the gun is operating in automatic control.

Control selector. The control selector (fig. 5-15) is a manually positioned hydraulic valve mounted on the bulkhead adjacent to the gun layer's station. The selector permits the gun layer to select the method of control desired. The selector valve block includes a related hydraulic valve called the synchro failure valve. The synchro failure valve is normally open to allow servo pressure flow to the control selector valve. If the synchro gun order signal fails, the valve automatically acts to block servo pressure flow to the control selector valve. When this happens, the synchro failure valve shifts control away from the receiver-regulator to the gun layer's handwheels without movement of the selector valve lever.

The control selector includes a synchro power indicator light (fig. 5-15) illuminated whenever the electric gun order signal is available for automatic gun elevation control. Should the synchro power fail, the indicator light goes out.

An emergency button (fig. 5-15) is provided on the control selector to permit selector movement if the gun captain's ready switch circuit fails while the gun is in LOAD control. The emergency button is disengaged by the emergency button release (fig. 5-15).

Servo stroking system. The servo stroking system is composed of:

1. The servo pump (fig. 5-3) mounted on and driven by the electric motor speed reducer.

3. Receiver-regulator

4. Control gear response gear

5. Control box mechanism

The units function together so that, when the control selector is moved to AUTO, the gun is automatically elevated or depressed in response to electrical signals from a remote station. The control gear response gear provides follow-up control and limit stop control as in hand control. However, the limit stop function is supplementary to an automatic limit stop device of the receiver-regulator.

Loading control elements. The elements of the loading control system are:

1. Gun captain's switch

2. Control selector

3. Servo stroking system

4. Receiver-regulator

5. Control gear response gear

6. Control box mechanism

2. The duplex filters in the discharge line of the servo control system.

3. A servo control system relief valve.

4. The servo piston housing and piston (fig. 5-4) and the connecting arm to the A-end tilting box.

5. Stroking piston control valve.

6. Hydraulic control valves.

The system responds to hand and electrical gun elevation order signals by forcing the heavy A-end tilting box away from the neutral stroke position. System pressure is supplied by the servo pump. The pump, filters, and relief valves are described on page 5-5 of this chapter. Other elements of the system are described in the following paragraphs.

Servo piston housing. The servo piston housing assembly (fig. 5-4) is a high-pressure piston and cylinder unit flange-mounted on the side of the A-end case. The piston moves the A-end tilting box through a connecting lever in response to hand or automatic gun elevation orders.

The assembly consists of a servo piston, a piston guide rod and end cap, a piston housing, an end bell cap, a stroking lever, a link, and a tube. The arrangement of the components is shown in figure 5-4. The piston is hollow for most of its length, with the piston guide rod inserted in the piston at one end and the stroking slide threaded into the other end. Servo system pressure is ported at one end or the other to move the A-end tilting box away from its neutral stroke position. Piston movements are controlled by the receiver-regulator in AUTO and LOAD, and by the servo control valve in HAND.

Stroking piston control valve. The stroking piston control valve, located at the receiver-regulator, is a valve block arrangement of the spool-type valves. The valve block (fig. 5-31) acts as a restriction in lines 12 and 13 to the loading transfer valve V13. The larger spool-type valve PCV1 is servo pressure positioned and is controlled by two adjustable needle valves PCN. The smaller spool-type valve PCV2 is spring-loaded to port back-up pressure, controlled by an adjustable screw PCS, through line 63 to the expansion tank. The stroking piston control valve block eliminates roughness in the automatic load linkage (actuated by movement of the handwheels) to port servo pressure to the constant horsepower valve V6.

Constant horsepower valve V6. The constant horsepower valve V6 located in the A-end control box is a linkage-operated, plunger-type valve that opens or blocks the flow of servo pressure from the servo control valve V23 to the directional valve V6A. The valve is connected by linkage to the pressure measuring piston P6. When V6 is lifted slightly, it blocks servo pressure from the servo control valve V23, and ports servo pressure from the directional valve V6A to the outer chamber of the servo piston. When V6 is lifted to its limit, it blocks servo pressure from V23, and ports servo pressure from V6A to the inner chamber of the servo piston.

Constant horsepower cut-in valve V6B. The constant horsepower cut-in valve V6B is a spool-type valve mechanically connected to the constant horsepower valve V6. In AUTO control, the cut-in valve ports servo pressure to shift the transfer acceleration limiting valve TALV and the control transfer valve V3B to transfer control of the servo piston

cycle which is caused by intermittent functioning of the constant horsepower mechanism.

Hydraulic control valves. Movement of the servo piston is automatically controlled within the power drive hydraulic system by the following interrelated valves.

Power-off valve VIN. The power-off valve VIN, located in the B-end valve plate, is a two-position, spool-type valve that opens or blocks the main hydraulic system lines between the A- and B-ends. It is spring-operated to block the main system lines when power fails or is shut off. With power on, servo pressure moves the valve to open the main system lines and to port servo pressure to the cutout valve V12N and the servo supply cutoff valve V22.

Power-off control valve V4N. The power-off control valve V4N, located in the A-end valve block, is a two-position, spool-type valve that ports or blocks the flow of servo pressure to the power-off valve V1N. The valve is spring-operated to block the flow of servo pressure to the power-off valve V1N and port this pressure to drain. When electric power is on, the valve is solenoid-positioned to port servo pressure to the power-off valve V1N.

Servo supply cutoff valve V22. The servo supply cutoff valve V22, located in the A-end control box, is a two-position, pressure- and spring-operated piston that opens or blocks the flow of servo pressure to the servo control valve V23. The cutoff valve V22 is spring-operated to block the flow of servo pressure to the servo control valve V23 when the power-off valve V1N is closed. The cutoff valve V22 is positioned against the pressure of its spring by a flow of servo pressure that is ported to it when the power-off valve V1N is open.

Servo control valve V23. The servo control valve V23 located in the A- end control box is a spring- and linkage-operated, plunger-type valve that opens or blocks the flow of servo pressure to the constant horsepower valve V6. The control valve V23 is spring-operated to block the flow of servo pressure from the servo supply cutoff valve V22 to the constant horsepower valve V6 when the controls are at neutral. The control valve V23 is positioned by linkage (actuated by movement of the handwheels) to port from the receiver-regulator to the constant horsepower device of the servo stroking system.

Directional valve V6A. The directional valve V6A located in the A-end control box is a linkage-operated, plunger-type valve that directs the flow of servo pressure from the constant horsepower valve V6 to either of the two chambers of the servo piston. The valve is connected by linkage attached to a sector gear that engages a gear on the tilting box shaft. When V6A is lifted, it directs the flow of servo pressure through the constant horsepower valve V6 to the inner chamber of the servo piston. When V6A is depressed, it directs the flow of servo pressure through V6 to the outer chamber of the servo piston.

Cutout valve V12N. The cutout valve V12N located in the A-end relief valve block is a spring-operated, spool-type valve that opens or blocks passages from the main system hydraulic lines to drain the A-end case. The cutout valve V12N is moved against its spring pressure by servo pressure which is ported from the power-off valve VIN when the electric motor is running and the elevating handwheel is at rest. V12N is spring-positioned to open the top chambers of the relief valves V9N and V10N to drain to the A-end case when electric power fails or is shut-off.

Pilot valve V11N. The pilot valve V11N located in the A-end relief valve block is a spring-centered, spool-type valve that moves only when main system pressure is excessively high in either end chamber. The cutout valve V12N, moved by servo pressure, ports main system pressure to either the left or right chamber of the pilot valve V11N, depending upon the direction of gun movement. Main system pressure is also ported to the top chamber of either the V9N or V10N relief valve, depending upon the direction of gun movement. When the gun is elevating, if main system pressure is excessively high, the pilot valve V11N is forced to the right to connect the top of the relief valve V9N to the low-pressure line of the main system. Main system high pressure lifts V9N and bypasses into the main system return until the high pressure drops to normal.

Relief valves V9N and V10N. The relief valves V9N and V10N, located in the A-end relief valve block, are spring-loaded, plunger-type valves that

function in dual capacities as replenishing valves operating under supercharge pressure and as relief bypass valves. In both capacities the relief valves

of a follow-up mechanism. The response drive for the right and left guns is straight shafting from the respective gun pockets to the electric deck spaces

V9N and V10N operate through differential loading of pressure and suction ported through the cutout valve V12N and the pilot valve V11N. V9N is the relief bypass valve during elevation and V10N is the relief bypass valve during depression.

Check valve V13N. The check valve V13N, located in the A-end relief valve block, is a spring-loaded, ball-check-type valve that regulates the flow of supercharge pressure to the top chambers of the relief valves V9N and V10N. Normal leakage in the hydraulic system will cause main system return pressure to drop below the pressure setting of tha check valve V13N. When this occurs, the system is replenished by supercharge pressure flow through V13N.

Shuttle valve V27. The shuttle valve V27, located in the A-end relief valve block, is a directional-flow, spool-type valve that is an element of the constant horsepower device. Shuttle valve V27 is free to move to either end of its sleeve porting main system high pressure to either end chamber of the pilot valve V11N, depending upon the direction of gun movement or the pressure measuring piston P6 of the constant horsepower device, which is forced down and thereby lifts the constant horsepower valve V6 through attached linkage.

Replenishing valves V5N. The replenishing valves V5N, located in the B-end valve plate, are spring-loaded, plunger-type, suction-operated valves. They are unseated by low pressure in the main system return valve plate port and connect the return line to the B-end case. When main system return pressure is normal, V5N is seated by its spring.

Neutral return valve V14N. The neutral return valve V14N located in the neutral return device is a spring-loaded, cam-positioned, plunger-type valve that ports or blocks the flow of servo pressure to the chambers of the servo piston. Movement of the neutral return lever 30 degrees either side of neutral rotates the attached cam, positioning the neutral return valve V14N so that it connects the chambers of the servo piston. Rotation of the lever beyond 30 degrees returns the tilting box to neutral. With the neutral return lever at neutral, V14N is positioned to block servo pressure and disconnect the chambers of the servo piston.

Control gear hand gear. The control gear hand gear for each gun layer is a pedestal bracket handwheel drive with bevel gear and shaft assembly arranged for hand control of the elevating gear. Located as shown in figure 5-1, the mechanism is arranged with its output shaft coupled through a friction clutch to a limit stop and geared to a differential follow-up mechanism. A mechanical linkage from the differential screw converts handwheel motion to valve movement to produce 2.5 degrees of gun elevation movement for one full turn of the handwheels. Handwheel control elements from the friction clutch to the valve linkage (fig. 5-6) are enclosed within the control box mechanism attached to the top of the A-end.

The response drive for the center gun is composed of vertical and horizontal shafting to accommodate the offset location of the center-gun elevating-gear A-end.

Control box mechanism. Servo stroking control is actuated through a case-enclosed transmission control box mechanism (fig. 5-6), mounted on top of the A-end case. The interior arrangement of interconnected and related components of the control box is shown in figure 5-6. These components are the mechanical, electrical, and hydraulic units described in the following paragraphs.

Friction clutch. Assembled between the handwheel input shaft and the limit stop screw is a clutch unit. It is a friction-type clutch that is engaged by spring pressure and disengaged by hydraulic pressure. The clutch is engaged when the control selector lever is positioned at HAND. The clutch is disengaged when the lever is positioned at AUTO or LOAD, and whenever the constant horsepower mechanism assumes control.

Limit stop. The limit stop is a screw and traveling nut device, arranged in the control drive as shown in figure 5-6. The adjustable limit stops are positioned to decelerate and stop gun movement within turret limits of gun elevation and depression (total of 47 degrees in turrets I and III; total of 45 degrees in turret II).

Follow-up control mechanism. The follow-up device (fig. 5-6) is a differential screw and nut gear mechanism that operates the control valve units through a linkage attached to a trunnion at one end of the control screw. The screw (and valve linkage) displacement is a differential movement. It is derived from handwheel rotation of the differential nut, which turns the control screw, and from B-end response rotation of the screw, which turns the screw in the opposite direction. Response input to the screw is through a quill drive. In operation, the follow-up mechanism is an automatic mechanical device for returning the valve linkage and stroking control toward neutral. Its return-to-neutral action varies with B-end speed and rotation to produce a graded deceleration of the valve gear, servo stroking control, and gun.

Control linkage. The link attached at one end to the trunnion of the follow-up control mechanism is pivoted at its opposite end and in a cam groove of a control cam. Cam movement of the link combines with control screw movement of the link to provide differential stroking of the servo control valve V23 attached near the mid-point of the link. Cam rotation is equivalent to the angle of the A-end tilting box because the cam is driven by gearing from the tilting box shaft. The arrangements of the control link, control valve, cam, and associated parts of the valve block assembly are shown in the schematic diagrams, figures 5-24 to 5-30, inclusive.

end.

Control gear response gear. The direction and speed of B-end rotation is transmitted from the B-end upper response drive bracket to the A-end control box mechanism by a system of bevel gears and shafts (fig. 5-2). The B-end response drive is coupled to a response input shaft that drives the differential screw

Valve block assembly. Tilting box stroking is controlled by a servo system valve block composed of three mechanically operated, plunger type valves and two pressure-and-spring-actuated pistons. The valves are designated: servo control valve V23, directional valve V6A, and constant horsepower valve V6. The automatic pistons are designated: pressure measuring piston P6 and servo supply cutout valve V22.

The valve block assembly is shown schematically in figures 5-23 to 5-29, inclusive.

Constant horsepower mechanism. The maximum horsepower taken from the electric motor is limited by the constant horsepower mechanism. This mechanism is a mechanical and hydraulic arrangement that acts automatically under overload conditions to return the tilting box toward neutral. The constant horsepower mechanism momentarily takes control if the combination of hydraulic pressure and stroke of the A-end causes an input horsepower to the A-end in excess of the desired limit. The mechanical components of the unit include: a control cam and a constant horsepower cam (fig. 5-6) mounted on a shaft within the control box; a cam follower roller, mounted on the pressure measuring piston P6 and arranged to bear on the cam surface of the constant horsepower cam; an eccentric slot in the control cam which actuates cam end of the control valve linkage. The pressure measuring piston is connected to the constant horsepower valve V6 by a crosslink that has a center point fulcrum. This arrangement operates with tilting box movement to vary the position of the pressure-measuring-piston outer sleeve and the control valve in accordance with the predetermined cam values.

Anti-overhauling device. The constant horsepower mechanism prevents overhauling of the transmission by back pressure under conditions of unbalanced load on the elevating screw, such as gun recoil. The constant horsepower mechanism takes over as an anti-overhauling control to move the A-end tilting box toward neutral.

Neutral return device. The neutral return device provides for manual return of the A-end tilting box to neutral, should there be an electric power failure (or the power be shut off) while the tilting box is in a stroke position. The device is a hand lever unit located on top of the A-end control case. A spur gear on the lower end of its vertical shaft meshes with a sector gear that engages a gear on the tilting box shaft. A cam on the neutral return device shaft operates the neutral return valve V14N. Thirty

switch plunger is extended and the solenoid is energized. The interlock solenoid assembly prevents gun elevating movement when the cradle and spanning tray are in a spanned or partially spanned position.

Receiver-regulator

A 16-inch Receiver-Regulator Mk 10 Mod 0 is the control instrument for automatic operation of the elevating gear. An electric-hydraulic instrument, enclosed in a square-shaped case (figs. 5-8 and 5-10), it is located on the electric deck between the electric motor and the A-end (fig. 5-7).

The receiver-regulator functions when the control selector lever is positioned at AUTO or LOAD. In these control selections, servo-system stroking pressure is ported to the stroking cylinder in response to gun orders or automatic loading orders that are received electrically in the receiver-regulator. In both of these control selections (AUTO and LOAD), the hand control servo-stroking valve gear is bypassed.

Components. Each receiver-regulator consists of the following components, all of which are enclosed within the instrument case.

Fine and coarse control synchros
Roller path and erosion correction input
Elevation response gear
Stroke response gear
Loading cam
Limit stop valve and adjusting cam
Stabilizing valve
Automatic stroking valve
Synchronizing valves
Loading pilot and transfer valves
Loading control linkage
Pressure regulator valve
Stabilizing piston and linkage
Amplifier piston and linkage
Hydraulic vibrator

The arrangement of the above electrical, hydrau-

degrees movement of the neutral return lever, either side of neutral, operates the valve to allow the servo piston to be moved freely. More than 30 degrees movement of the neutral return lever rotates the gear shaft and returns the tilting box to neutral.

Neutral starting device. The electric-motor starting-circuit interlock switch is located on the A-end control case. The switch is arranged with a plunger that extends to the top surface of the constant horsepower cam. At three degrees from the neutral position, this plunger rides into a detent on the cam and closes the starting circuit. While the cam is at any other position, the switch is open and the main electric motor cannot be started. The neutral return device must be used to restore the tilting box to neutral and thereby close the starting circuit.

Cradle and spanning tray interlock solenoid. The cradle and spanning tray interlock solenoid, located in the electric motor controller, actuates an interlock switch which is connected in series with the servo and tilting box neutral interlock switches. The solenoid is actuated by a micro switch that is mounted on a bracket attached to the hoist cradle fulcrum. The micro switch plunger extends upward to contact a piece that is mounted on the cradle. The relationship of the micro switch plunger and its contact piece is such that when the cradle and spanning tray are spanned or partially spanned, the micro

lic, and mechanical components of the receiver-regulator is shown schematically in figure 5-30

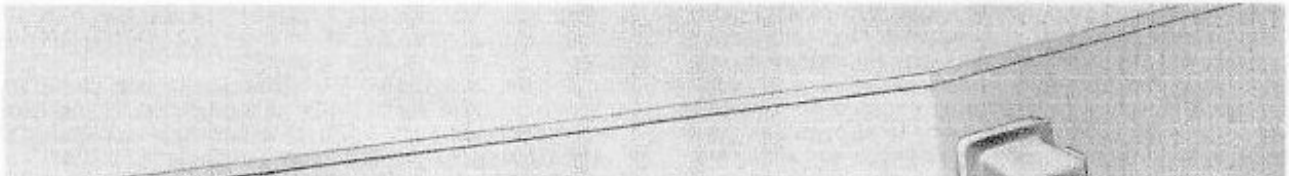
Receiver-regulator instrument.

Fine and coarse control synchros. Gun elevation orders are transmitted to the receiver-regulator by synchro circuits. The rotors of the generators and receivers of both the fine (36-speed) and coarse (2-speed) synchros (fig. 5-13) are connected in parallel to a 115-volt, 60-cycle, single-phase, alternating-current supply. Both the fine and coarse synchros are bearing-mounted so that the stators of the synchros can be rotated by corrected mechanical response, elevation response, and stroke response. This rotation is accomplished by a system of shafts, gears, and gear differentials. The two synchros and their gear train assembly are located in the synchro compartment of the receiver-regulator (fig. 5-11).

The rotor of the coarse synchro positions the synchronizing pilot valve V15 and the synchronizing valve V3A through the synchronizing linkage designated 14. The rotor of the fine synchro positions the amplifier linkage designated L1 and its attached valves (fig. 5-9).

Roller path and erosion correction input. Corrections for roller path inclination and for gun erosion are combined in differential gearing in the elevation indicator (chapter 13). The combined correction is transmitted by a shaft from the indicator that is coupled to the correction input shaft (fig. 5-13) of the receiver-regulator. Inside the receiver-regulator, the correction is combined in a differential gear with B-end response; the output of the differential positions the stators of the coarse and fine synchros.

Elevation response gear. The elevation response gear (figs. 5-11, 5-12, and 5-13) drives one input gear of the differential that rotates the stators of the coarse and fine synchros through a gear train assembly within the receiver-regulator case.



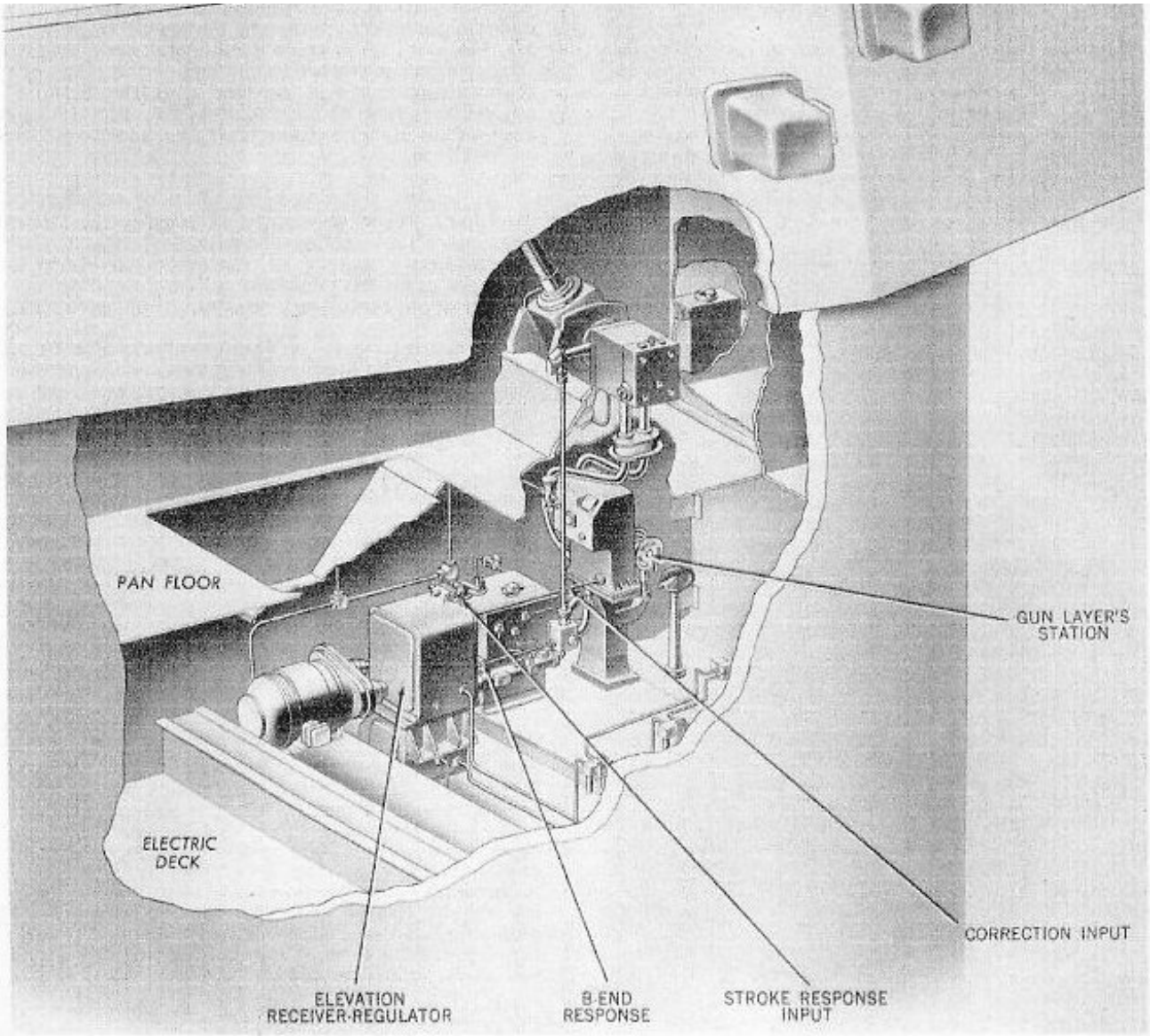


Figure 5-7. 16-inch Elevation Receiver-Regulator Mk 10 Mod 0, General Arrangement

From the B-end, elevation response is simultane-

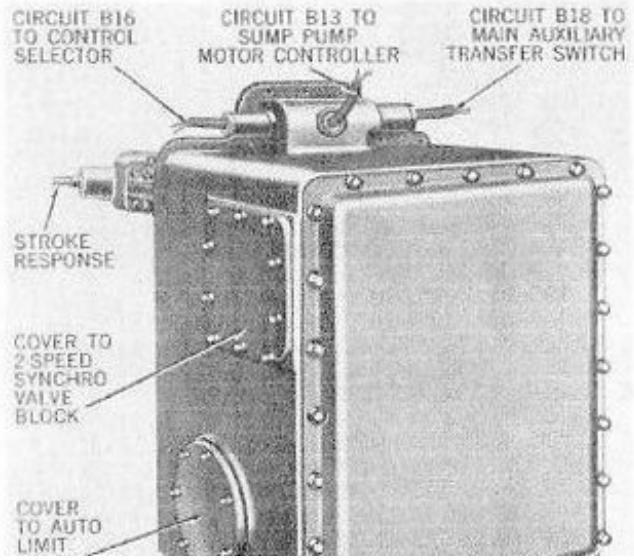
by a cam follower and linkage from the limit stop adjusting cam. V34 shifts servo pressure flow to

ously transmitted through the upper response drive bracket to the elevation indicator and by a shaft and an adjustable coupling to the receiver-regulator. In the receiver-regulator, the B-end response rotates the loading cam and combines with roller path and erosion correction input to rotate the stators of the coarse and fine synchros. The combined B-end and stroke response inputs position the limit stop valve V34 through gear sector F and the limit stop adjustment cam.

Stroke response gear. A-end stroke response is transmitted to the receiver-regulator from the neutral return device by a system of shafts and gears. In the receiver-regulator, stroke response is combined with B-end response through differential gearing to position the limit stop valve V34 through gear sector F and the limit stop adjustment cam. Stroke response represents gun elevating speed; it is combined with B-end (gun position) response to make the limit stop valve V34 operate sooner at high speeds than it does at low speeds as the gun approaches its limit.

Loading cam. The loading cam is rotated by the B-end elevation response through a gear train; it is geared directly, without correction input, so that the gun loading position is always the same. The loading pilot valve V12 is positioned by the loading cam through a cam follower and crank arrangement. Smooth deceleration and stopping at the load position are provided by the cam, which is adjustable for gun loading position.

Limit stop valve V34. The limit stop valve V34 (fig. 5-9) is located in a valve block at the bottom of the receiver-regulator valve compartment. Positioned



and drain from the servo piston P2 to decelerate and stop the gun at its preset limit.

Limit stop adjusting cam. The limit stop adjusting cam (fig. 5-31) is located in the synchro compartment of the receiver-regulator. The limit stop mechanism has two elements of data in its input. These are the position of the gun (B-end response) and the speed of the gun's movement (stroke response). Because both the position of the gun and the speed of gun movement are required for smooth, even stopping at all speeds at a definite stop position, the stroke response is added to the gun response in a gear differential within the receiver-regulator case. The output of the differential turns the limit stop adjusting cam (fig. 5-12).

Stabilizing valve V1. The stabilizing valve V1, located in the valve block at the bottom of the receiver-regulator (fig. 5-9), acts with the stabilizing piston P1 to prevent overtravel of the gun (B-end), which would result in oscillation about the elevation order signal. Positioned by the stabilizing linkage L2, the stabilizing valve V1 directs receiver-regulator control pressure to one end or the other of the stabilizing piston P1. Movement of P1 positions the amplifier piston P3 and the amplifier linkage L1 and also moves the stabilizing valve V1 back to its original position.

Automatic stroking valve V2. The automatic stroking valve V2 is located adjacent to the stabilizing valve V1, as shown in figure 5-9. Positioned by the stabilizing linkage L2, the automatic stroking valve V2 ports servo pressure flow to and drain from the servo piston through the limit stop valve V34.

Synchronizing valve V3A and synchronizing pilot valve V15. The synchronizing valve V3A and the synchronizing pilot valve V15 are located in the valve block at the upper part of the receiver-regulator valve compartment (fig. 5-9). The rotor of the coarse synchro actuates the synchronizing linkage L4 that positions these two valves. V15 ports servo pressure to V3A, which directs the servo pressure to the fine synchro valve V3 as long as gun position is within four degrees of gun elevation order. V3 then controls servo piston movement through the amplifier piston P3, stabilizing linkage L2, and automatic stroking valve V2. When gun position is more than four degrees away from gun elevation order, V3A cuts off servo pressure to V3 and ports servo pressure directly to P3 to drive the gun at full speed toward its synchronized position.

Loading pilot valve V12 and loading transfer valve V13. The loading pilot valve V12 (fig. 5-9) and the loading transfer valve V13 are located in the valve block in the center of the receiver-regulator valve compartment. Together with the loading interlock valve V44, these valves act to drive the gun at full speed toward the LOAD position, decelerate it, and stop it there. The loading transfer valve V13 is positioned by servo pressure ported to it from the load-

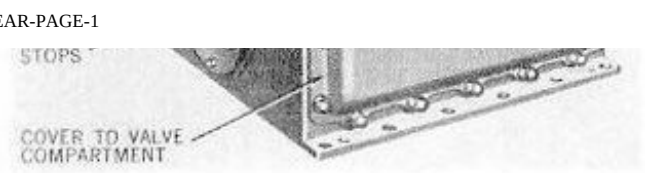


Figure 5-8. Elevation Receiver-Regulator Mk 10 Mod 0, Front View

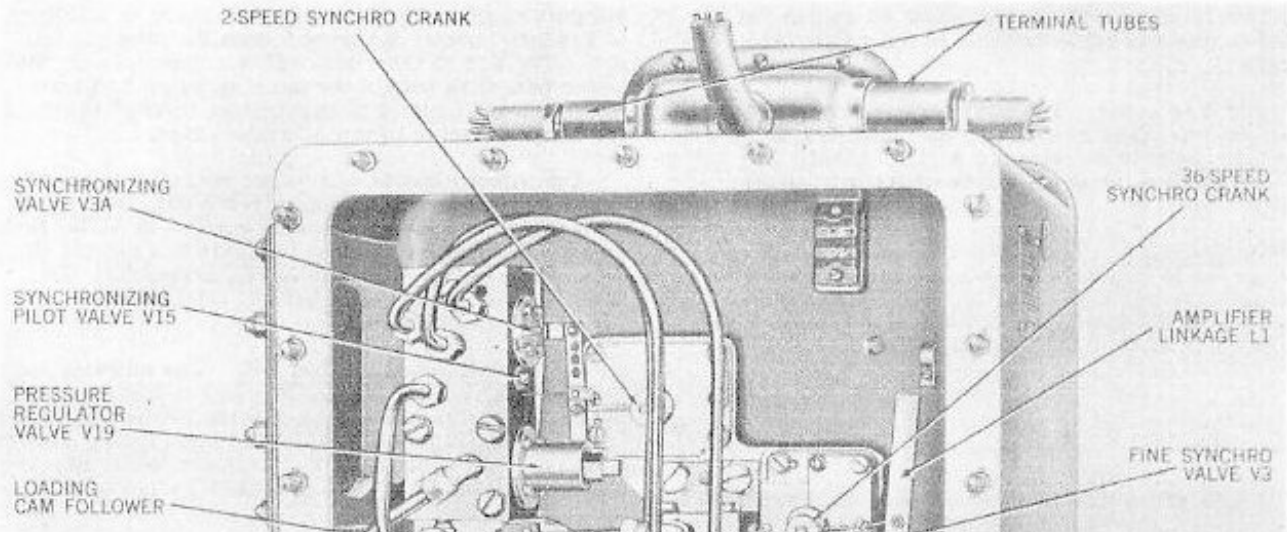
positioned by the loading control linkage L3, ports servo pressure through the loading transfer valve V13 to the amplifier piston P3.

Loading control linkage L3. The loading control linkage L3 is located in the valve compartment of the receiver-regulator (fig. 5-9). Actuated by rotation of the loading cam, the linkage positions the loading pilot valve V12.

Pressure regulator V19. The pressure regulator valve V19 is located in the valve block at the upper part of the receiver-regulator valve compartment (fig. 5-9). Servo pressure, ported to it at a pressure of approximately 350 pounds per square inch, is reduced to a control pressure of approximately 135 pounds per square inch. Control pressure is ported through the stabilizing valve V1 to the stabilizing piston P1.

Stabilizing piston P1. The stabilizing piston P1 is located in the valve block in the lower right side of the receiver-regulator valve compartment (fig. 5-9). This piston acts to change the pivot point in the stabilizing linkage L2, thereby affecting the response of the amplifier piston P3 to the movement of the fine synchro valve V3. The arrangement prevents overtravel and oscillation of the gun about the elevation order signal. The stabilizing valve V1 regulates the porting of receiver-regulator control pressure to the chambers of the stabilizing piston P1.

Stabilizing linkage L2. The stabilizing linkage L2 (fig. 5-9) mechanically connects the stabilizing valve V1 and automatic stroking valve V2 with the stabilizing piston P1 and the amplifier piston P3.



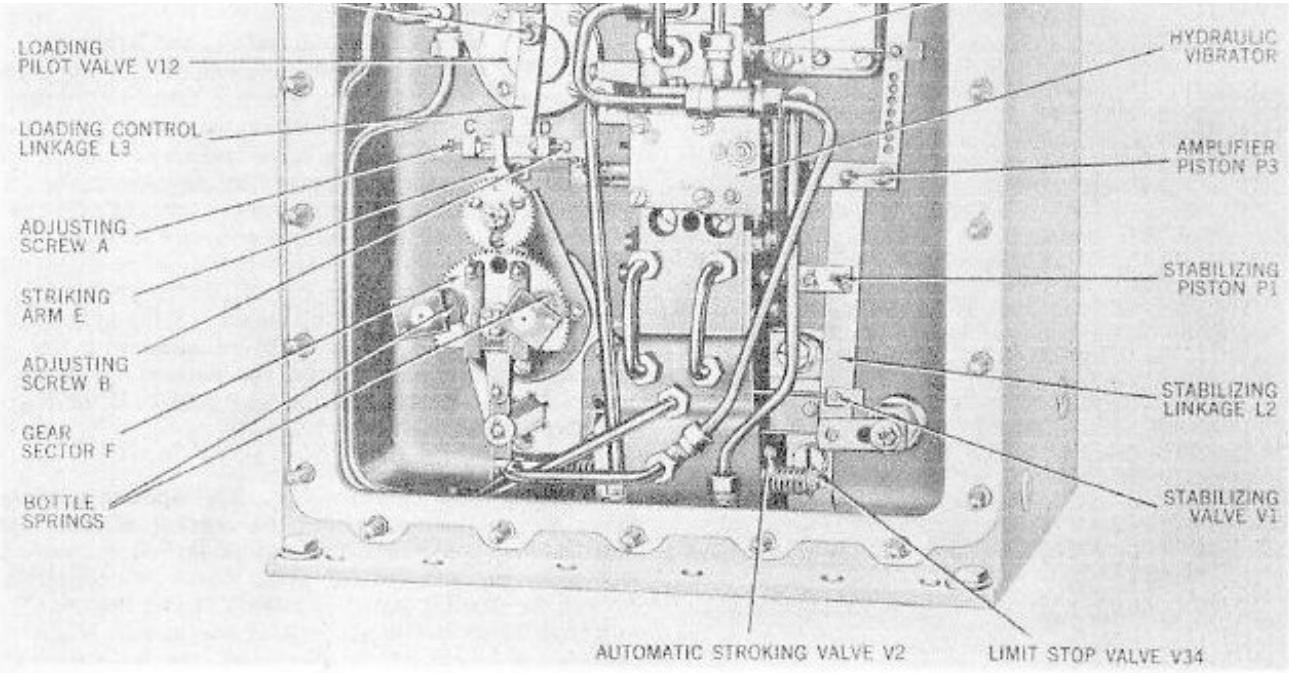


Figure 5-9. Elevation Receiver-Regulator Mk 10 Mod 0, Valve Compartment

Amplifier piston P3. The amplifier piston P3 (fig. 5-9) is moved in fine synchro control by servo pressure ported to it by the fine synchro valve V3. Amplifying V3 movement, the piston acts through the amplifier linkage L1 to return V3 to neutral. P3 acts through the stabilizing linkage L2 to position the automatic stroking valve V2. In coarse synchro control and in LOAD control, servo pressure is ported directly to P3 to drive the gun at full speed.

Amplifier linkage L1. The amplifier linkage L1 (fig. 5-9) interconnects the fine synchro rotor shaft, the fine synchro valve V3, and the amplifier piston P3. Synchro rotor movement acts through L1 to move V3. Amplifiying movement of P3 acts back through L1 to return V3 to its original position.

Hydraulic vibrator (fig. 5-14). The hydraulic vibrator, located in the center of the valve compartment, runs on servo pressure as a double-acting, two-cylinder reciprocating engine. The device oscillates the amplifier piston P3 through an amplitude of

the selector lever. The control selector valve V4, the loading valve V43, and the loading interlock valve V44 are positioned in the control selector valve block by rotation of the selector lever. The valves are positioned by gears attached to the shaft of the selector lever that mesh with gear racks attached to the connecting rods of the valves.

Control selector valve V4. The control selector valve V4 is located in the control selector unit, as shown schematically in figure 5-30. Servo pressure is admitted to the valve block through the loading position valve V14. From this point, the servo pressure passes through the synchro failure valve V11 to the center section of the control selector valve V4 and to the left end of the latching valve V45. From the center section of the control selector valve V4, servo pressure is ported to the transfer acceleration limiting valve TALV, to the control transfer valve V3B, and to the handwheel clutch. When the selector lever is at AUTO, the control selector valve V4 ports servo pressure out of the control selector valve block

a few thousandths of an inch at about 60 cycles per second to prevent static friction in the valves and linkages.

Control selector. The gun elevating control selector (fig. 5-15) is a manually operated hydraulic valve that permits selection of AUTO, LOAD, or HAND control of the power drive hydraulic transmission.

Selector lever. The control selector unit is adjacent to the gun layer's station and is provided with a readily accessible selector lever. The lever is positioned by the gun layer to the desired method of control, indicated on the lever position dial plate by

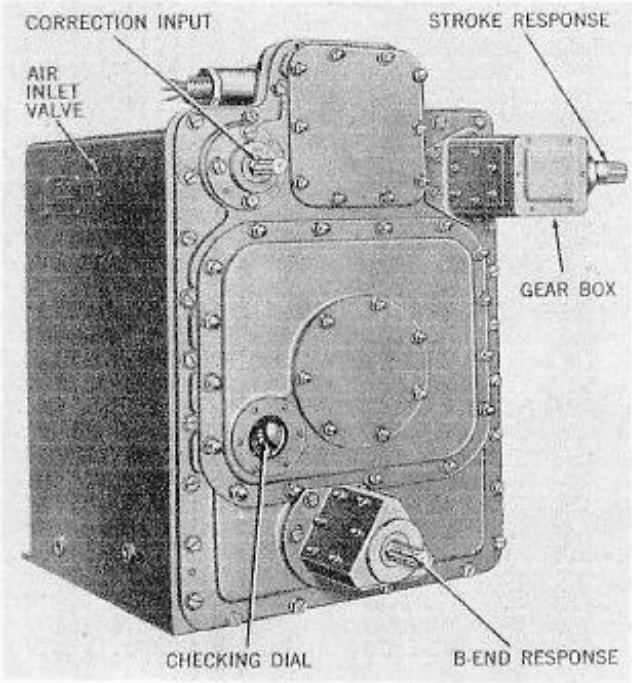


Figure 5-10. Elevation Receiver-Regulator Mk 10 Mod 0, Rear View

via port number 10 (fig. 5-15). If there is a failure of synchro power, a spring forces the synchro failure valve V11 to the right. This action cuts off the servo pressure behind the latching valve V45 and transfers the control to HAND even through the selector lever remains in the AUTO position.

Emergency button and button release. The emergency button on the control selector (fig. 5-15) is used by the gun layer to return control to AUTO from LOAD, if the gun captain's ready switch circuit (fig. 5-30) fails while the gun is in LOAD control. To disengage the emergency button, the button release (fig. 5-15) is depressed.

Selector interlock piston P46. The selector interlock piston, located within the control selector unit, prevents the gun layer from moving the selector lever from the AUTO position while the gun captain's switch is at the SAFE position. The selector interlock piston is positioned by servo pressure ported to it by the loading position valve V14.

Synchro failure solenoid, valve, and latching valve. The synchro failure solenoid S3, the synchro failure valve V11, and the synchro failure latching valve V45 are all enclosed within the control selector unit. The synchro failure valve transfers control automatically to the gun layer's handwheels in the event of a failure of synchro power. Should synchro power fail, the synchro failure solenoid S3 is de-energized and a spring forces the synchro failure valve V11 to the right to cut off servo pressure to the automatic control elements. If the synchro power is restored, the control remains with the gun layer's handwheels until the selector lever is moved to the HAND position and then back to the AUTO position.

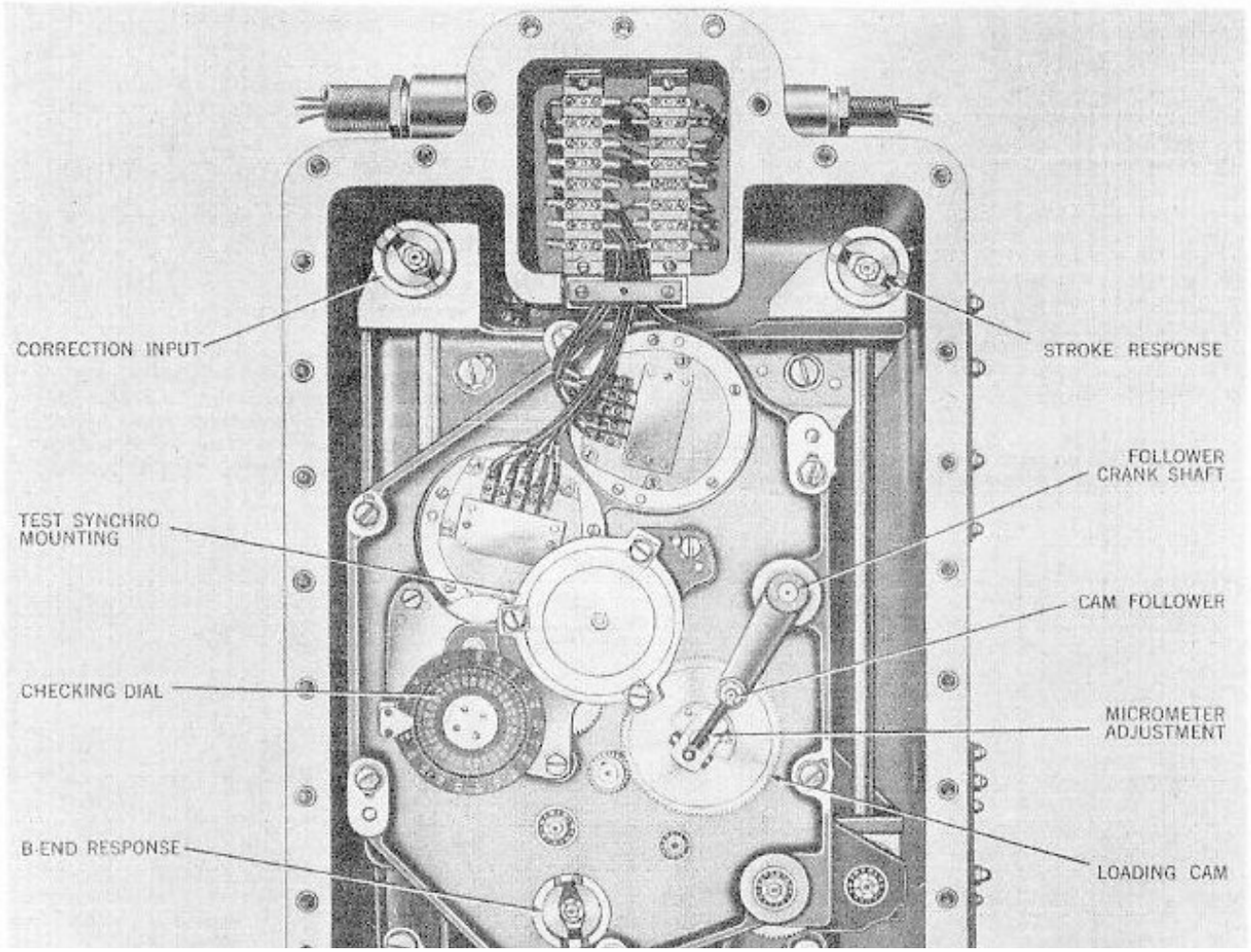
Loading position valve V14. The loading position valve V14 is located within the control selector unit. The loading position valve V14 is moved to position by a valve operating arm, which is connected to both the loading position valve V14 and the load solenoid S1 at the upper end of the arm. When the load solenoid S1 is energized, the loading position valve V14 moves to the right to port servo pressure directly to the loading transfer valve V13.

Loading interlock valve V44. The loading interlock valve V44 is located within the control selector unit. This valve is a sleeve that is moved back and forth in the block by the selector lever. The loading position valve V14 is moved back and forth inside V44 by the action of the load solenoid. Movement of the selector lever to LOAD positions V44 by means of a gear and rack arrangement (fig. 5-30). This mechanically connects servo pressure to the loading transfer valve V13. The arrangement provides gun layer selection of LOAD and AUTO control should the gun captain's circuit fail.

Loading valve V43. The loading valve V43 is located within the control selector unit. Movement of the selector lever positions the loading valve V43 through a gear and gear rack arrangement. The gear rack (fig. 5-30) butts up against the loading valve V43 and moves it to the left when the selector lever is moved from the AUTO to the LOAD position. This permits the gun to be brought to the load position by the selector lever when synchro power is not available.

Solenoids. The load and automatic solenoids are both located within the control selector unit.

Load solenoid. The load solenoid S1, connected to the valve operating arm, is energized when the gun captain's switch is moved to the SAFE position. When the load solenoid has been energized, it moves the operating arm so that the loading position valve V14 is moved to the left. This ports servo pressure to the loading transfer valve V13. The solenoid is de-energized by moving the gun captain's switch to READY.



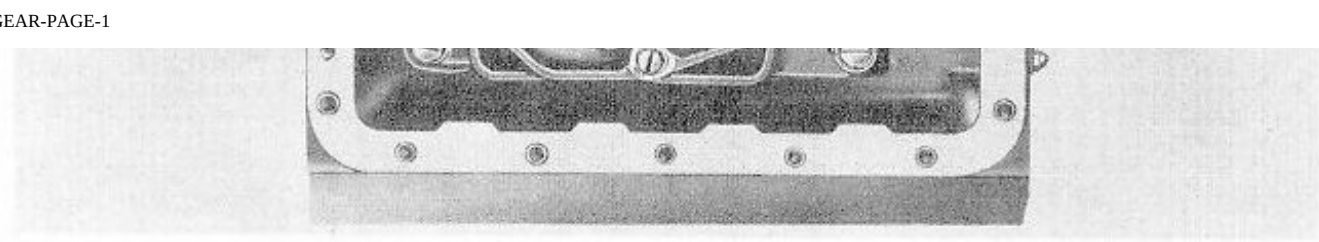
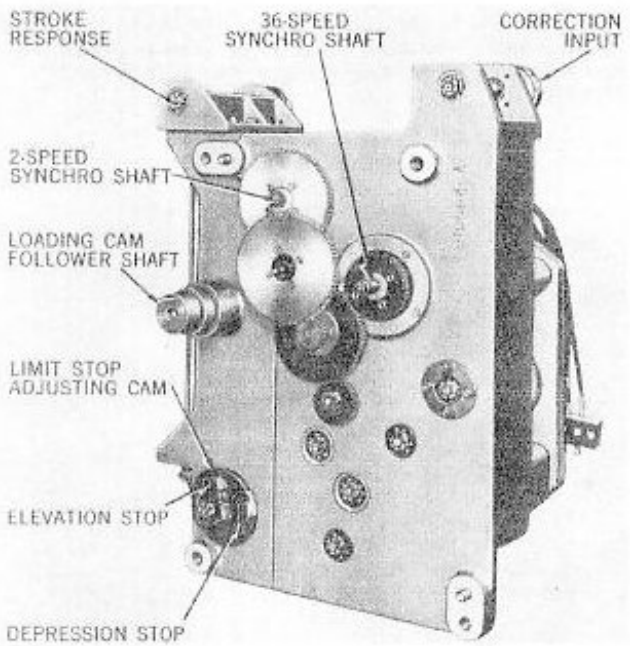


Figure 5-11. Elevation Receiver -Regulator Mk 10 Mod 0, Rear View - Back Plate Removed

Automatic solenoid. The automatic solenoid S2 is connected to the lower end of the valve operating arm. With the selector lever at AUTO, the solenoid is energized when the gun captain's switch is moved to READY. When the automatic solenoid S2 is energized, it moves the operating arm so that the loading position valve V14 is moved to the right to port servo pressure to the receiver-regulator automatic control elements.



Control transfer valve V3B. The control transfer valve V3B (fig. 5-16), located near the servo piston P2, transfers elevation control of the gun from the gun layer's handwheels to the receiver-regulator. When servo pressure is ported to the control transfer valve from the control selector unit, the control transfer valve is moved to the right against spring pressure. This connects the automatic stroking valve V2 in the receiver-regulator to the servo piston P2 through V3B.

Transfer acceleration limiting valve TALV. The transfer acceleration limiting valve TALV (fig. 5-18), located near the A-end, prevents excessive gun elevation speeds when shifting from AUTO to HAND. In AUTO, servo pressure is ported to the transfer acceleration limiting valve TALV from the control selector unit to hold the valve open against its spring. When the selector lever is moved from AUTO to HAND, the unbalanced valve TALV, bound against the side wall by servo pressure, closes partly and restricts flow in the line to the outside of P2. As soon as the gun synchronizes with the handwheels, V23 cuts off servo pressure to TALV, which then is moved by its spring to remove the restriction in the line to the servo piston.

Sump tank. The sump tank (fig. 5-19) forms the base on which the receiver-regulator is mounted. The tank is a rectangular, box-like weldment with internal arrangements for two floats, a valve, a mercury switch, and a hydraulic pipe manifold. There is a removable inspection cover on one side of the tank and six flanged ports for hydraulic pipes on the opposite side of the tank. A drain plug is provided in the bottom of the tank. The sump tank is a receptacle for hydraulic fluid leakage and drainage from the receiver-regulator valve block.

Sump pump. The sump pump (fig. 5-20) is a separate motor-pump set, located on the electric deck near the A-end. Hydraulic fluid leakage and drainage from the receiver-regulator valve block

Figure 5-12. Elevation Receiver-Regulator Mk 10 Mod 0, Gear Train Assembly, Front View

drainage from the receiver-regulator valve block goes into a sump tank from which the oil is pumped back to the expansion tank. Under normal operation,

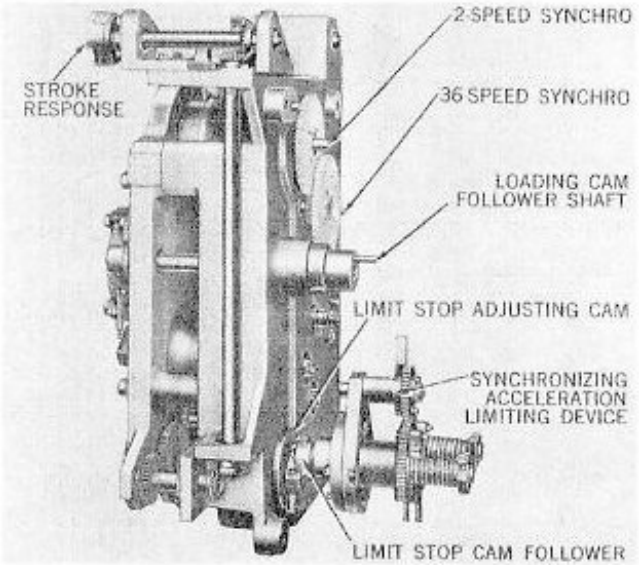


Figure 5-13. Elevation Receiver-Regulator Mk 10 Mod 0 Gear Train Assembly, Side View

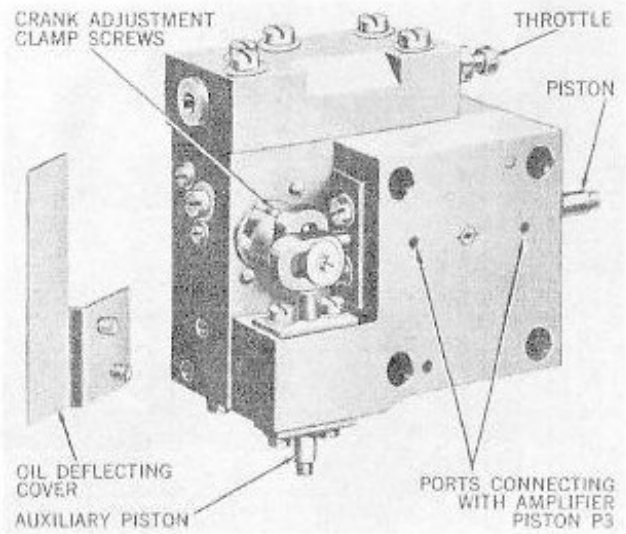


Figure 5-14. Elevation Receiver-Regulator Mk 10 Mod 0 Hydraulic Vibrator

the sump pump runs whenever the main electric motor is running. The capacity of the pump is greater than the normal drainage into the sump tank; therefore, part of the oil is recirculated back to the sump tank. Whenever the oil level drops too low, the float-operated sump pump valve V40 opens and permits the pump discharge to return to the sump tank to assure adequate supply to the pump at all times.

If the sump pump unit is not used for several days, oil may gradually fill the sump tank. Should the oil level get abnormally high, the float-operated mercury switch actuates a magnetic switch in the sump pump control unit and thereby starts the pump. The pump lowers the oil level until the float switch cuts off the pump motor circuit. Should the float switch fail, the pump may be run by closing the sump pump emergency switch.

electric deck, near the training gear A-end. It consists of a standard-type controller case, inside of which is a shock-mounted switch panel, a line switch, a control transformer, and necessary interlocks. The controller contains four separate circuits which operate the sump pump motors of the elevating gears for the right gun, the center gun, the left gun, and the turret training gear. Each circuit is complete in itself.

When the electric motor of any one of the elevating gear power drives is started, the corresponding magnetic switch in the sump pump controller closes a circuit to the sump pump for that power drive. Each magnetic switch has two solenoids that are joined together mechanically and are connected to the contact mechanism. One solenoid is for 440 volts and the other is for 110 volts; either solenoid is capable of

If the sump pump should fail, the sump tank will be completely filled. Sump tank check valve V41 will close, sealing the synchro compartment, and pressure will build up in the valve compartment. When the pressure reaches eight pounds per square inch, the discharge oil will be forced through the block valve to the expansion tank.

Sump pump controller. The sump pump controller (figs. 5-21 and 5-22) is mounted on the bulkhead at the

closing the switch. While the power drive is operating, the 440-volt solenoid is energized from one phase of the main controller; therefore, the sump pump operates whenever its power drive is operating.

If the power drive is not operating and fluid leakage fills the sump tank, a float-operated mercury switch (fig. 5-19) closes a 110-volt circuit and thereby closes the magnetic switch by energizing the 110-volt solenoid. The 110-volt power is supplied by a transformer in the controller unit case.

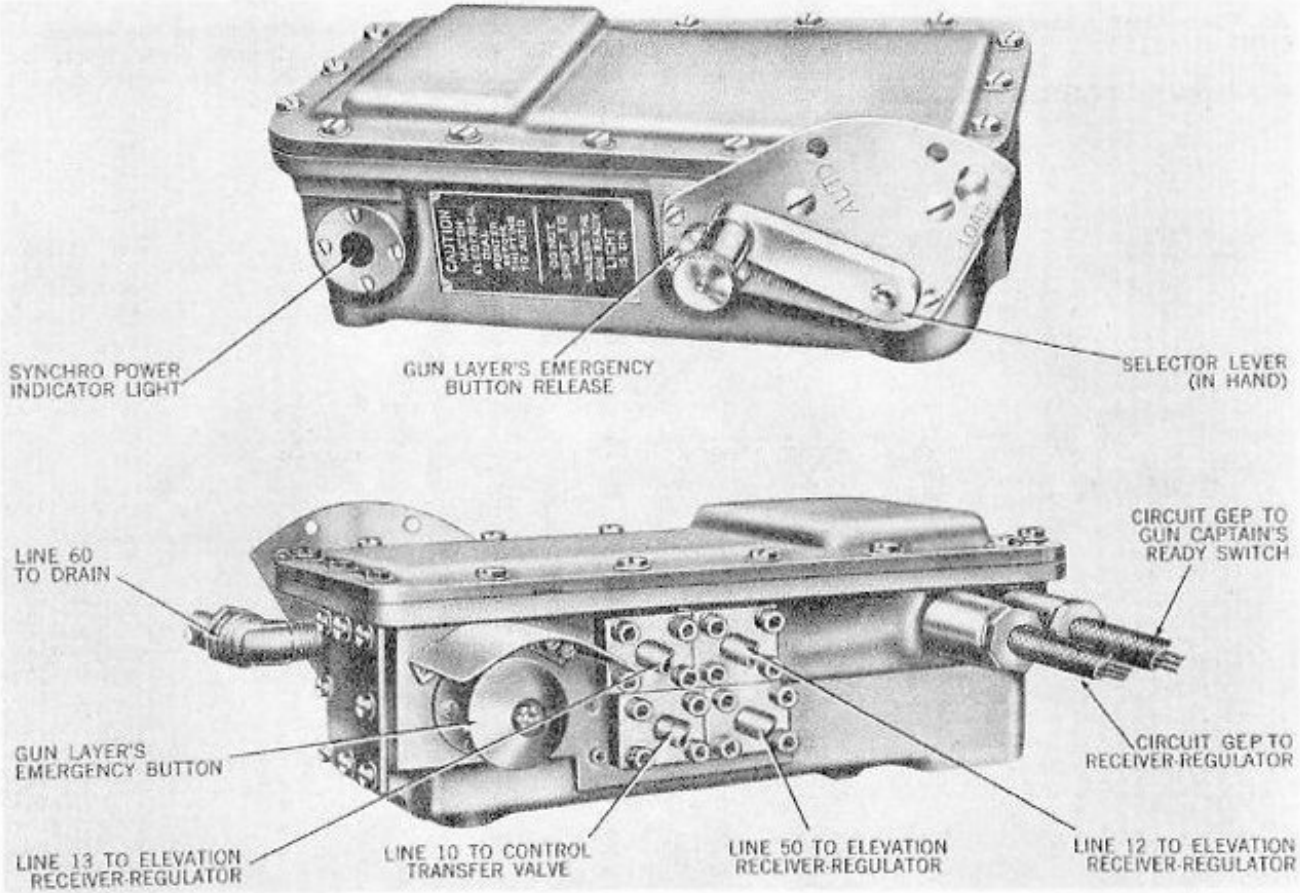


Figure 5-15. Elevation Receiver-Regulator Mk 10 Mod 0 Selector and Synchro Failure Valve

OPERATION

General - hand and automatic control

In normal HAND operation, the gun order signal is received in the elevation indicator. The gun layer observes the gun order signal, indicated by the pointers in the elevation indicator, and compares that signal with the position of the gun. If there is a "matching error" in the pointers, the gun layer operates his handwheels in a direction and at a speed calculated to "match pointers."

In AUTO operation, the receiver-regulator receives the same gun order signal as that received by the elevation indicator. By comparing the gun order signal with a mechanical indication of the gun position, the receiver-regulator continually measures "matching error." The receiver-regulator measures the error by electrical and mechanical devices and acts on the servo stroking piston to reduce the error. In AUTO, the receiver-regulator replaces the gun layer's function of visually checking the error and manually controlling the gun position in order to "match pointers."

Starting

Perform the following operations when starting the electric motor:

1. Place the controller circuit-breaker lever at ON.

2. Place the gun layer's control selector lever at HAND.

3. Press the START-EMERG button.

Stopping

When stopping the elevating gear, perform the following operations:

1. Place the gun layer's control selector lever at HAND.

2. Bring the gun to the desired angle of elevation and stop handwheel rotation.

3. Press the STOP button.

Hand control, servo operation

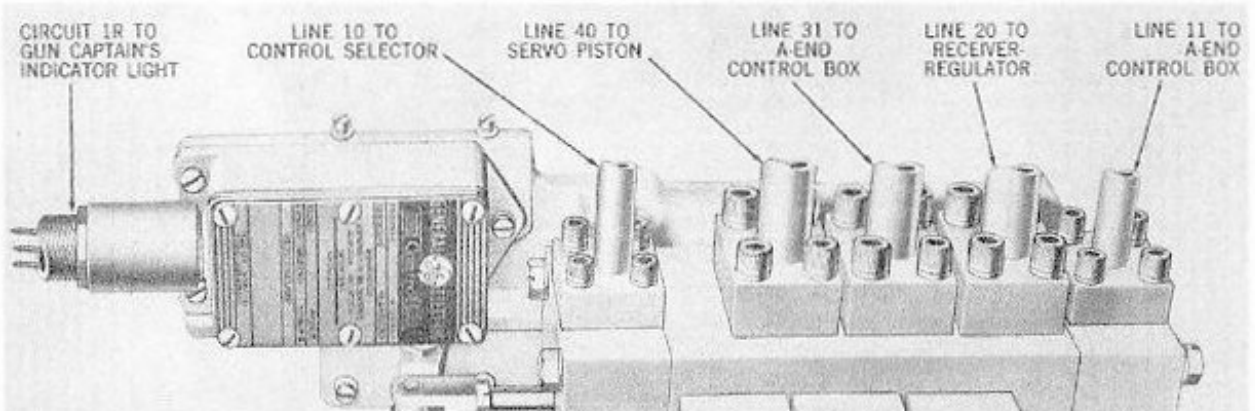
For servo operation in hand control, the gun layer's selector lever is positioned at HAND. To start the power drive, the START-EMERG push button must be depressed when the A-end tilting box is at the neutral position.

Controls neutral. With the power drive electric motor running and the elevating handwheels at rest, the following conditions exist (fig. 5-23):

1. The A-end tilting box is at neutral (zero tilt); no hydraulic fluid is being pumped, and there is no pressure in the main hydraulic lines between the A- and B-ends.

2. The power-off control valve V4N is held by its solenoid against spring action.

3. Hydraulic fluid is delivered by the servo pump (at servo pressure) through ports in the power-off control valve V4N to the left of the power-off valve V1N.



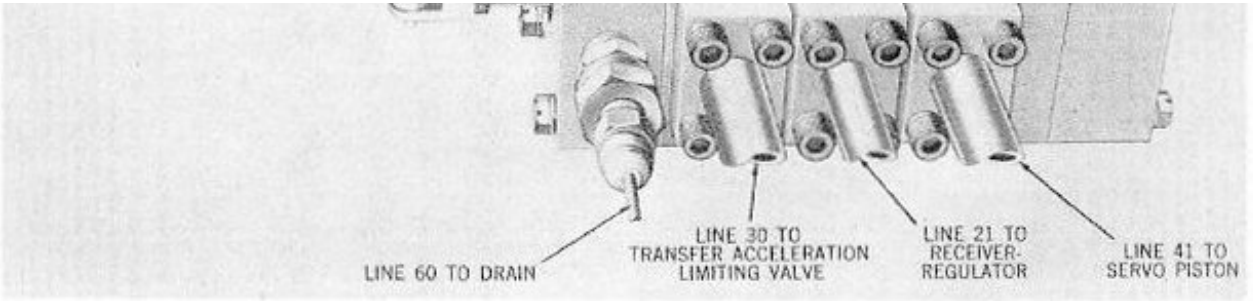


Figure 5-16. Elevation Receiver-Regulator Mk 10 Mod 0 Control Transfer Valve

4. Forced to the right by servo pressure, V1N opens the main hydraulic lines from the A-end to the B-end.

5. Movement to the right V1N also connects servo pressure to the cutout valve V12N and to the servo supply cutout valve V22. V12N is moved against its spring to open passages from the main hydraulic lines to the tops of the A-end relief valves V9N and V10N. V22 is forced down against its spring to admit servo pressure from another line to the servo control valve V23, where the pressure is blocked.

6. Servo pressure from the servo pump ported directly to the directional valve V6A is blocked by that valve in its neutral position.

7. Supercharge pressure is maintained to the A-end relief valve block (check valve V13N) by the supercharge pump to keep the main system filled with hydraulic fluid.

Normal control, elevating. With the power drive in operation (controls neutral, as shown in figure 5-23), the gun is elevated by turning the handwheels up and toward the operator. The following actions occur:

1. Handwheel motion is transmitted through the friction clutch and differential (fig. 5-25) to the trunnion to move it upward.



2. Through a linkage, pivoted in a slot in the control cam, the trunnion lifts the servo control valve V23. This ports servo pressure through grooves in the constant horsepower valve V6 through V3B to the inside of the servo piston. The hydraulic fluid on the outside of the piston drains through V3B to TALV to V6 to V23 to tank.

3. Servo pressure moves the servo piston and, through it, the A-end tilting box. Tilting box movement is transmitted mechanically through the sector gear to the control cam.

4. A-end pumping action drives the B-end to elevate the gun. The control cam moves V23 through the trunnion linkage to block further hydraulic flow to the servo piston. B-end response acts on the trunnion through the differential; trunnion displacement represents the difference between handwheel input and B-end response. At a constant handwheel speed, the servo piston, A-end tilting box, control cam, and trunnion remain in a state of equilibrium with servo control valve V23 blocking flow to the servo piston.

5. Increase in handwheel speed causes an increase in A-end tilt through further movement of the servo piston.

6. Decrease in handwheel speed combines with B-end response to move the trunnion in the opposite direction. This forces V23 down and reverses the pressure and drain connections to the servo piston to drive the A-end tilting box back toward the neutral position.

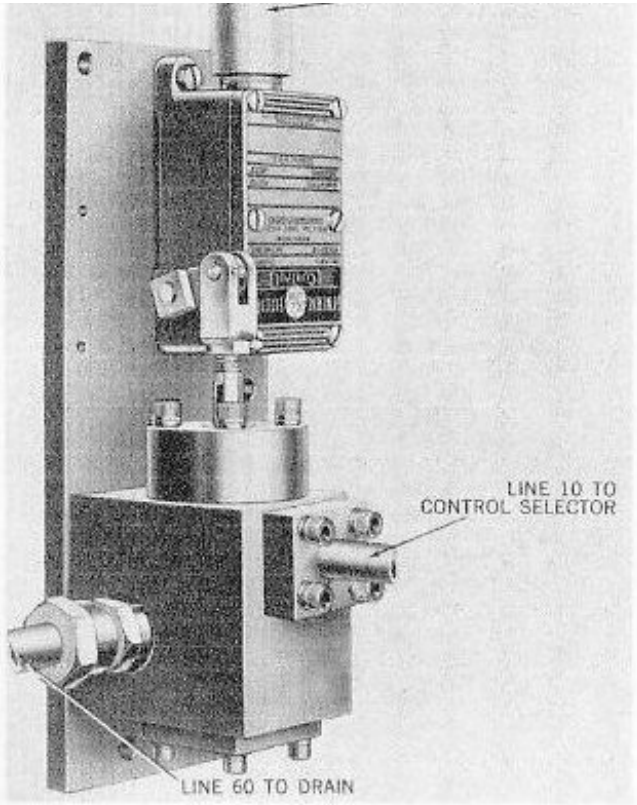


Figure 5-17. Elevation Receiver-Regulator Mk 10 Mod 0 Pressure-operated Indicator Switch

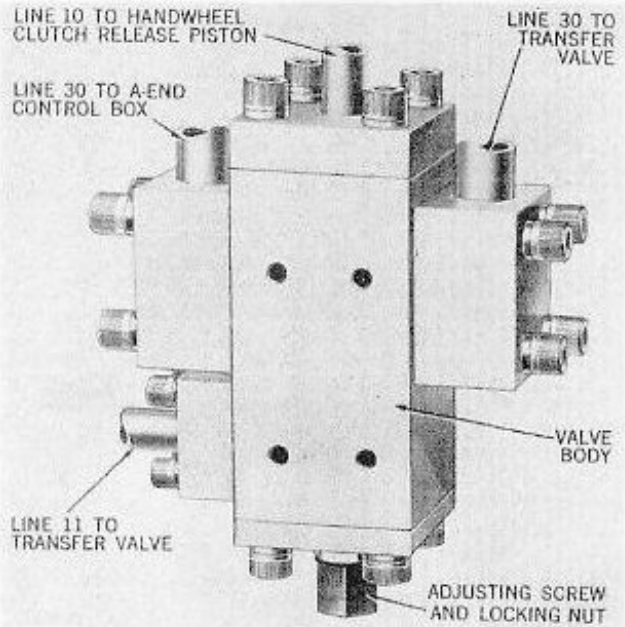


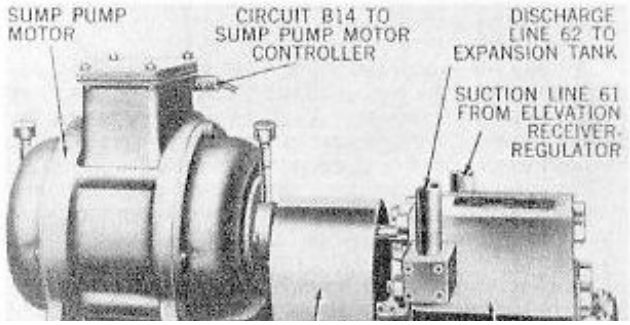
Figure 5-18. Elevation Receiver-Regulator Mk 10 Mod 0 Transfer Acceleration Limiting Valve

5-23

7. Main system high pressure is ported through pilot valve V11N and cutout valve V12N to the top of relief valve V9N to hold the valve closed. If main system pressure rises too high, V11N is forced to the right to connect the top of V9N to the low-pressure side of the main line. System high pressure then lifts V9N and bypasses into the main system return until the high pressure has dropped to normal.

8. Normal leakage will cause the main system return pressure to drop below the setting of the check valve V13N. When this occurs, the system is replenished by the supercharge pump through V13N.

Constant horsepower control, elevating. If the combination of A-end stroke and main system high



pressure requires the electric motor to deliver more than the desired horsepower, the constant horsepower device takes control (fig. 5-26). When this occurs:

1. System high pressure from the shuttle valve V27 acts on the measuring piston P6 to force it down. Through a link, the piston lifts the constant horsepower valve V6.

2. In its new position, V6 blocks servo pressure from V22 and V23. Servo pressure is ported through the directional valve V6A, V6, TALV, and V3B to the outside of the servo piston to drive it back toward its neutral position. The inside of the servo piston is open to drain through V3B, V6, and V6A.

3. Movement of the A-end toward neutral turns the control cam, which changes the position of the outer sleeve of P6. When the horsepower demand has dropped to normal, the positions of P6 and its outer sleeve act to move V6 back to its normal position.

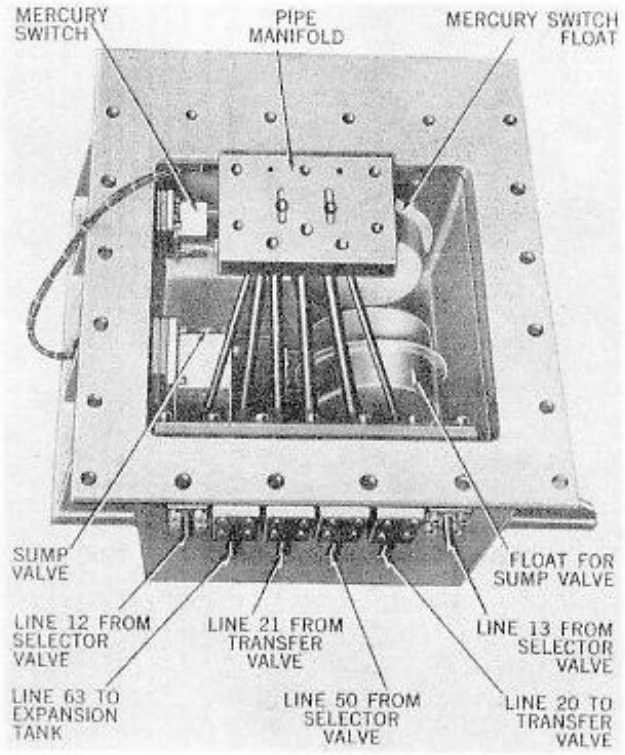


Figure 5-19. Elevation Receiver-Regulator Mk 10 Mod 0 Sump Tank, Top View

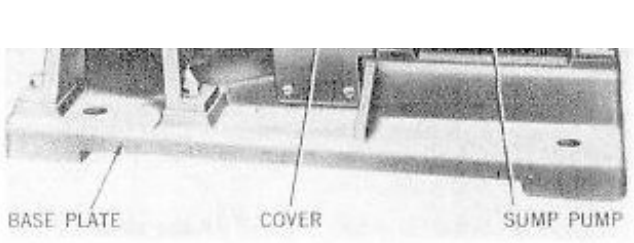


Figure 5-20. Elevation Receiver-Regulator Mk 10 Mod 0 Sump Pump

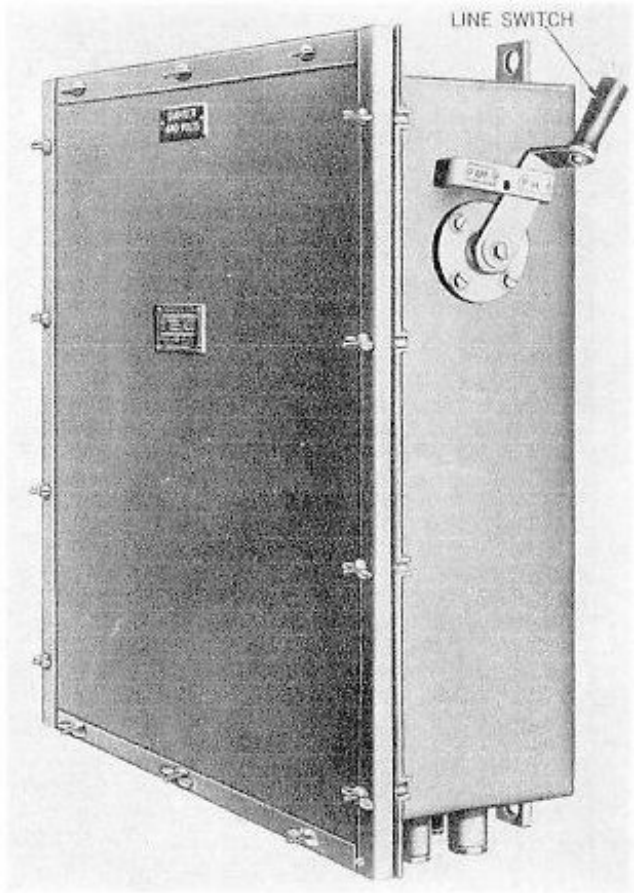


Figure 5-21. Elevation Receiver-Regulator Sump Pump Control Unit

Normal control, depressing. With the power drive in operation (controls neutral, as shown in figure 5-23), the gun is depressed by turning the handwheels down and away from the operator. The following actions occur:

1. Handwheel motion is transmitted through the friction clutch and differential (fig. 5-27) to the trunnion to move it downward.

2. Through a linkage, pivoted in a slot in the control cam, the trunnion pushes the servo control valve V23 down. This ports servo pressure around the constant horsepower valve V6 through TALV and V3B to the outside of the servo piston. The inside of the servo piston is opened to drain through V3B and other ports in V6 and V23.

3. Servo pressure moves the servo piston and through it, the A-end tilting box. Tilting box movement is transmitted mechanically through the sector gear to the control arm.

4. A-end pumping action drives the B-end to depress the gun. The control cam moves V23 through the trunnion linkage to block further hydraulic flow to the servo piston. B-end response acts on the trunnion through the differential; trunnion displacement represents the difference between handwheel input and B-end response. At a constant handwheel speed, the servo piston, A-end tilting box, control cam, and trunnion remain in a state of equilibrium, with servo control valve V23 blocking flow to the servo piston.

5. Increase in handwheel speed causes an increase in A-end tilt through further movement of the servo piston.

6. Decrease in handwheel speed combines with B-end response to move the trunnion in the opposite direction. This forces V23 up and reverses the pressure and drain connections to the servo piston to drive the A-end tilting box back toward the neutral position.

7. Main system high pressure is ported through pilot valve V11N and cutout valve V12N to the top of relief valve V10 to hold the valve closed. If main system pressure rises too high, V11N is forced to the left to connect the top of V10 to the low-pressure side of the main line. System high pressure then lifts V10N and bypasses into the main system return until the high pressure has dropped to normal.

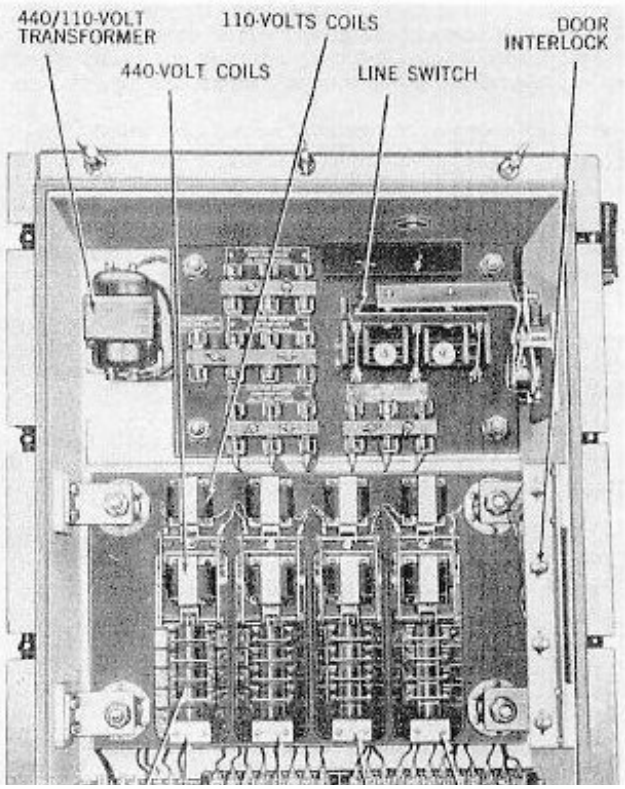
8. Normal leakage will cause the main system return pressure to drop below the setting of the check valve V13N. When this occurs, the system is replenished by the supercharge pump through V13N.

position. The outside of the servo piston is open to drain through V3B, TALV, V6 and V6A.

Limit stop control. If handwheel motion is continued in one direction until the gun is approaching its positive stop, the limit stop in the control mechanism stops the handwheels (fig. 5-29). When this occurs:

1. B-end response acts directly on the trunnion to return it to neutral.

2. Trunnion movement shifts the servo control valve V23 to port servo pressure around V6 to the servo piston to return the A-end tilting box to neutral.



Constant horsepower control, depressing. If the combination of A-end stroke and main system high pressure requires the electric motor to deliver more than the desired horsepower, the constant horsepower device takes control (fig. 5-28). When this occurs:

1. System high pressure from the shuttle valve V27 acts on the measuring piston P6 to force it down. Through a link, the piston lifts the constant horsepower valve V6.

2. In its new position, V6 blocks servo pressure from V22 and V23. Servo pressure is ported through the directional valve V6A, V6 and V3B to the inside of the servo piston to drive it back toward its neutral

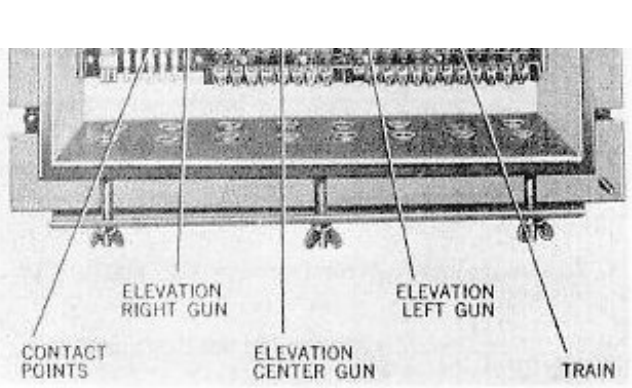


Figure 5-22. Elevation Receiver-Regulator, Sump Control Unit, Door Open

Power-off. The solenoid of the power-off control valve V4N is in the circuit of the electric motor controller. If the STOP push button is depressed or if 440-volt power fails, this solenoid is de-energized with the following results:

1. V4N (fig. 5-24) is moved by its spring to port the pressure above power-off valve V1N to drain.

2. V1N is moved by its spring to block the main hydraulic lines in the B-end. This blocks hydraulic flow between the A-end and B-end and "freezes" the gun in elevation.

3. In its power-off position, V1N ports trapped servo pressure from the cutout valve V12N to drain through the B-end case. V12N is then moved by its spring to port the spaces above relief valves V9N and V10N to drain through the throttle valve VT. This allows system high pressure to bleed to drain through the pilot valve V11N, the cutout valve V12N, and the spaces above V9N and V10N.

When the elevating gear has been stopped while in motion, either by power failure or by use of the STOP push button, the power drive cannot again be started until the A-end tilting box is manually returned to neutral with the neutral return device.

Receiver-regulator control, servo operation (fig. 5-30)

With the power transmission operating, the selector lever at AUTO, and with the gun synchronized with a stationary signal, hydraulic circuit conditions

To the fine synchro valve V3 through the synchronizing pilot valve V15 and the synchronizing valve V3A. V3 is centered and blocks servo pressure between its lands.

5. Servo pressure is delivered through the loading position valve V14 and the loading interlock valve V44 to one end of the loading transfer valve V13. This positions V13 so that it connects port of V3 to corresponding ports of the amplifying piston P3.

Fundamental (fine synchro) automatic control. When the gun is within four degrees of synchronization with the gun elevation order signal, the fine (36-speed) synchro E (fig. 5-30) controls automatic operation of the receiver-regulator. With gun elevation order for increasing gun elevation, the following actions take place:

1. The synchro rotor turns an amount corresponding to the "error" between actual elevation and elevation order. Its motion is transmitted through the amplifier linkage L1 to move the fine synchro valve V3 to the right.

2. Servo pressure between the lands of V3 is ported through the loading transfer valve V13 to the right end of amplifier piston P3.

3. Servo pressure forces P3 to the left a distance corresponding to, but greater than, the movement of V3. This movement is transmitted back through L1 to return V3 to neutral. At the same time, the motion of P3 is transmitted through the

are as follows:

1. Servo pressure is delivered through the power-off control valve V4N and the power-off valve V1N to the cutout valve V12N and the servo supply cutout valve V22.

2. Servo pressure is delivered directly from the servo pump to the directional valve V6A and from the pump through V22 to the servo control valve V23.

3. Servo pressure from the servo pump is delivered through the synchro failure valve V11 and the control selector valve V4 to the following:

The friction clutch to disengage the handwheels.

The transfer acceleration limiting valve TALV to position it against spring action for AUTO operation.

The control transfer valve V3B to open the passage from the limit stop valve V34 to the servo piston.

4. With the gun between its limits, servo pressure is delivered through the limit stop valve V34 to the following:

To the loading control valve V12, where it is blocked.

To the automatic stroking valve V2, where it is blocked.

To the hydraulic vibrator for oscillation of the amplifier piston P3.

To the pressure regulator valve V19, where it is reduced to control pressure and delivered to the stabilizing valve V1.

stabilizing linkage L2 to the stabilizing valve V1 and the automatic stroking valve V2.

4. The stabilizing valve V1 ports control pressure from V19 to the stabilizing piston P1. This causes P1 to move to the left and change the pivot of L3 to modify the action of P3 on V2. Without this action, the entire system would overtravel and then oscillate about the input gun elevation order signal. This action makes the automatic stroking valve V2 move an amount that will limit the delivery of servo pressure to the pervo piston.

5. V2 moves to the right and ports servo pressure to the inside of the servo piston through V3B.

6. B-end response is combined with roller path and erosion correction input in a differential; the differential drives the stator of the fine synchro E. Overtravel of the servo piston would result in a reversal of the synchro rotor and regulator valve actions; this is prevented by the stabilizing action of V1 and P1, which operate in conjunction with B-end response to bring the gun smoothly into synchronization and to hold it there.

Coarse (2-speed) synchro control. Because the fine (36-speed) synchro E has identical positions 10 degrees of elevation apart, the gun position could agree with the synchro and still be 10 degrees away from the gun elevation order signal. The coarse (2-speed) synchro prevents this. Its rotor is turned electrically an amount equal to the difference between actual gun elevation and gun elevation order. When this difference is more than four degrees:

1. The rotor of synchro D has turned far enough to move (through the synchronizing linkage L4) the synchronizing pilot valve V15 to port servo pressure to the end of the synchronizing valve V3A.

CHAPTER-5-ELEVATING-GEAR-PAGE-2

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Chapter 6

TRAINING GEAR

16-inch Training Gear Mark 2 Mod 0

16-inch Train Receiver-Regulator Mark 18 Mod 0

GENERAL DESCRIPTION

The turret training gear, shown in figure 6-1, is the same in all turrets of the IOWA class battleships. It is designated 16-inch Training Gear Mk 2 Mod 0.

The equipment drives and controls the movements of turret train. It rotates the turret within an arc of 300 degrees, limited by positive stops 150 degrees left and right of the turret centerline position.

The 16-inch Training Gear Mk 2 Mod 0 is a stationary gear rack type with pinion gears driven by an electric-hydraulic power drive, through worms and wormwheels. The equipment is controlled by an arrangement of hand and automatic servo-type controls.

The turret training equipment includes the following design features:

Equal drive torque at each of the two worm and wormwheel assemblies drives the two training pinion gears. Twin hydraulic motors (B-ends) drive the two worms; both B-ends are powered by a single pump (A-end).

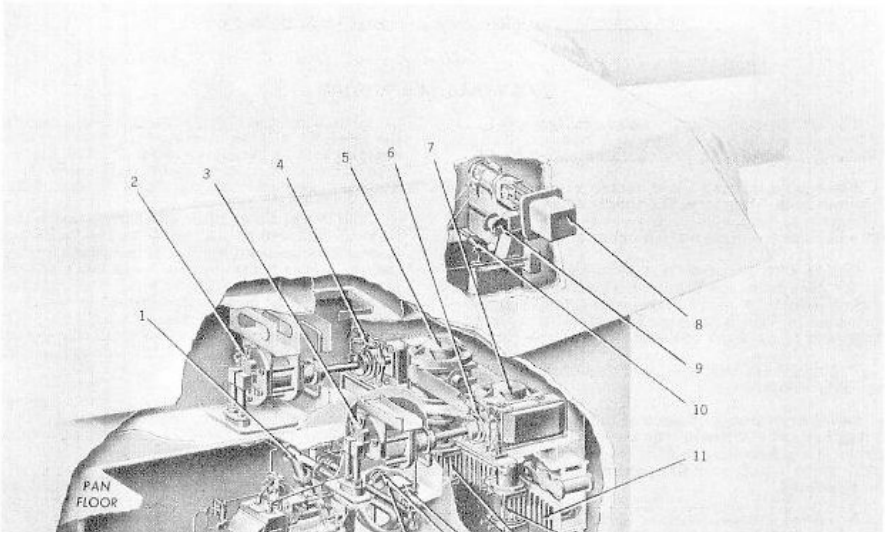
A control selector permits control selection of turret train either automatically from a remote ship's station or by hand from a local trainer's station. The method of control is selected by the train operator. These control methods are designated AUTO and HAND.

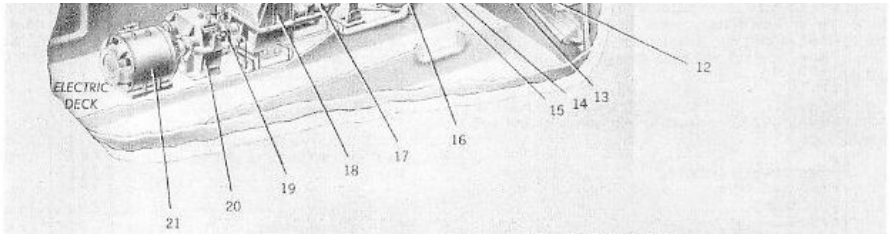
all mounted on the electric deck, in the space between the pan floor and the electric deck directly below the center gun. The train operator's control station is also in the electric deck space, forward of the A-end and the train indicator, as shown in figure 6-1.

The B-end assemblies are located above the pan floor at the forward part of the turret, in the spaces between the parallel divisional bulkheads formed by the gun girder boxes, with a B-end mounted either side of the center gun girder box. The training worm, wormwheel, and pinion assemblies are located forward of their respective B-ends. Relative positions, worm couplings, and A-end manifold pipe connections are shown in figure 6-2 together with the annular training rack.

The electric power supply controller is located in the lower projectile handling deck machinery space. The remote ON-OFF push-button control is at the train operator's station.

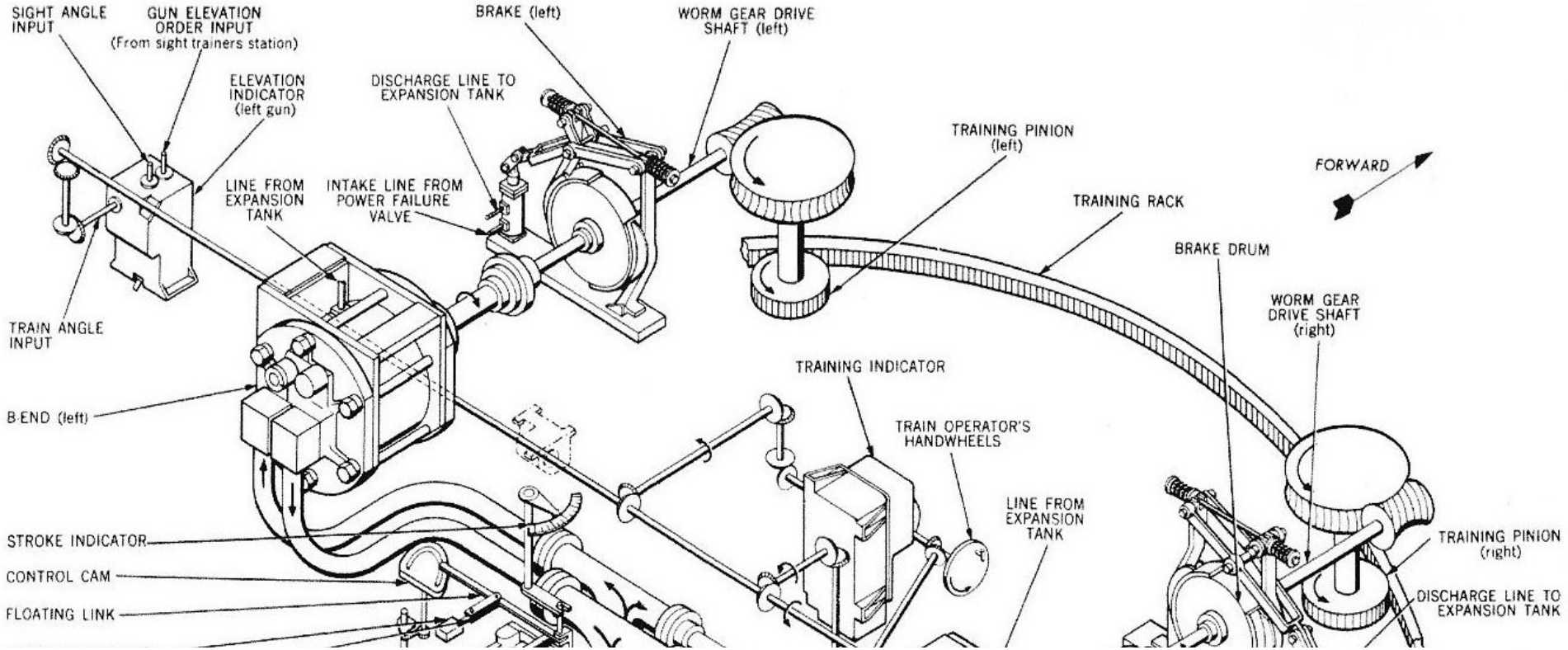
There are two stations for the local sight trainer's gear controls. A station is located at each side of the turret officer's booth. These stations are isolated from the gun compartments by turret subdivision bulkheads. A system of shafts and gear boxes connects the hand training control gear with the other control elements assembled in the control box on top of the A-end.

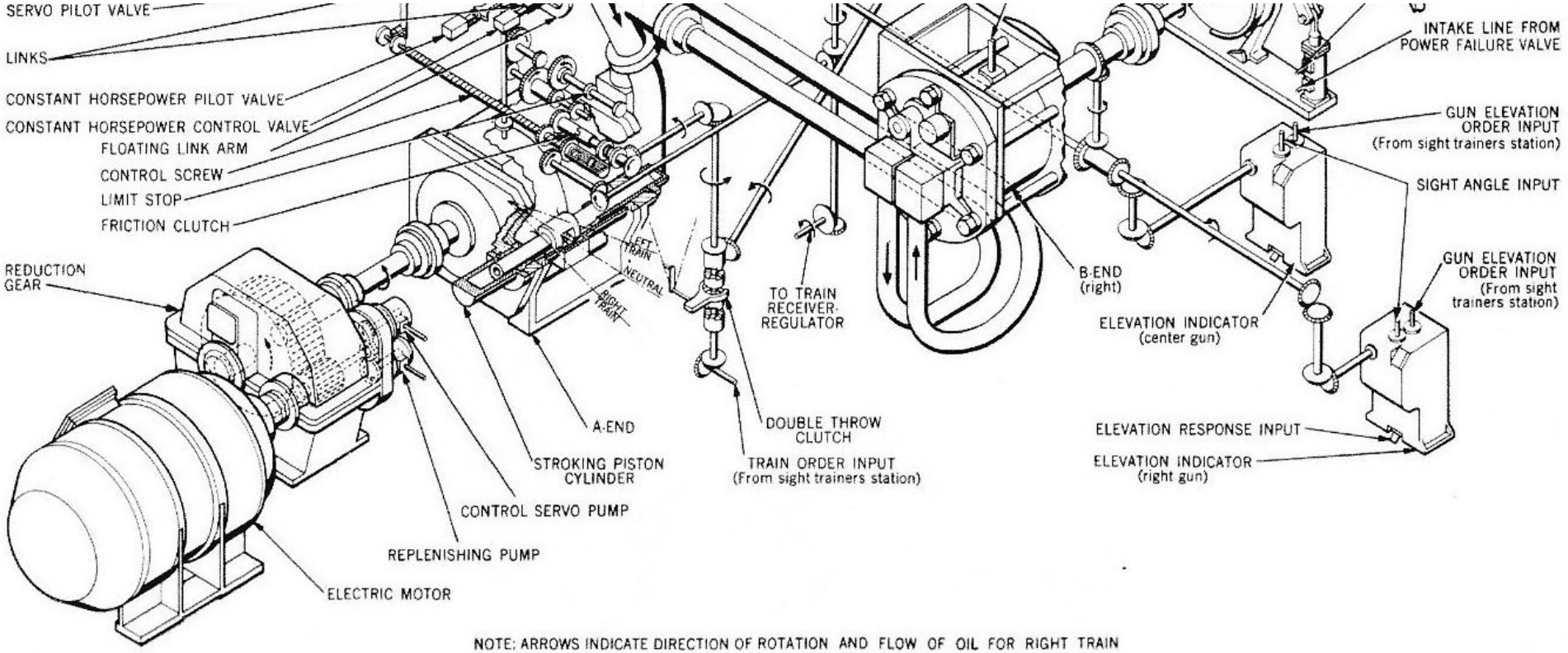




1. HYDRAULIC PIPE MANIFOLD
2. LEFT B-END ASSEMBLY
3. RIGHT B-END ASSEMBLY
4. LEFT BRAKE ASSEMBLY
5. LEFT TRAINING WORM AND WORMWHEEL ASSEMBLY
6. RIGHT BRAKE ASSEMBLY
7. RIGHT TRAINING WORM AND WORMWHEEL ASSEMBLY
8. SIGHT HOOD
9. SIGHT TRAINER'S HANDWHEELS
10. SIGHT TRAINER'S SEAT
11. TRAINING RACK
12. RIGHT TRAINING PINION
13. LEFT TRAINING PINION
14. NEUTRAL RETURN HAND PUMP
15. TRAIN OPERATOR'S HANDWHEELS
16. TRAIN OPERATOR'S SEAT
17. A-END ASSEMBLY
18. TRAIN RECEIVER-REGULATOR
19. AUXILIARY PUMP CLUSTER
20. REDUCTION GEAR
21. ELECTRIC MOTOR

Figure 6-1. 16-inch Training Gear Mk 2 Mod 0, General Arrangement





NOTE: ARROWS INDICATE DIRECTION OF ROTATION AND FLOW OF OIL FOR RIGHT TRAIN

Figure 6-2. 16-inch Training Gear Mk 2 Mod 0, Schematic Arrangement

In HAND control, the train operator's or either of the sight trainer's handwheels are mechanically connected (through shafts and gears, and the transmission control case mechanism) to a hydraulic valve block assembly which ports servo pressure to the servo piston. Offset from neutral stroke by handwheel movement, the A-end tilting box is controlled through the servo pilot valve of the control case valve block assembly. The amount and direction of tilting box offset regulates the speed and direction of rotation of the B-ends as they drive the worm and pinion assemblies to train the turret. B-end (turret) response is transmitted to the control case through shafts and gears from a take-off of the right B-end drive shaft. Handwheel input combined with B-end response in a differential screw and nut device results in follow-up control of turret train. Follow-up control automatically returns the tilting box to neutral stroke when handwheel input is stopped.

Design data

Turret train limits, speeds, and other data are as follows:

Arcs of train, all turrets, deg	300
Train limits, clockwise from above (bow zero)	
Turret I, deg	210 to 150
Turret II, deg	210 to 150
Turret III, deg	30 to 330
Train limits, dial indications	
Right train, turrets I, II, deg	150
Left train, turrets I, II, deg	210
Right train, turret III, deg	330
Left train, turret III, deg	30
Turret train speed (maximum), deg per sec.	4

DETAIL DESCRIPTION

Power drive

The hydraulic power drive of the training gear assembly is composed of a variable-displacement pump (the A-end) and two fixed-displacement motors (the B-ends). Each B-end is mechanically independent of the other, and both are independent of the A-end. The A-end is connected to both B-ends by the large hydraulic pipe manifolds shown in figure 6-2. The A-end, the B-ends, and the pipe manifold connections are the basic units that transmit hydraulic power for training the turret. They function to convert input shaft rotation of constant speed and direction to reversible, variable-speed rotation of the B-end drive shafts.

Components. The components of the power drive are:

- Electric motor
- Controller
- Reduction gear
- Auxiliary pumps
- Shaft couplings
- Hydraulic pump (A-end)
- Hydraulic motors (B-ends)

Arrangement. The arrangement of the power drive components is shown in figure 6-2. The electric motor drives the A-end pump at constant speed through the reduction gear. Two large pipe manifolds connect the valve plate ports of the A-end with the valve plate ports of the two B-ends. The B-end shafts are each coupled to separate training worm, worm-wheel, and pinion assemblies. A gear take-off drive at the right B-end shaft is connected to response inputs of the A-end and the receiver-regulator follow-up control.

Electric motor. The 300-horsepower electric motor is mounted toward the rear of the center gun pocket on a structural foundation that raises it slightly above the electric deck. The motor shaft is connected to the driving pinion of the reduction gear through a self-aligning coupling, as shown in figure 6-3.

Motor data.

Type	squirrel cage, induction
Design features	horizontal, internal and external fan cooled, watertight
Horsepower	300
Revolutions per minute, synchronous	1800
Revolutions per minute, full load	1755
Rotation (output shaft)	counterclockwise
Speed class	constant
Voltage	440
Amperes, full load	355
Amperes, locked rotor	2200
Phases	3
Cycles	60
Ambient temperature, C	40
Torque class	normal torque, low starting current
Weight, pounds	4500
Manufacturer	Electro Dynamic Works
Manufacturer's designation	Frame 304-BH/M type KNX
Drawing	231775

Controller. The electric motor is powered and controlled through an autotransformer magnetic starter-controller. The controller case and separate autotransformer case are mounted adjacent to each other at the rear center of the machinery space of the lower projectile handling deck. The contactors, overload relays, and control relays of the controller are housed in a conventional metal cabinet that includes power supply connections.

The circuits that control starting and stopping of the controller include a remote master switch, located at the train operator's station, a neutral interlock switch, located on the left side of the A-end case, and the servo interlock switch assembly, located on the rear face of the control valve block at the top of the A-end assembly. The neutral interlock and the servo interlock switches, connected in series, prevent the electric motor from being started when either switch is open due to the A-end mechanism being off neutral.

When the electric power is removed, a spring-loaded power-off solenoid functions (through a hydraulic valve) to set spring-actuated brakes on the training pinions. The solenoid is normally energized from the single-phase control circuit supply of the controller. The solenoid is located in the center gun pocket on the transverse bulkhead, immediately forward of the oscillating bearing for the center gun elevating gear.

Controller data. Motor controller data are listed on the following page.

Type	autotransformer starter, watertight, controlled by remote pushbutton
Ampere rating, full load	355
Protection	
Overload, inverse time thermal relay; automatic reset	
Adjustable range, amperes	360 to 440
Normal setting, amperes	400
Short circuit	
Main motor	none
Drop out at, volts	220
Sealing voltage	372
Shock rating	high impact
Weight, pounds	
Autotransformer	500
Starter-controller	1300
Manufacturer	Ward-Leonard Electric Co.
Drawing	318740

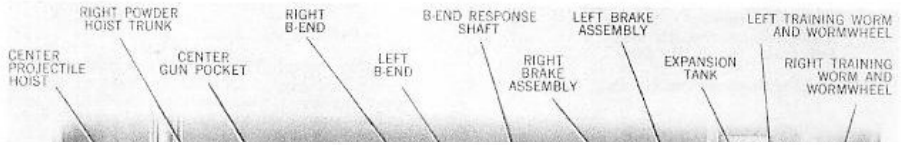
Reduction gear. The reduction gear, shown in figure 6-4, is a speed reducer for driving the A-end with a separate drive on the high speed input shaft for the auxiliary pumps. The unit consists of a spur gear and pinion enclosed within a vented case arranged for oil-bath lubrication. The case includes a depth-rod gage for checking the oil level. The reduction gear is mounted and coupled between the electric motor and the A-end, as shown in figure 6-2.

Reduction gear data. Reduction gear data are listed below:

Revolutions per minute	
Output shaft, A-end	350
Auxiliary shaft to pump drive	1200
Rotation (both shafts)	clockwise
Lubrication	
Type	oil bath
Capacity, gallons	14
Weight, pounds	3100
Drawing	273618

Auxiliary pumps. The auxiliary pumps are bolted on the pump drive assembly of the reduction gear through integral flanges of the pump housings. Mounted one above the other, each pump is independently driven, at 1200 revolutions per minute, through a shaft of the pump drive assembly. Of identical vane-type design, the pumps have different rated capacities. The replenishing pump, with greater capacity than the control (servo) pump, supplies the main system with hydraulic fluid. The control pump delivers pressure to the servo stroking cylinder.

Replenishing pump. With its intake line connected to the main system supply tank, the replenishing pump discharges through a duplex filter into the replenishing valves of the A-end valve plate.



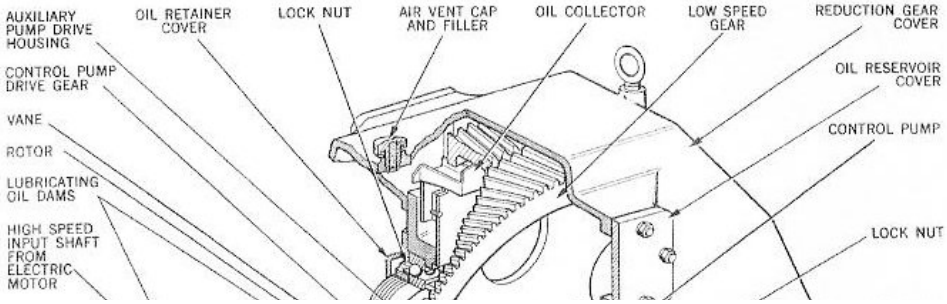
The pump, with a rated capacity of 36.5 gallons per minute at a pressure of approximately 40 pounds per square inch, weighs 74 pounds.

Control pump. With its intake line also connected to the main system supply tank, the control pump discharges through a duplex filter into the control selector and servo stroking systems. The pump, with a rated capacity of 28.8 gallons per minute at a pressure of approximately 400 pounds per square inch, weight 75 pounds.

Shaft couplings. Flexible couplings are used to interconnect the power units of the training gear assembly. The couplings are all of commercial design and manufacture.

The electric motor-to-reduction gear coupling, is a direct drive connection between these two units. The coupling consists of two identical steel hubs, a specially heat-treated and tempered steel alloy grid spring, and two identical steel shells which form the cover. The coupling design provides drive connection through the grid spring which is engaged in grooves accurately milled in the outer flanges of each hub. The hubs and grid spaces are packed with lubricant that is retained within the steel shells by two grease seals.

The reduction gear-to-A-end coupling is a semi-floating unit. Each coupling is an assembly of splined hubs which seat on respective shaft ends. The hubs mounted on each end of the connecting drive shaft are rigidly secured in position. The hubs mounted on the shafts of the reduction gear and A-end provide the floating compensation for slight misalignment of the connected units and have gear teeth on the outer surface. The flanged sleeves which enclose the hubs have meshing teeth that mate with the geared hubs. When installed, each coupling is partially filled with oil to provide lubrication for the gearing.



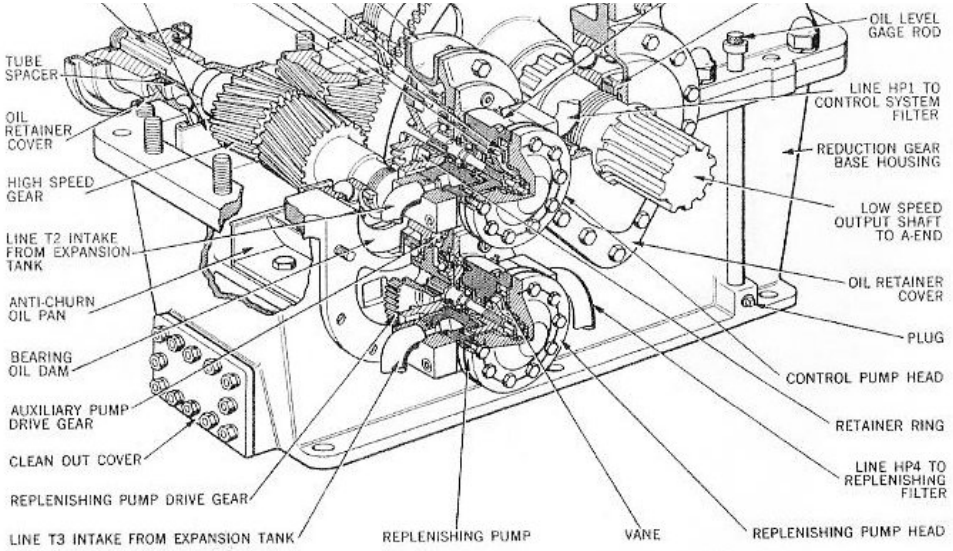


Figure 6-4. Training Gear Reduction Gear and Replenishing Pump Assembly, Cutaway View

Hydraulic pump (A-end). The (A-end) hydraulic pump (figs. 6-2 and 6-5) is a type K, size 150, variable-stroke, multi-cylinder, positive displacement pump. The assembly includes an attached stroking piston cylinder and a transmission control mechanism. The pump is a nine-piston rotating group of the same basic design as the A-end of the elevating gear (ch. 5).

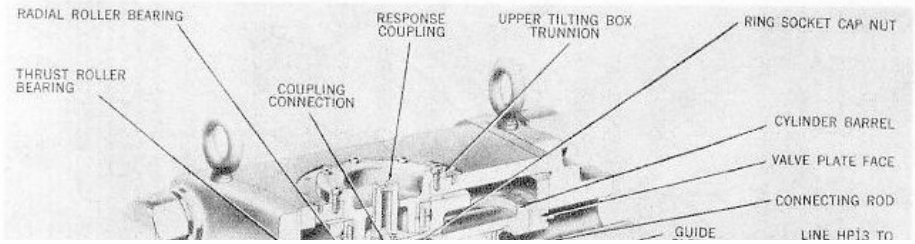
Mounting. The A-end pump is mounted on a foundation weldment of the electric deck, with its input shaft aligned with the output shaft of the reduction gear. Proper shaft alignment is provided by the special gear-type couplings described on page 6-5 of this chapter.

Pressure and tank connections. In addition to the main system pipe manifolds, the A-end assembly has drain, circulating, control and replenishing connections. The drain connections direct hydraulic fluid from the stroking piston assembly and control case mechanism back to the supply tank. The control pump delivers control pressure to the stroking piston assembly and the control case mechanism. The replenishing pump delivers replenishing fluid to the A-end valve plate. The A-end and B-end units, and the A-end and expansion tank are interconnected by piping and flanged fittings, for fluid circulation, which aids in cooling the mechanism.

Associated equipment (receiver-regulator; servo stroking cylinder; transmission control case mechanism). The receiver-regulator, servo stroking cylinder, and transmission control case mechanism are each connected to the A-end either mechanically or hydraulically. These units operate the A-end tilting box to control the speed and direction of rotation of the two B-ends. The receiver-regulator provides automatic control of turret train movement from a remote ship's station. The transmission control case mechanism provides control of turret train movement from a local trainer's station.

Design differences (from elevating gear A-end). The A-end design is similar to the smaller A-end of the elevating gear assembly (chapter 5) with the following exceptions.

A-end valve plate. The A-end valve plate (fig. 6-5) is a stationary part of the A-end assembly and forms one end of the A-end case. The A-end valve plate main ports are provided with spring check replenishing valves. These valves supply the respective low-pressure sides of the main system with replenishing fluid at 40 pounds per square inch. A shuttle valve between the two ports directs high pressure to the constant horsepower valve of the A-end control case.



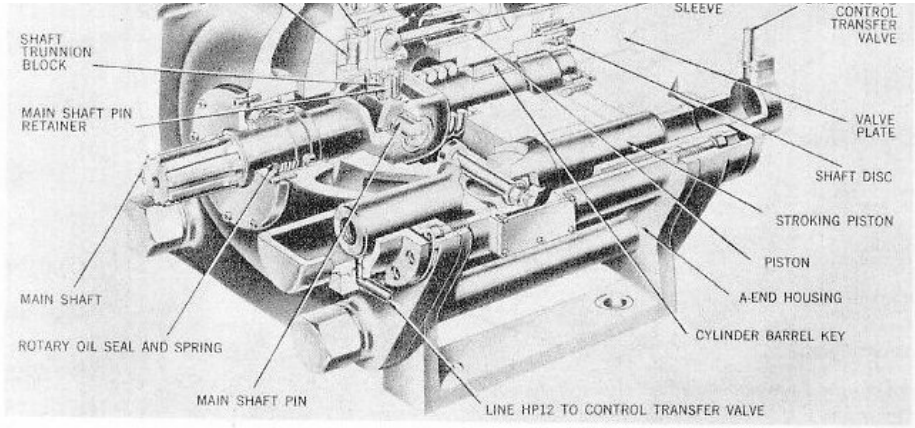


Figure 6-5. Training Gear A-end Assembly, Cutaway View

Keyway for tilting box shaft and arm. The side of the A-end control case, to which the servo stroking cylinder assembly is attached (fig. 6-5), is cut out to form a keyway that permits movement of the tilting box shaft and connecting arm linkage between the stroking piston and the tilting box.

A-end data.

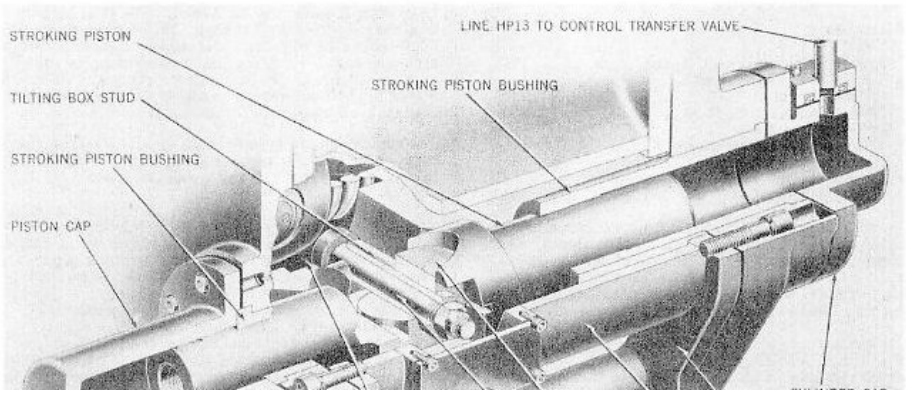
Driven speed, revolutions per minute	350
Temperatures	
Normal, operating range, F	120 to 175
Maximum permitted, F	185
Displacement, cubic inches	692
Manufacturer	Waterbury Tool Co.
Manufacturer's designation	size 150
Drawing	268157

Follow-up control. The follow-up control consists of response shafting from the right B-end drive shaft to the train indicator, the receiver-regulator, and the A-end control case mechanism. The follow-up mechanism within the control case consists of a follow-up response gear, a control screw, and a control nut. This mechanism uses B-end response to return the A-end tilting box to its neutral stroke position. A complete description of this mechanism will be found on page 6-11 of this chapter.

Servo stroking cylinder. The stroking piston cylinder assembly (fig. 6-6) is a high-pressure, double-acting piston and cylinder assembly mounted on the side of the A-end case. This assembly changes the position of the A-end tilting box to vary the volume delivered by the A-end to the B-end units. The stroking piston cylinder assembly is described in detail on page 6-9 of this chapter.

Hydraulic motors (B-ends).

Type. The two hydraulic motors (B-end assemblies) are type K, size 150, fixed-displacement units of modified commercial design. Both are case-enclosed units with rotating groups similar to the A-end pump, but arranged with socket-ring bearings fixed at an angle of 20 degrees. The units differ in that the drive shaft of the right B-end has response take-off shafting (fig. 6-2).



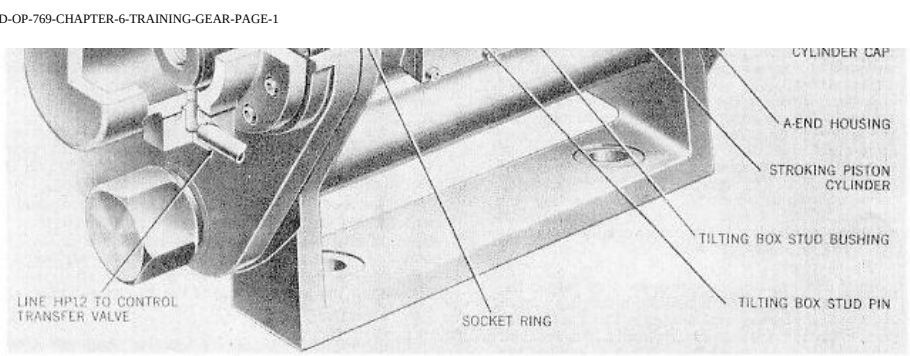


Figure 6-6. Training Gear A-end Stroking Piston, Cutaway View

6-7

Mounting. Both hydraulic motors are mounted on foundation weldments above the pan floor level at the forward part of the turret. The units are located in the spaces between the parallel divisional bulkheads formed by the gun girder boxes, with a B-end mounted on either side of the center gun girder box. Each B-end is mounted with its drive shaft coupled to the worm, wormwheel, and pinion gear assembly.

Pressure and tank connections. In addition to the pipe manifolds of the main system, the B-end assemblies are interconnected by flanged fittings for fluid circulation, and have a common drain line to the supply tank. The circulation of hydraulic fluid aids in cooling the mechanism.

Drive reduction. The total displacement of the two B-ends is equal to twice the displacement of the A-end to give a drive reduction of 2 to 1.

Design differences (from elevating gear B-end and B-end valve plates). The valve plates of the two hydraulic motors of the training gear are identical to each other. Each valve plate houses one relief valve which relieves high pressure for one direction of train. The relief valve in the left B-end valve plate relieves for right train, the relief valve in the right B-end valve plate relieves for left train. Both valves, of adjustable-spring plunger design, bypass high pressure to the main system return pipe at a pressure of 1525 pounds per square inch.

B-end data.

Speed (maximum) each B-end, rpm. . . .	175
Torque load (each shaft)	
Normal, rated, ft-lb	11,200
Maximum, rated, ft-lb	12,300
Oil temperatures	
Normal operating range, F. . . .	120 to 175
Maximum permitted, F	185
Displacement, each B-end, cubic inches per rev.	653

B-end-to-brake couplings. A brake assembly is mounted on each of the worm gear drive shafts. Each of these shafts is coupled to its B-end output shaft through a flexible gear-type coupling similar to the reduction gear-to-A-end coupling described on page 6-5 of this chapter.

Brake assemblies. Each B-end brake is a spring-actuated mechanical assembly with servo pressure actuated release. The brakes hold the turret, at any position of train when power is off. Each brake unit is composed of a brake drum spline-mounted on the worm gear drive shaft, two lined brake shoes, two main springs, three brake shoe levers, and a linkage connection to the piston of a hydraulic cylinder. Each unit is supported on a separate mounting base. The

The filter unit for each system is located in the discharge line of each pump. Each cartridge in the filter unit consists of an assembly of discs and spacers mounted on a movable spindle stacked alongside cleaner blades mounted on a fixed rod. This arrangment permits clearing the filter cartridge while the hydraulic system is in operation. One complete revolution of the cartridge handle passes the discs through the cleaner blades to remove foreign particles from the discs.

The control filter has a flow capacity of 28 gallons per minute with control pump pressure of 350 pounds per square inch. The replenishing filter has a flow capacity of 36 gallons per minute with replenishing pump pressure of 40 pounds per square inch.

Control and replenishing relief valves. The control and replenishing relief valves, connected in the discharge lines of the control and replenishing filters, are mounted in a common valve block near the A-end. They are spring-operated plunger-type safety relief valves. The valves open and bypass excess pressure flow to the expansion tank when control and replenishing lines are overloaded.

Expansion tank. The expansion tank, located at the high point for the training gear, is a vented type with gravity feed connections to the control and replenishing pumps. Return oil lines lead to the tank from both B-ends and the A-end. The tank body is box-shaped, 19.5 inches high, 35.5 inches deep, and 50.0 inches wide. The sheet-copper tank has a cover, high-and low-level trycocks, a filler cap, an oil strainer inside the tank, and four vertical baffle plates. The tank serves to dissipate heat from the oil returned by the recirculating system.

The expansion (supply) tank capacity is 150 gallons. When the oil level is at the upper trycock, there are approximately 120 gallons in the tank.

Training worm, wormwheel, and pinion assembly. The B-end units turn the turret by driving a worm, wormwheel, and pinion assembly of Bureau of Ships design. Each assembly, enclosed within a separate case, is a nonoverhauling Hindley-type worm and wormwheel. Each is fitted and adjusted to a fixed position to ensure correct mesh of the pinion with the training rack. The assemblies are securely seated in heavy structural blocks and plates at the front of the turret rotating structure. The mounting weldment allgns each worm, wormwheel, and pinion with its B-end drive shaft. The case forms an oil-tight, vented enclosure for the worm, the wormwheel, and their bearings, which are immersed in a circulating lubricant.

Worm and wormwheel. The worm and wormwheel

units are right and left arrangements of identical parts, and they simultaneously set or release the B-end output shafts. The hydraulic circuit valve porting arrangements automatically release the brakes when power is on. A solenoid moves a power failure valve against spring action to port servo pressure to the two brake release cylinders.

Control and replenishing filters. The duplex filters used in both the control and replenishing systems are of modified commercial design. The control filter and the replenishing filter are virtually identical, double-cartridge filter assemblies. Each assembly has a manually-operated selector lever that permits porting of the hydraulic oil through either or both cartridges.

assemblies are located within a common compartment at the front of the turret rotating structure (fig. 6-1). The wormwheel, with 28 teeth cut around its 9.8-foot circumference, is spline-mounted on the upper end of the pinion shaft. The driving unit of the worm-wheel, a single-thread worm, is integral with its shaft and thrust rings. The worm and wormwheel assemblies are accessible through the hatch in the bulkhead at the forward end of the center gun pit.

Pinions. The pinions are integral shaft and spur tooth gears. Each pinion has 12 teeth of 20.53-inch pitch diameter. The faces of the pinion teeth are 20.0 inches in length.

Training rack. The training rack, an internal annular gear, is made in six equal-sized segments. The segments, butted end to end, are keyed and bolted to the structural foundation of the ship. The rack has 210 teeth with a pitch diameter of 359.29 inches.

Lubrication. The worm-gear lubricating unit is of Bureau of Ships design. The electric motor and pump are mounted on a foundation weldment between the worm and wormwheel case enclosures. The pump is supplied with lubricating oil from two sump tanks, mounted directly below the turret compartment containing the worm and wormwheel assemblies.

Training gear controls

The training gear control arrangements consist of:

Start-Stop controls
Power drive transmission controls
Control selector
Servo stroking system
Control gear hand gear
Control gear response gear
Control case mechanism
Receiver-regulator

Start-stop control. The training gear power drive is started and stopped from its controller. The controller is remotely operated by two push buttons adjacent to the train operator's station. One button is designated START-EMERG, the other STOP.

The START-EMERG button closes a normally-open, three-pole switch and energizes the coil of the main contactor to connect three-phase power to the electric motor. Holding contacts on the relays keep the power circuit closed when the START-EMERG button is released until the STOP button is pressed. The control selector lever may be moved from HAND to AUTO or AUTO to HAND without interrupting the supply of power to the electric motor. In the event of a power failure, the main contactor opens and remains open until closed by pressing the START-EMERG button. An overload relay opens the circuit when current demand is too great. The main contactor may be kept closed to keep the electric motor running in an emergency by holding the START-EMERG button closed. The electric motor is stopped by pressing the STOP button.

Transmission controls. The transmission controls are the A-end control mechanisms and hydraulic system devices that position the A-end tilting box and control the main system hydraulic pressure. They include hand control elements and automatic control elements.

Hand control elements. The elements of the hand control system are:

1. Control selector
2. Servo stroking system
3. Control gear hand gear

Automatic control elements. The elements of the automatic control system are:

1. Control selector
2. Servo stroking system
3. Receiver-regulator
4. Control gear response gear
5. Control case mechanism

The units function together so that, when the control selector is at AUTO, the turret is automatically trained in response to electrical signals from a remote station. The control gear response gear provides follow-up control and limit-stop control as in hand control. The limit stop function is supplementary to an automatic limit stop device of the receiver-regulator.

Control selector. The control selector (fig. 6-15) is a manually-positioned hydraulic valve mounted on the bulkhead adjacent to the train operator's station. The selector permits the train operator to select HAND or AUTO control. The selector valve block includes a related hydraulic valve called the synchro failure valve which is normally open to allow servo pressure flow to the control selector valve. The synchro failure valve automatically moves to block servo pressure flow to the control selector valve when the synchro gun train order signal fails. The synchro failure valve automatically shifts control away from the receiver-regulator to the train operator's handwheels.

The control selector includes a synchro power indicator light (fig. 6-15) which is lit whenever the gun train order signal (synchro power) is available. Should the synchro power fail, the indicator light goes out.

Servo stroking system. The servo stroking system is composed of:

1. The control pump (fig. 6-4) mounted on and driven by the reduction gear.
2. The duplex filters in the discharge line of the servo control system.
3. A servo control system relief valve.
4. The stroking cylinder and piston, and the connecting arm to the A-end tilting box.
5. Hydraulic control valves

The system responds to hand and electrical gun train order signals by moving the A-end tilting box away from neutral stroke position. System pressure is supplied by the control pump. The pump is described on page 6-5 and the filters and relief valves are described on page 6-8 of this chapter. Other elements of the system are described in the following

4. Control gear response gear

5. Control case mechanism

The units function together so that, when the control selector is at HAND, the turret is trained by manually turning the handwheels. The response gear and the control case devices provide follow-up control and limit-stop control.

paragraphs.

Servo stroking cylinder. The servo stroking cylinder (figs. 6-2, 6-5, and 6-6) is a high-pressure double-acting piston and cylinder unit, which is mounted on the side of the A-end. The stroking piston changes the position of the A-end tilting box in response to hand or automatic turret train orders.

The cylinder assembly consists of a cylinder case, a piston, two piston bushings, a cylinder cap, a piston cap, a tilt box stud, and tilt box bushings. The arrangement of the components is shown in figure 6-6. The piston is a solid, cylindrical piece, assembled with a piston bushing on each end, mounted within the stroking cylinder case. The piston is free to slide through these bushings. Servo system pressure is ported to either end of the piston to move the A-end tilting box from neutral stroke. Piston movements are controlled by the receiver-regulator in AUTO and by the servo control valve in HAND.

Hydraulic control valves. Movement of the stroking piston is automatically controlled within the power drive hydraulic system by the following interrelated valves.

Power failure valve PFV. The power failure valve PFV, mounted on the forward bulkhead above the pan floor in the center gun pocket, is a two-position, spool-type valve that opens or blocks the brake release system hydraulic lines between the control pump and the two brake release cylinders. It is spring-operated to block the system hydraulic lines when power fails or is shut off. With power on the valve is solenoid actuated to open and port servo pressure to the two brake release cylinders.

Constant horsepower directional control pilot valve V6A. The constant horsepower directional control pilot valve V6A, located in the A-end transmission control case, is a spring-and-pressure-operated plunger type valve. Acting as a pilot valve it directs the flow of servo pressure to either the servo pilot valve V23 and the constant horsepower valve V6 or to the left end of the stroking piston transfer valve V31. Valve V6A is positioned against main system pressure by a spring. The spring, with its pressure varied by the position of the constant horsepower cam (actuated by tilting box movement) is between valve V6A and a plunger actuated by the cam. When moved toward the right by excessively high main system pressure, valve V6A directs the flow of servo pressure to the left end chamber of stroking piston transfer valve V31 to force valve V31 to the right. When moved toward the left by spring pressure, valve V6A directs the flow of servo pressure to the servo pilot valve V23 and the constant horsepower valve V6.

Servo pilot valve V23. The servo pilot valve V23, located in the A-end transmission control case, is a spring-and-linkage-operated plunger type valve. It directs the flow of servo pressure through either of the two chambers of the stroking piston transfer valve V31. Pilot valve V23 is spring operated to block the flow of servo pressure to the stroking piston transfer valve V31 when the controls are at neutral. Pilot valve V23 is positioned by linkage which is actuated by movement of the handwheels. When servo pilot valve V23 is moved toward the right, it ports servo pressure through the left chamber of the stroking piston transfer valve V31 to the right end of the servo stroking cylinder. This results in right train of the turret. Moved toward the left, control valve V23 ports servo pressure through the right chamber of transfer valve V31 to the left end of the servo stroking cylinder. This results in left train of the turret.

Constant horsepower valve V6. The constant horsepower valve V6, located in the A-end transmission control case, is a linkage-operated plunger type valve. Positioned by linkage which is actuated by the handwheels, constant horsepower valve V6 constant horsepower directional control pilot valve V6A to the stroking piston transfer valve V31. Constant horsepower valve V6 blocks the flow of servo pressure to the stroking piston transfer valve V31 when the controls are at neutral. Constant horsepower valve V6 is positioned by linkage to port servo pressure to the stroking piston transfer valve V31.

Stroking piston transfer valve V31. The stroking piston transfer valve V31, located in the A-end transmission control case, is a spring-and pressure-operated spool type valve. Acting as a directional valve it directs the flow of servo pressure from the servo pilot valve V23 to either the right or left end of the servo stroking cylinder. Transfer valve V31, spring positioned toward the left, permits servo circuit pressure and drain flow for either left or right train as ported by the servo pilot valve V23. Stroking piston transfer valve V31, when forced to the right by servo pressure ported to its left end by the constant horsepower directional control pilot valve V6A, blocks servo pilot valve V23 and reverses the servo circuit pressure and drain flow for either right or left train. Under these conditions the constant horsepower valve V6 momentarily acts as a directional valve and tends to move the servo stroking piston toward neutral stroke.

Main system relief valves V28. The relief valves V28, one located in each B-end valve plate, are spring-loaded, plunger-type valves. Each valve serves to relieve high pressure for one direction of train. They operate to by-pass fluid directly to the low pressure transmission pipe.

Replenishing valves V32. The replenishing valves V32, located in the A-end replenishing valve block assembly, are spring-loaded plunger-type valves. They replenish the main system through the low pressure transmission pipe depending on the direction of train.

Shuttle valve V27. The shuttle valve V27, located in the A-end replenishing valve block assembly, is a directional-flow, spool-type valve that is an element of the constant horsepower device. Shuttle valve V27 is free to move to either end of its sleeve, porting main system high pressure to the left end of the constant horsepower directional control pilot valve. The action of V27 is the same in either direction of train.

Control gear hand gear. The control gear hand gear for the train operator is a pedestal bracket handwheel drive with bevel gear and shaft assembly arranged for hand control of the training gear. Located as shown in figure 6-1, the mechanism is arranged with its output shaft coupled through a friction clutch to a limit stop and geared to a differential follow-up mechanism. A mechanical linkage from the differential screw converts handwheel motion to valve movement to produce 2.0 degrees of turret rotation for one full turn of the handwheels.

Control gear response gear. The direction and speed of B-end rotation is transmitted from the right B-end response drive takeoff to the A-end control case mechanism by a system of shafts and bevel gears (fig. 6-2). The B-end response drive is coupled to a response input shaft that drives the differential screw of the follow-up mechanism. In addition, train B-end response is coupled to response input shafts of the train and elevation indicators and the

opens or blocks the flow of servo pressure from the train receiver-regulator.

Transmission control case mechanism. Servo stroking control is actuated through a case-enclosed transmission control mechanism, mounted on top of the A-end case. The interior arrangement of interconnected and related components of the control case is shown schematically in figures 6-22 through 6-26. The components are the mechanical, electrical, and hydraulic units described in the following paragraphs.

Friction clutch. Assembled between the handwheel input shaft and the nut of the differential follow-up mechanism is a clutch unit. A friction-type clutch, it is engaged by spring pressure and disengaged by hydraulic pressure. The clutch is engaged when the control selector lever is positioned at HAND. The clutch is disengaged when the lever is positioned at AUTO, and whenever the constant horsepower mechanism assumes control in HAND.

Automatic cutoff (limit stop). The automatic cutoff (limit stop) device in the control case mechanism limits the train movement of the turret. The device consists of a traveling nut on a screw which carries an adjustable limit stop at either end. The limit stop screw is geared to the handwheel input shaft. As the handwheels are turned, the nonrotating nut travels toward one or the other limit stop. When the nut contacts the limit stop, the turret is brought to a stop. The limit stops are set to correspond to the limits of turret train.

Follow-up control mechanism. The follow-up device is a differential screw and nut gear mechanism that operates the control valve units through a linkage attached to a trunnion at one end of the control screw. Displacement of the screw and valve linkage is a differential movement. It is derived from handwheel rotation of the differential nut and B-end response rotation of the screw, which turns the screw in the opposite direction. B-end response input positions the differential screw through a quill drive. In operation, the follow-up control mechanism is an automatic mechanical device for returning the tilting box to neutral through the valves and stroking control linkage of the control case. The return-to-neutral of the tilting box varies with the speed and rotation of the B-end, to produce a graded deceleration of the valve gear, servo stroking control, and the turret train movement.

Control linkage. The differential screw is rotated at one end by train response. At its opposite end, the differential screw vertical displacement actuates a spring-loaded, pivoted lever which functions as a differential screw follower. The follower is attached to a geared sector that actuates the control linkage through a control cam. The control linkage positions the servo pilot valve V23 and the constant horsepower directional control pilot valve V6A of the servo stroking system. Attached to the tilting box through the tilting box shaft and arm assembly of the transmission control case mechanism, the control linkage is actuated by tilting box movement. The arrangements of the control linkage and associated parts of the valve block assembly are indicated in figures 6-22 through 6-26.

Valve block assembly. Tilting box stroking is controlled by a servo system valve block composed of two mechanically operated plunger-type valves and two pressure-and-spring-actuated valves. The plunger-type valves are those designated the servo pilot valve V23 and the constant horsepower valve V6. The automatic valves are designated the constant horsepower pilot valve V6A and the transfer valve V31. The valve block assembly is shown schematically in figures 6-22 through 6-26, inclusive.

Constant horsepower device. The maximum horsepower taken from the electric motor is limited by the constant horsepower device. This mechanism is a mechanical and hydraulic arrangement that acts automatically under train overload conditions to return the tilting box toward neutral. The mechanism is actuated by a pilot valve V6A that is opened by main system pressure acting against valve spring tension. The compression of the spring is controlled by a cam which moves with the tilting box to reduce compression as the A-end moves away from neutral. The constant horsepower mechanism momentarily takes control if the combination of hydraulic pressure and stroke of the A-end causes an input horsepower to the A-end in excess of the desired limit. When this occurs, V6A takes control away from the servo pilot valve V23 by shifting the transfer valve V31 to port servo pressure to the opposite end of the servo stroking cylinder. The A-end stroke is then reduced to a point where the overload is relieved. The constant horsepower directional control pilot valve V6A is then shifted by its spring, and control is restored to the servo pilot valve V23.

Neutral return device. The neutral return device provides for manual return of the A-end tilting box to neutral should the electric power fail (or be shut off) while the tilting box is in a stroke position. A hand operated hydraulic pump, the neutral return device is located conveniently near the train operator's station. The pump, with intake connected to the expansion tank, has discharge circuit connections with the transmission control case mechanism valve block. The circuit connections (fig. 6-26) are such that hand pump pressure is directed to the left end of the stroking piston transfer valve V31 to force it to the right. Simultaneously hand pump pressure, directed by servo pilot valve V23, is ported through either chamber of transfer valve V31 to the stroking piston. The hand pump pressure and drain flow which are in reverse of the servo circuit pressure and drain flow at the time of power failure, return the stroking piston (and tilt box) to neutral.

Neutral starting device. The neutral starting device is a starting-circuit switch, which interlocks the position of the A-end tilting box with the electric motor starting circuit. The device is part of an assembly mounted on the side of the A-end. The switch is operated by a cam which is attached to and moves with the tilting box. When the tilting box is at neutral position, the switch and the motor starting circuit are closed. An additional interlock in the electric motor starting circuit is provided by a switch operated by the servo pilot valve V23. The switch closes only when train response and stroke input shafts are not in motion.

Receiver-regulator

A 16-inch Receiver-Regulator Mk 18 Mod 0 is the control instrument for automatic operation of the turret training gear.

An electric-hydraulic instrument enclosed within a case (figs. 6-8 and 6-9), it is located on the electric deck between the electric motor and the A-end (fig. 6-7). The case is divided into two compartments, one of which contains the electric synchros and related gear train. The other compartment contains the valve block and related devices.

The receiver-regulator functions when the control selector lever is positioned at AUTO. In this control selection, servo-system stroking pressure is ported to the stroking cylinder in response to train orders received electrically in the receiver-regulator. In AUTO, the hand control servo stroking valve gear is bypassed.

Components. Each receiver-regulator consists of the following components, all of which are enclosed within the instrument case:

Fine and coarse control synchros
Parallax computer
Turret response gear
Stroke response gear
Limit stop device
Limit stop valve V34
Stabilizing valve V1
Stabilizing linkage L2
Automatic stroking valve V2
Synchronizing valves V3A and V15
Synchronizing valve linkage L3
Pressure regulator valve V43
Stabilizing piston P1
Amplifier piston P3
Amplifier linkage L1
Hydraulic vibrator

The arrangement of the above electrical, hydraulic, and mechanical components of the receiver-regulator is shown schematically in figure 6-27.

Receiver-regulator instrument (figs. 6-8 and 6-9).

Fine and coarse control synchros. Gun train orders to the receiver-regulator are transmitted by synchro circuits. The rotors of the generators and receivers of both the fine (36-speed) and coarse (1-speed) synchros are connected in parallel to operate on a 115-volt, 60-cycle, single-phase, alternating-current supply. Both synchros are bearing-mounted so that the stators of the synchros can be rotated by parallax correction, turret response, and stroke response. Rotation is accomplished by a system of shafts, gears, and gear differentials. The two synchros and their gear train are located in the synchro compartment (fig. 6-11).

The rotor of the coarse synchro positions the synchronizing pilot valve V15 and the synchronizing valve V3A through the synchronizing linkage L3. The rotor of the fine synchro positions the amplifier linkage L1 and its attached valves.

Parallax computer (fig. 6-10). The parallax correction is computed for the horizontal distance between the director and the turret, and is derived from train angle and parallax range. The parallax computer mechanism enters a mechanical correction to the train order signal and the angle of turret train. The parallax value is variable for each turret, depending upon three factors:

1. The base line distance from the director to the turret.

2. The range of the target.

3. The angle of turret train.

For any angle of turret train, except dead ahead or dead astern, the parallax correction varies inversely with the range. The maximum correction when the target is abeam at short range, and the minimum correction when the target is a few degrees on the bow or quarter at long range.

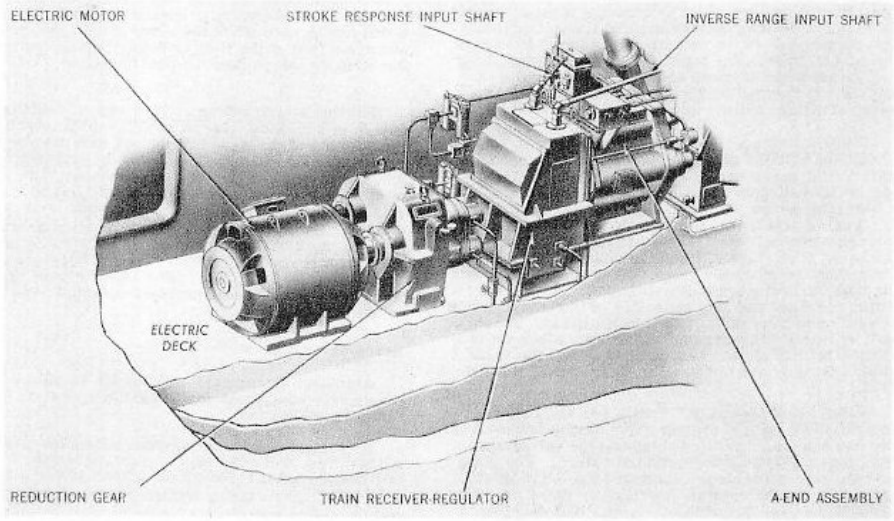


Figure 6-7. 16-inch Receiver-Regulator Mk 18 Mod 5, General Arrangement

The parallax computer solves each problem for each turret and automatically adds the correction to the train response.

The parallax computer receives a shaft input (designated as inverse range) from the train indicator. The input has a limited movement of 18.5 turns, which is equivalent to ranges from infinity to the shortest range of 3400 yards. The other shaft input to the parallax computer (designated angle of turret train) is received in the form of 1-speed input from the B-end response gear. The two designated valves are continuously converted to mechanical correction by the motions of the block (K, fig. 6-28), the crank M and the yoke rack which turns shaft 10B. The movement of the shaft 10B drives the change gears and shaft 10 that add parallax correction to the response input to the fine and coarse synchros, as shown in figure 6-28.

Train response gear. The train (B-end) response gear (figs. 6-11 and 6-12) drives one input gear of the differential that rotates the stators of the coarse and fine synchros through a gear train assembly within the receiver-regulator case. From the right B-end, train response is simultaneously transmitted to the train and elevation indicators to the transmission control case, and to the receiver-regulator. In the receiver-regulator, the B-end response combines with parallax correction to rotate the stators of the coarse and fine synchros. B-end response and stroke response are combined in a differential to position the limit stop valve V34 through a connecting link from the train limit stop.

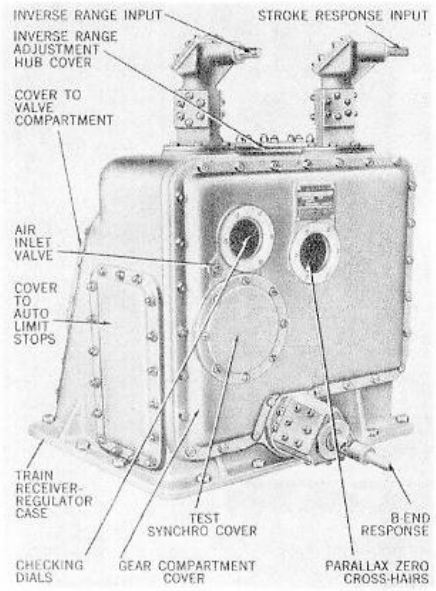


Figure 6-8. Train Receiver-Regulator Mk 18 Mod 5, Front View

Stroke response gear. The A-end stroke response is a mechanical input derived from a gear box attached above the A-end control case. The gear box receives tilting box motion through the A-end control case and steps up the motion to a ratio of 15 to 1. This new value is transmitted as stroke response to the receiver-regulator by means of shafts connected to the adjustable coupling, designated B. In the receiver-regulator, stroke response combines with B-end response through differential gearing to position the limit-stop valve V34 through the train limit stop. Stroke response represents turret training speed; it is combined with B-end (turret position) response to make the limit stop valve V34 operate sooner at high speeds than it does at low speeds as the turret approaches its limit.

Limit stop device. The automatic train limit stop (figs. 6-13 and 6-14) receives a combination of the angle of turret train and the speed of turret train through a mechanical differential.

The device consists of series of discs and lugs which are free to rotate on shaft 8B (fig. 6-27). Each disc contains a pin which extends about 3/32 inch on either side of the disc and is pressed through the disc about 9/16 inch from its center. The discs are assembled alternately on a common shaft with the lugs. The lugs engage the pins as the drive shaft input rotates. As the disc at the input end of the assembly is rotated, the pins on successive discs engage successive lugs, until after several revolutions of the first disc the entire assembly rotates as a unit. The last lug to be engaged operates a cam which rotates the limit stop drive shaft. The shaft then moves the limit stop valve V34 which is also the sleeve for the stabilizing valve V1.

Limit stop valve (V34). The limit stop valve V34, located in a valve block at the bottom of the receiver-regulator, is positioned by the movement of a crank which is actuated by the limit stop device. V34 is normally centered in its position by a spring at either end. When displaced from center by the limit stop device, V34 shifts servo pressure flow to and drain from the stroking piston P2 to decelerate and stop the turret at its preset limit.

Stabilizing valve V1. The stabilizing valve V1, located within the limit stop valve V34 body, acts with the stabilizing piston P1 to prevent overtravel of the turret (B-ends) which would result in oscillation about the train order signal. Positioned by the stabilizing linkage L2, the stabilizing valve V1 directs regulator control pressure to one end or the other of the stabilizing piston P1. Movement of piston P1 positions the amplifier piston P3 and amplifier linkage L1 and also moves the stabilizing valve V1 back to its original position.

Stabilizing linkage L2. The stabilizing linkage L2, shown in figure 6-9, is mounted in a vertical position in the valve compartment of the receiver-regulator. At its upper end, the stabilizing linkage L2 is connected to the amplifier piston P3. The middle of L2 is connected to the stabilizing piston P1. At the lower end, L2 is connected to both the automatic stroking valve V2 and the stabilizing valve V1.

Automatic stroking valve V2. The automatic stroking valve V2 is located in a separate valve block, shown in figure 6-9, at the lower left side of the receiver-regulator valve compartment. Positioned by the stabilizing linkage L2, V2 ports servo pressure flow to and drain (through control transfer valve V3B) from the stroking piston P2.

Synchronizing valve V3A and synchronizing pilot valve V15. The synchronizing valve V3A and synchronizing pilot valve V15 are located in a valve block, shown in figure 6-9, in the upper part of the receiver-regulator valve compartment. Both valves are positioned by the synchronizing valve linkage L3, which is actuated by rotation of the rotor of the coarse (1-speed) synchro. The synchronizing pilot valve V15, when centered, ports regulator control pressure to the synchronizing valve V3A, which directs the regulator control pressure to the fine synchro valve V3 as long as the turret position is within three degrees of the gun train order. V3 then controls servo piston movement through the amplifier piston P3, stabilizing linkage L2, and the automatic stroking valve. V2. When the turret position is more than three degrees away from gun train order, V3A cuts off regulator control pressure to V3 and ports the pressure directly to P3 to drive the turret at full speed toward its synchronized position.

Synchronizing valve linkage L3. The synchronizing valve linkage shown in figure 6-9 is located in the upper part of the receiver-regulator valves compartment. L3 is actuated by rotation of the rotor of the coarse (1-speed) synchro to position V3A and V15.

Pressure regulator valve V42. The pressure regulator valve V42 is located in the valve block in the center portion of the receiver-regulator valve compartment (fig. 6-9). Servo pressure, ported to valve V42 at a pressure of approximately 350 pounds per square inch, is reduced to a control pressure of approximately 135 pounds per square inch. Control pressure is ported through the stabilizing valve V1 to the stabilizing piston P1. It is also ported to the synchronizing pilot valve V15 and through it to the synchronizing valve V3A. From V3A, control pressure is ported through the fine synchro valve V3 to the amplifier piston P3.

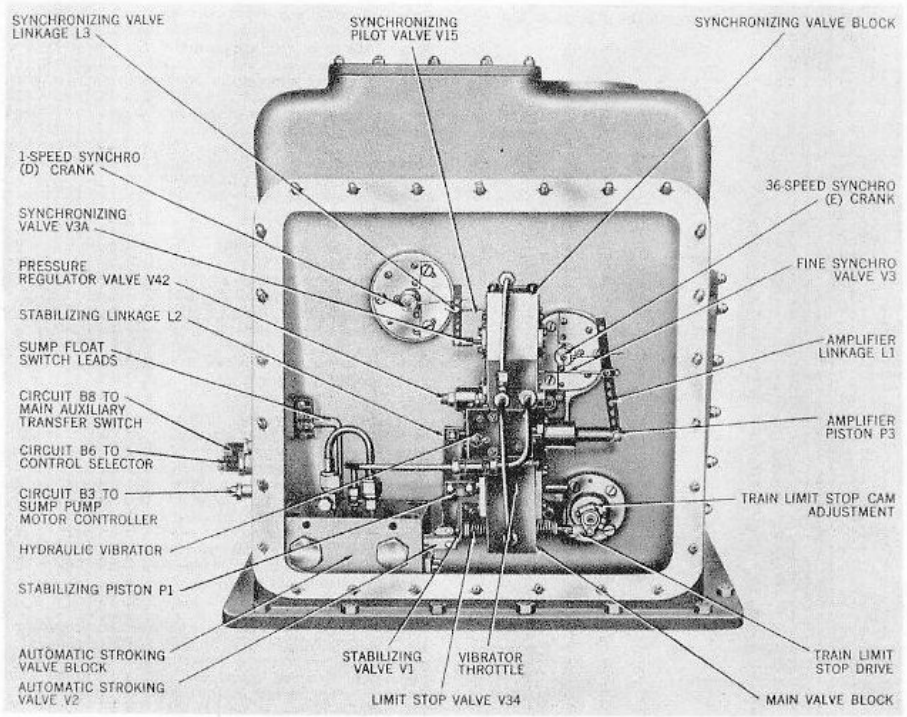


Figure 6-9. Train Receiver-Regulator Mk 18 Mod 5,Valve Compartment

Stabilizing piston P1. The stabilizing piston P1 is located in the valve block in the center of the receiver-regulator valve compartment (fig. 6-9). Piston P1 acts to change the pivot point in the stabilizing linkage L2, thereby affecting the response of the amplifier piston P3 to the movement of the fine synchro valve V3. The arrangement prevents overtravel and oscillation of the turret about the train order signal. The stabilizing valve V1 regulates the porting of regulator control pressure to the chambers of the stabilizing piston P1.

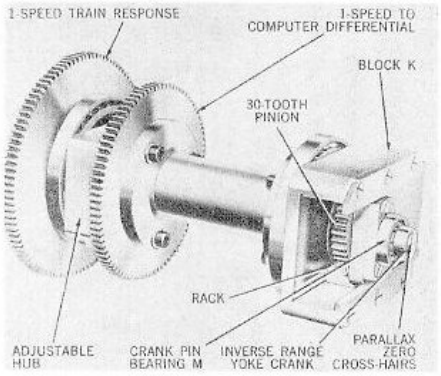
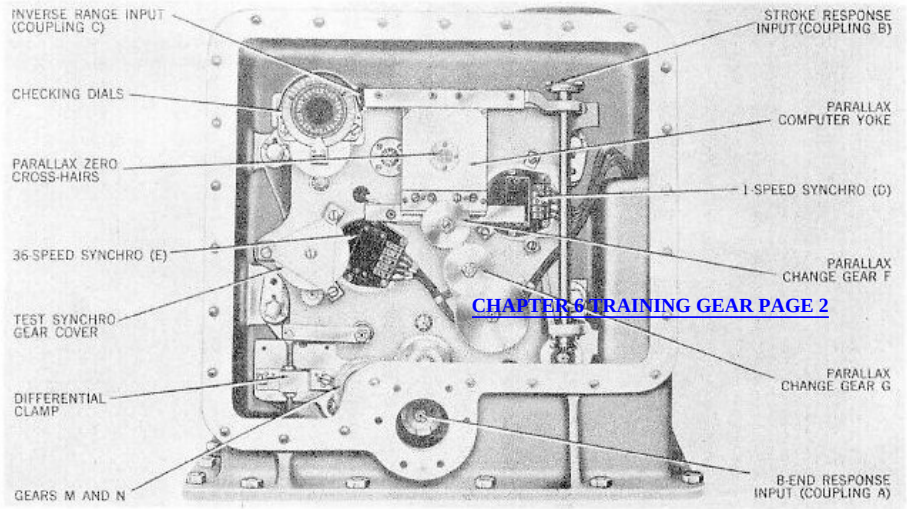


Figure 6-10. Train Receiver-Regulator Mk 18 Mod 5 Parallax Computer Drive

Amplifier piston P3. The amplifier piston P3 (fig. 6-9) is located in the valve block in the center of the receiver-regulator. P3 is moved in fine synchro control by regulator control pressure ported to it by the fine synchro valve V3. Amplifying V3 movement, P3 acts through the amplifier linkage L1 to return V3 to neutral. P3 acts through the stabilizing linkage L2 to position the automatic stroking valve V2. In coarse synchro control, regulator control pressure is ported directly to P3 to drive the turret at full speed toward its synchronized position.

Amplifier linkage L1. The amplifier linkage L1 (fig. 6-9) is located in the upper right portion of the receiver-regulator valve compartment. The upper end of L1 is connected to the rotor of the fine (36-speed) synchro, and is positioned by rotation of the rotor. The opposite end of L1 is connected to the amplifier piston P3. Synchro rotor movement acts through L1 to move the fine synchro valve V3. Amplifying movement of P3 acts back through L1 to move V3 back to its original position.

Hydraulic vibrator. The hydraulic vibrator (fig. 6-9), located in the center of the receiver-regulator valve compartment, runs on servo pressure as a double-acting, two-cylinder reciprocating engine. The device oscillates the amplifier piston P3 through a very small amplitude at about 30 cycles per second to prevent static friction in the valves and linkages.



CHAPTER 6 TRAINING GEAR PAGE 2

Figure 6-11. Train Receiver-Regulator Mk 18 Mod 5 Front View - Cover Removed

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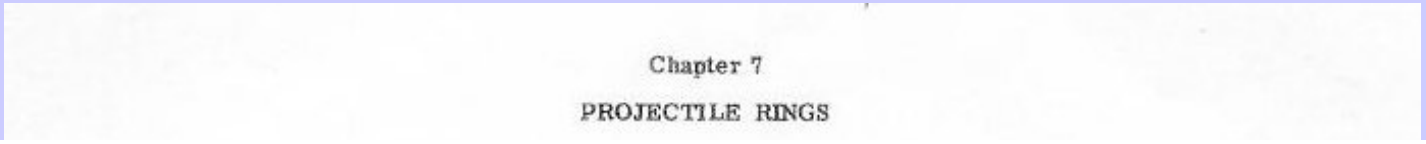
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Chapter 7

PROJECTILE RINGS

16-inch Projectile Ring Mark 2

GENERAL DESCRIPTION

Turret stowage

Projectile stowage in each turret is located in the upper and lower projectile flats. In addition to the two projectile flats, turret II is provided with a third projectile stowage level. The stowage arrangements of the projectile flats, illustrated in figure 7-1 (the third level of turret II is not shown), are described in the following paragraphs of this chapter.

Compartments. The compartment subdivisions of the upper and lower projectile flats, and their space arrangements for stowing and handling projectiles, are identical. Each projectile flat is separated into two compartments, inner and outer, by a circular bulkhead. The inner compartment is the machinery space. Within this enclosed space are the projectile ring power drive machinery, and the electric motor controllers. The floor of the outer compartment

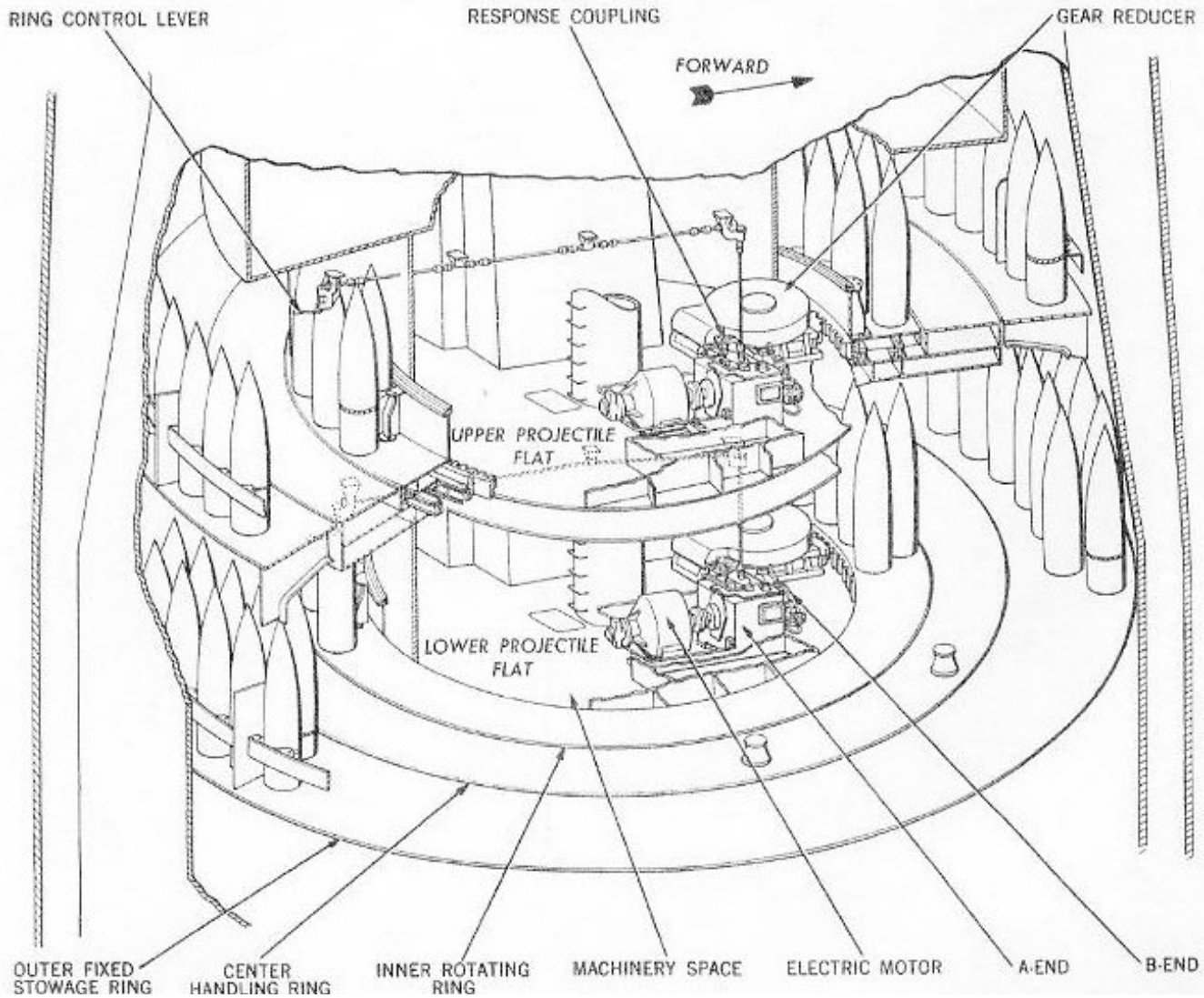


Figure 7-1. 16-inch Projectile Ring Mk 2 Mod 0, General Arrangement

is subdivided into three concentric, ring-shaped platforms. The outer ring, a nonrotating platform, is attached to the cylindrical turret foundation and provides an area for the fixed stowage of projectiles. The inner ring, a rotating platform, is mounted on rollers that are supported by the rotating structure of the turret. The inner ring provides a projectile stowage area that is power-driven either to the left or to the right, with respect to the center ring. The center ring, a part of the rotating structure of the turret, is the projectile handling platform. Located in the rear part of the center ring are the three projectile hoist tubes. This part of the handling platform is an area for personnel operating when parbuckling projectiles from the stowage platforms to the projectile hoist loading apertures. The arrangements of the projectile flats and parbuckling gear also provide for parbuckling projectiles from the fixed stowage platform to the rotating stowage area. The projectile hoist tubes are arranged with loading apertures at each projectile flat. The three projectile hoist tubes can be served simultaneously from one projectile flat.

Stowage compartments. The inner stowage rings of each flat, identical weldments, are roller-mounted carriages. Each carriage is composed of a low cylindrical coaming mounted around the inner edge of a platform plate. The platform plate provides sufficient space for stowing two concentric rows of projectiles, with each projectile standing on its base and lashed to a coaming flange and securing plates. The carriage roller assembly is located below the platform plates of the flat. The top of the inner ring platform plate is flush with the platform plates of the center and outer rings.

The stowage arrangement of the outer rings provides sufficient space for stowing two concentric rows of projectiles (one row in turret II, upper projectile flat only). The projectiles, stowed standing on base end, are lashed to a coaming flange and securing plates which are attached to the turret foundation encircling the outer edge of the stowage ring.

Turret II is provided with a third level of fixed projectile stowage. This projectile platform is located in the powder handling room, immediately below the outer ring of the lower projectile flat. The stowage arrangement provides sufficient space for stowing two concentric rows of projectiles with each pro-

main deck outside the turret to the stowed positions on the projectile flats. A separate stowage route is located on each side of the turret. The routes (or ammunition loading trunks) are formed by hatch openings in each deck, each opening being located directly below the main deck hatch. The accessory equipment installations and the special provisions for stowage handling are similar for both routes and are described below. The equipment includes ship's structural arrangements and equipment, and Ordnance accessories.

Stowage handling

Ship and turret arrangements for projectile 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 to the projectile flats.

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

Structural arrangements for the stowage handling routes are the trunks, the annular handling space, and hatch arrangements within the turret. The arrangements within the turret 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 are located at the rear of each outer ring. The hatches 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.

Hoists. Equipment arrangements for the stowage

jectile standing on its base and all projectiles lashed in the same manner as those on the outer rings of both flats.

The inner ring of each flat is equipped with an independent power drive assembly. Each drive assembly is arranged with manual control selection and starting control for clockwise or counterclockwise drive of the inner ring, and its load of projectiles. When started, the drive assembly moves the ring through an arc of 30 degrees, and then stops automatically. This action moves an unloaded section of the inner ring out of the way and places a supply of projectiles where they may be parbuckled into the aperture of the hoist tubes.

Projectile parbuckling mechanisms are described in chapter 8. The gypsy heads of the parbuckling gear are mounted in the projectile handling space of the center ring. Transfer of projectiles is always performed by use of the parbuckling gear.

Stowing projectiles

Two separate routes and certain special equipment are utilized for moving projectiles from the

handling routes are two sets of hoists and the overhead trolley conveyor at the magazine-level. The main deck hoists are 1 1/2-ton electric-motor-driven with remote start-stop controls. The hoist motors each rotate a drum and are 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 a sheave that is mounted on the outer end of the portable beam. The control for lowering and hoisting projectiles is a pushbutton station located at the main deck hatch.

The hoists, for lifting projectiles from the annular handling space to the projectile flats, are electric-motor-driven chain hoists of 1 1/2 tons capacity, with remote start-stop controls and an automatic stop. The hoists are permanently mounted on the overhead of each projectile flat, adjacent to and above the round hatch opening in the floor below the hoist. The hoisting chain is led downward from the hoist through a sheave that is secured to the floor alongside of the round opening. From the sheave in the floor, the hoisting chain is led upward to a second sheave that is secured to the overhead directly over the center of the round hatch opening in the floor of the ring.

The control for lowering and hoisting projectiles is a push-button station located on the turret foundation bulkhead adjacent to the hatch.

Conveyor. The trolley equipment for moving projectiles from the bottom of the main-deck strikedown hatches (ammunition trunks) through the annular handling space, is an overhead monorail trolley with a manually operated traveling 1 1/2-ton chain hoist. At the end of the monorail, the projectiles are transferred from the trolley to the hook of the electric-motor-driven chain hoist described in the preceding paragraph.

Projectile carrier. Accessory Ordnance equipment, provided for handling projectiles by the previously described routes, consists of an adequate allowance of 16-inch Projectile Carrier Mk 3 Mod 1. The carrier is a projectile holding yoke and base stirrup with a wire rope sling and becket. The arrangement and use of the carrier are shown in figure 7-2. The carrier is a two-position carrying design. It is used to carry projectiles in the horizontal position as well as vertical.

The carrier is removed from each projectile after the projectile is delivered in a vertical position to the magazine level at the bottom of the trunk. A similar carrier is then fitted into position on the projectile, and the first carrier is hoisted empty to the main deck. The projectiles are transported in a horizontal position through the annular handling space, by means of the second carrier and the overhead trolley-conveyor, to a position beneath the turret strike-down hatches. The projectiles are then hoisted in a vertical position through the hatches to the projectile flats. Stowing of projectiles on the inner and outer rings is performed by parbuckling.

Projectiles, when positioned on the stowage rings, are secured as illustrated in figure 7-3.

Serving the rings and securing projectiles

The stowage of the projectiles on the inner and outer stowage rings is accomplished by the following procedure:

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. To do this, the projectile must be removed from the personnel working area in the vicinity of the turret strike-down hatches. This is done by parbuckling the projectile onto the inner ring and then rotating the ring

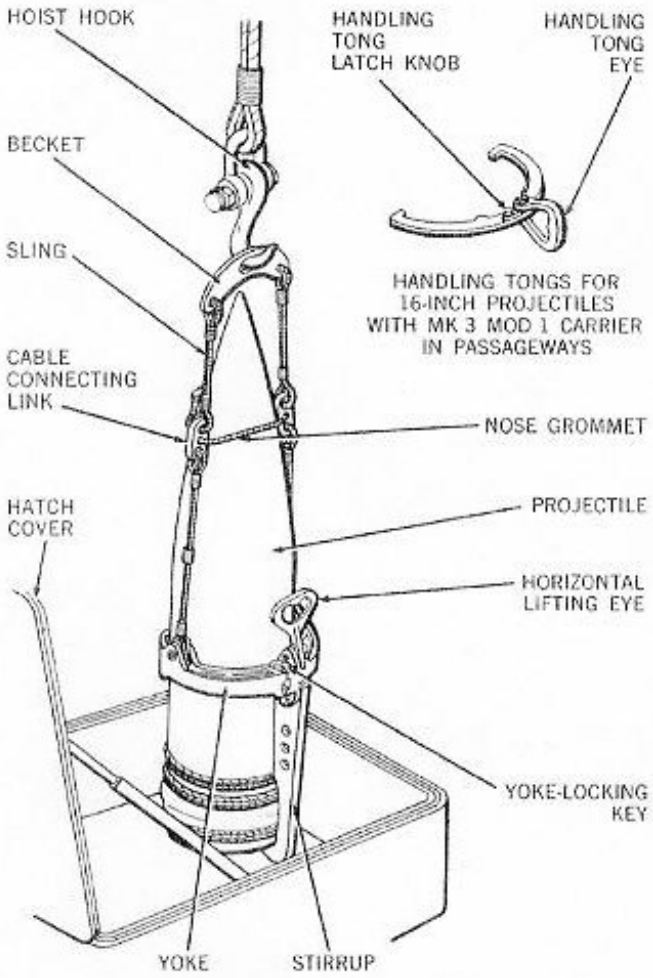


Figure 7-2. 16-inch Projectile Carrier Mk 3 Mod 1 Handling Ammunition

so that the projectile is delivered to the desired part of the projectile flat. The handling personnel may either remove the projectile to the outer ring by par-buckling or secure it to the inner ring.

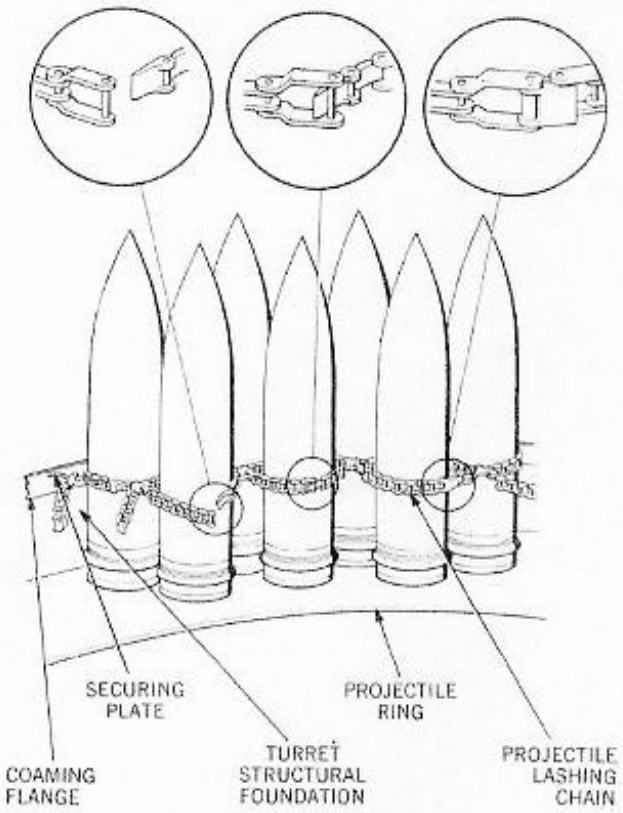


Figure 7-3. Method of Lashing Projectiles in Stowed Position

The stowing procedure described requires rotation of the inner projectile rings in order to load their empty stowage spaces. Ring rotation is through the projectile ring power drive. The action is manually initiated by moving a hand lever control device. Rotation of the ring can be stopped with the hand lever

PROJECTILE STOWAGE DATA

Service projectiles:	Number
Turret I	

as each empty stowage space comes close to the personnel working area adjacent to the chain hoists. As an alternative to manual start-stop operation of projectile ring rotation, the ring drive may be permitted to continue its operation to an automatic stop. This semiautomatic operation moves the inner ring through a 30 degree arc.

Securing projectiles. When projectiles have been served to the stowage ring, they are positioned as shown in figure 7-3, and are secured by special chain lashings. The outer row of projectiles of the outer ring fit into notches in a flange, and are chained to the flange. The inner row of projectiles are secured by chains that are connected by toggles to the flange chains. The method of securing projectiles to the rotating inner ring is identical to that of the outer ring. All securing chains are equipped with pelican-type fasteners, which permit rapid and separate unlashing of the projectiles.

Projectile stowage quantities

The storage arrangements and capacities of the turrets differ. The stowage allocations for the inner and outer rings and the total stowage of each turret are tabulated below:

Upper projectile flat, outer ring . . 120
Lower projectile flat, outer ring . . 126
Each inner ring 72
Total stowage 390

Turret II

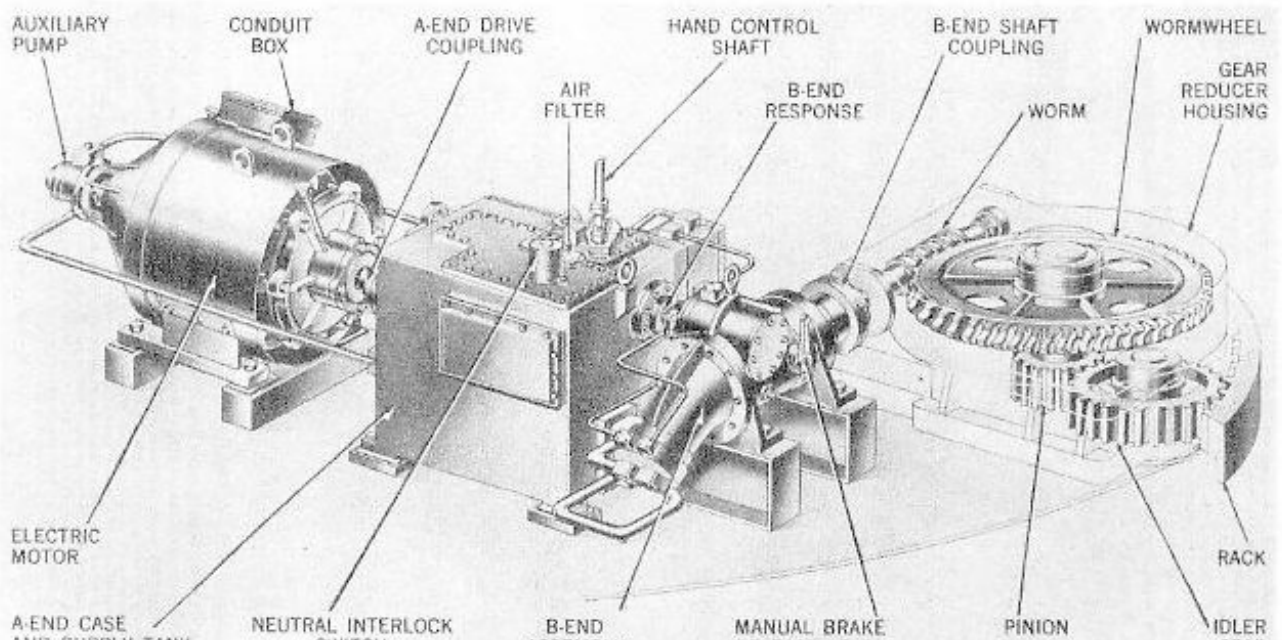
Upper projectile flat, outer ring . . 70
Lower projectile flat, outer ring . . 125
Each inner ring 72
Fixed stowage, third level 121
Total stowage 460

Turret III

Upper projectile flat, outer ring . . 100
Lower projectile flat, outer ring . . 126
Each inner ring 72
Total stowage 370

Power drive

The electric-hydraulic power drive assemblies that rotate the inner rings of each turret are separate Ordnance installations that are designated 16-inch Projectile Ring Mk 2 Mod 0. Both the upper and lower assemblies of this design are identical installations of the components identified in the next paragraph. Installed positions of the inner ring drives of both flats and their control arrangements are shown in figures 7-1 and 7-4.



AND SUPPLY TANK SWITCH ASSEMBLY RELEASE LEVER GEAR

Figure 7-4. 16-inch Projectile Ring Drive Mk 2 Mod 0, General Arrangement

Components. Each of the two projectile ring drives is composed of the following principal units:

Electric motor
Electric motor controller
Motor to auxiliary pump coupling
Auxiliary pump
Motor to A-end coupling
A-end assembly
B-end assembly
Hydraulic pipe installation

Component locations and arrangements. In each projectile flat the electric motors, A-end assemblies, and B-end assemblies of the inner ring drives are similarly mounted on the floor of the inner compartment. Each electric motor is arranged with rotor shaft coupling provisions for the auxiliary pump and A-end. Flange-mounted on the motor case, the motor case, the auxiliary pump is coupled directly to the rotor shaft. The A-end is coupled to the motor through a self-aligning flexible coupling. Mounted on a foundation weldment adjacent to the A-end, the B-end has its output shaft coupled to a wormshaft of a pinion drive mechanism. Hydraulic pipes connect the valve plate ports of the B-end motor with the A-end pump.

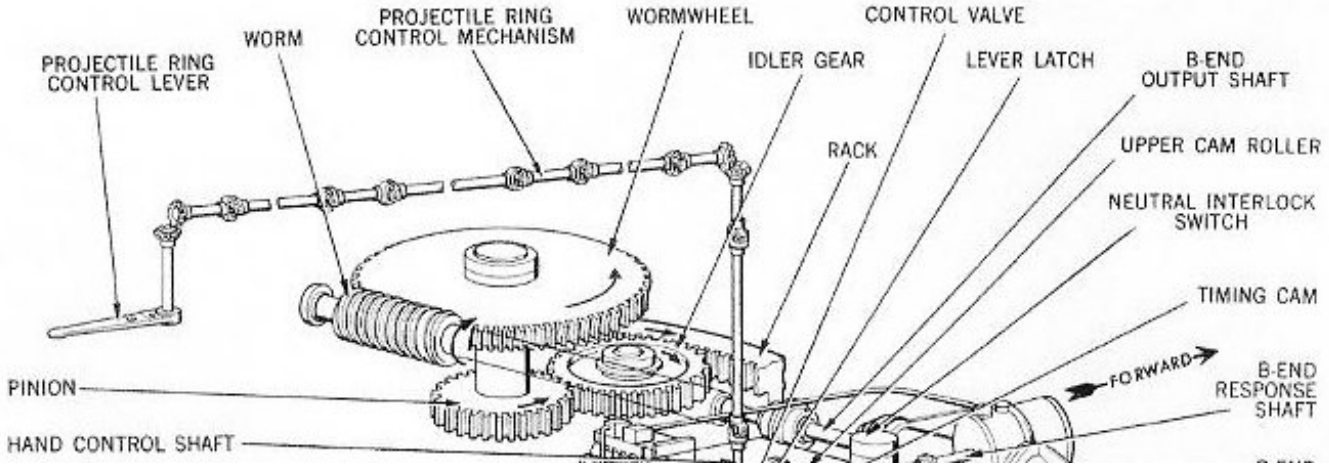
The electric motor controller for the upper projectile flat is mounted on the circular subdivision bulkhead, within the machinery space, immediately forward of the power drive assembly. The controller for the lower projectile flat is mounted on the center powder hoist trunk, within the machinery space. Each controller includes master and emergency stop push-button switches, which are located and arranged as indicated in the detail description of the controllers, and as shown in figure 7-6.

The response gear, worm-driven by the B-end drive shaft, is coupled to an input shaft of the A-end by means of a flexible coupling.

The levers of the manual control mechanism, similarly located for both the upper and lower projectile flats, are adjacent to the projectile handling area of each flat and are suspended from the overhead by a bracket.

Data. General data concerning the power drive speeds, movements, operating pressures, and loads are as follows:

Ring speed, maximum revolution per minute	
Ring movement, arc per cycle, deg	30
Hydraulic operating pressure	
Main drive, relief setting, psi . . .	2200
Auxiliary pump system, psi	100



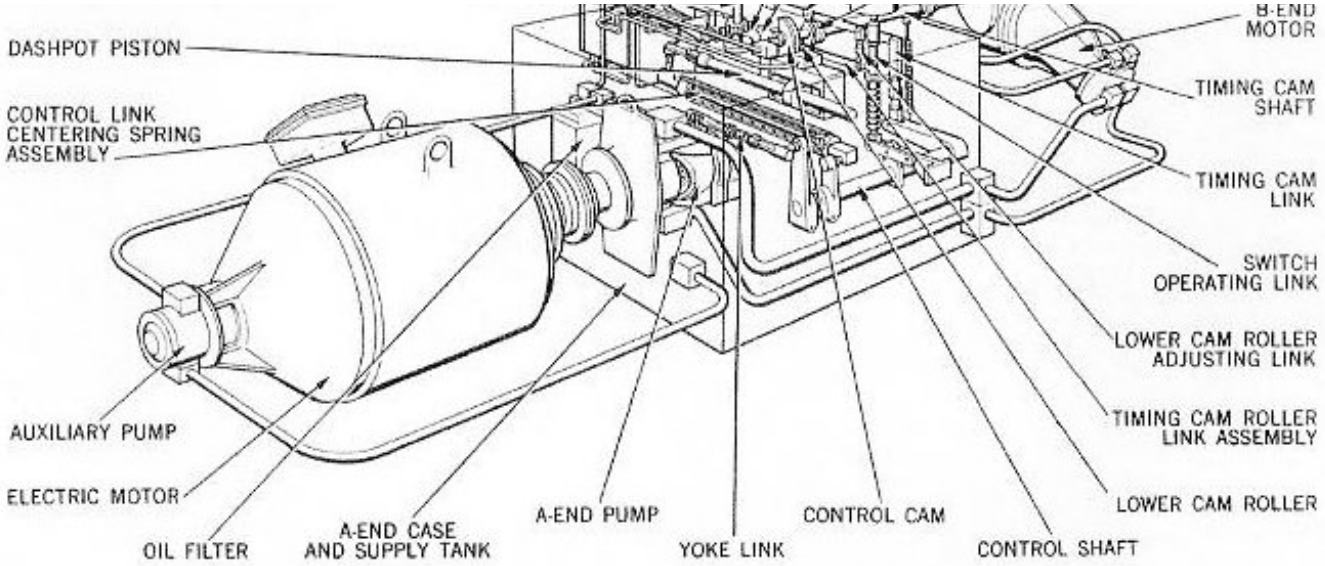


Figure 7-5. Projectile Ring Drive Components, Schematic Arrangement

DETAIL DESCRIPTION

Power drive

Design and functional details of the electric motor, controller, A-end and B-end assemblies, and their control and connecting arrangements, are shown in figures 7-4 and 7-6, and are described in the following paragraphs. These details are characteristic of all power drive installations except as noted.

Components. The projectile ring-power drive is composed of the following:

Electric motor
Electric motor controller
Motor to auxiliary pump coupling
Auxiliary pump
Motor to A-end coupling
A-end assembly
B-end assembly
Hydraulic pipe installation



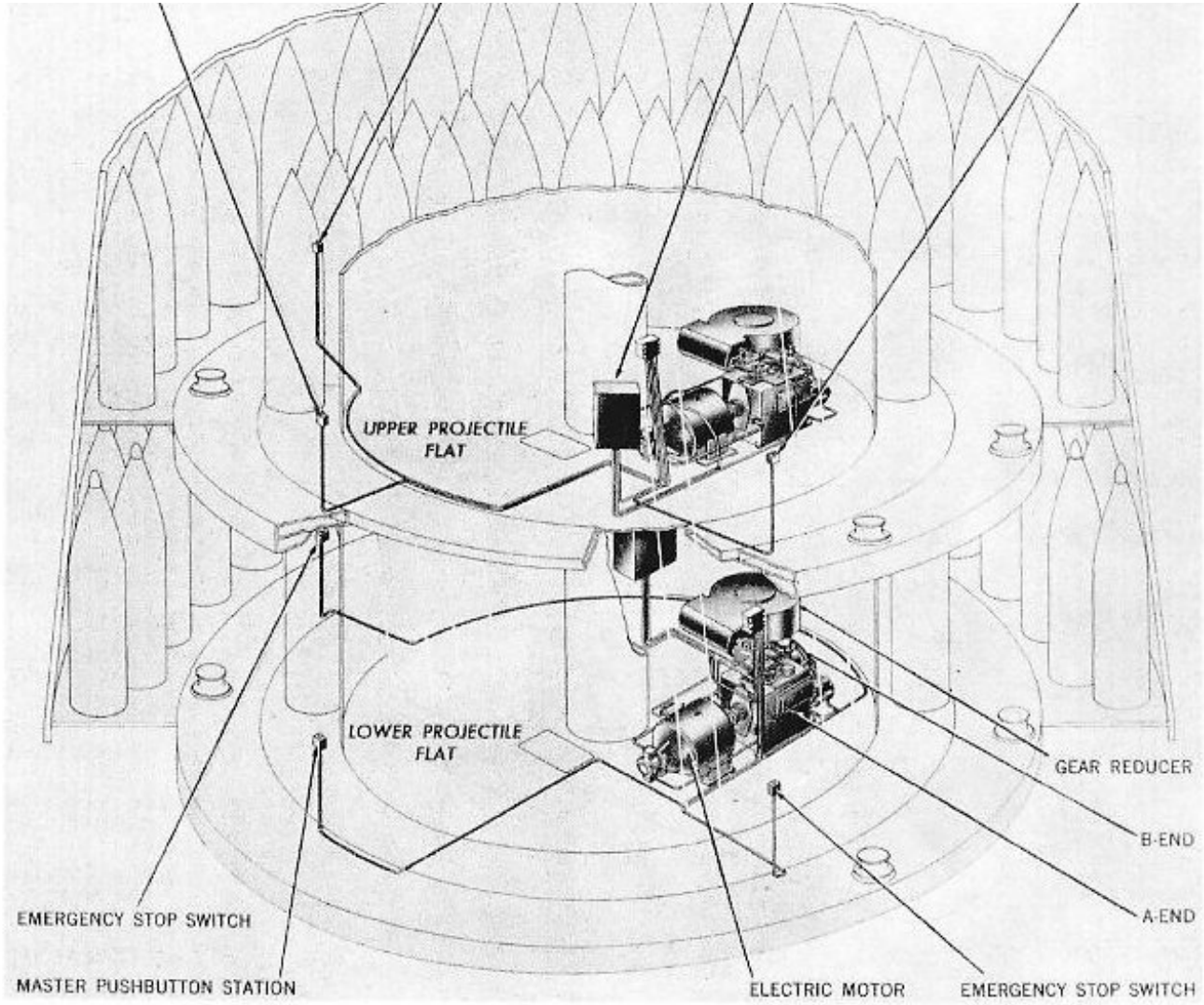


Figure 7-6. 16-inch Projectile Ring Mk 2 Mod 0, Electrical Installation

Electric motor. The electric motor is a 40-horsepower, squirrel cage, induction type, of commercial design and manufacture. The motor is mounted hori-

Controller data (second design).

Type	semiautomatic, across-the-line magnetic start

zontally at the right side of the machinery space, adjacent to the A-end it drives.

Motor data

Type	Squirrel cage, induction
Design features	waterproof, fan cooling, direct coupling drive, horizontally mounted
Horsepower	40
Revolutions per minute, synchronous	1200
Revolutions per minute, full load	1160
Rotation (at drive end)	counterclockwise
Speed class	constant
Voltage	440
Amperes, normal full load	48
Amperes, locked rotor	400
Phases	3
Cycles	60
Ambient temperature, deg C	40
Torque class	normal torque, low starting current
Weight, pounds	1200
Manufacturer	Louis Allis Co.
Manufacturer's designation	Type RX-445-S
Drawing	231543

Controller. The controllers are assemblies of commercial design and manufacture. They provide control and protection for the electric motors previously described. Each controller is an enclosed cabinet, across-the-line, magnetic starter arranged with remote push-button control switches. The circuit arrangements of the remote control switches include a master push-button switch and two emergency stop push-button switches for each controller. The power supply is arranged with a manual disconnect switch, externally accessible and interlocked with the cabinet cover. The starting circuit includes a neutral interlock switch, mounted on the A-end assembly. Controller data (first design) applies to the IOWA and the NEW JERSEY. Controller data (second design) applies to the MISSOURI and the WISCONSIN.

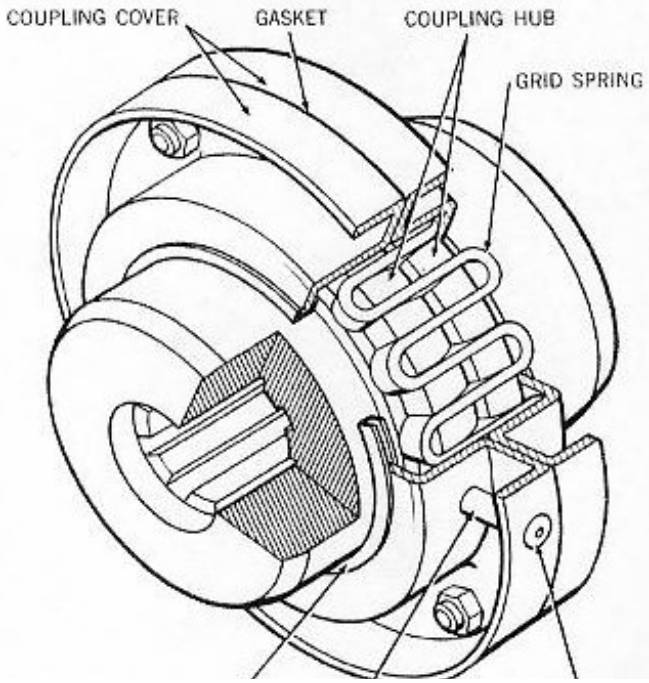
Controller data (first design).

Type	semiautomatic, across-the-line magnetic starter, controlled by remote push button
Ampere rating, full load	48
Protection:	
Overload	thermal type, automatic reset
Adjustable range, amperes	59.1 to 71.0
Normal setting, amperes	60.0
Short circuit, ampere fuses	400
Undervoltage	

across-the-line magnetic starter, controlled by remote push button

Ampere rating, full load	48
Protection:	
Overload	thermal type, automatic reset
Adjustable range, amperes	47.5 to 58.1
Normal setting, amperes	52.8
Short circuit, ampere fuses	250
Undervoltage	
Drop-out voltage	110
Sealing voltage	374
Shock rating	high impact
Weight, pounds	150
Manufacturer	Ward Leonard Electric Co.
Drawing	293881

Motor to auxiliary pump coupling. The electric motor to auxiliary pump coupling is shown in figure 7-7. The coupling serves as a direct drive connection between these two units. It is enclosed within the end housing of the electric motor. The coupling consists of two identical steel hubs, a specially heat-treated and tempered steel allow grid-spring, and two identical steel shells, which form the cover. The coupling design provides direct-drive connection through the grid spring, engaged in grooves milled in the outer flanges of the hubs. The hubs and grid spaces are packed with lubricant confined within the steel shells by grease seals.



Drop-out voltage	110
Sealing voltage	374
Shock rating	50
Weight, pounds	130
Manufacturer	Ward Leonard Electric Co.
Drawing	231756

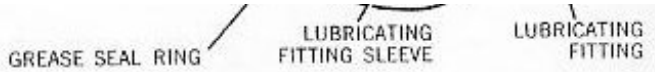
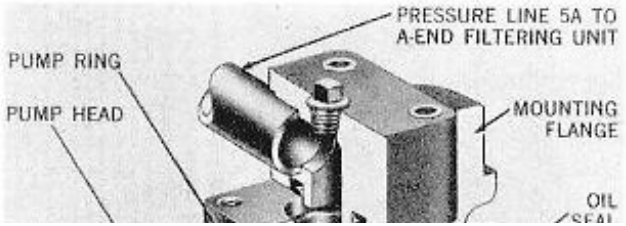


Figure 7-7. Projectile Ring Drive, Motor to Auxiliary Pump Coupling, Cutaway View

Auxiliary pump. The auxiliary pump (fig. 7-8) is a constant-displacement balanced-vane type. It is flange-mounted on the electric motor and is driven directly from the rotor shaft (and opposite the A-end coupling) at a speed that is approximately constant. Principal components of the pump are a rotor, 12 vanes, a pump ring, and two bronze bushings mounted inside a housing that consists of a body, pump head, and mounting flange. The rotor is supported by ball-bearings in the head and mounting flange. The vanes are free to slide in the rotor slots as they are rotated within the elliptical pump ring. Semiannular ports in the head and in the bushings are aligned radially with suction and pressure ports between the rotor and pump ring. Two grooves cut in each bushing between the pressure ports, and a circular groove aligned radially with the base of the vanes, force the vanes into constant engagement with the pump ring. As the rotor is rotated, the vanes form pockets with the pump ring. These alternately increase in size across one pair of opposite ports, causing suction. The pockets decrease across the other pair of ports, creating pressure and pumping action. The pump operates at a constant pressure limited by the auxiliary relief valve which is set to relieve at a pressure of approximately 100 pounds per square inch. The pump supplies fluid for operating the control circuit and for replenishing the main system.



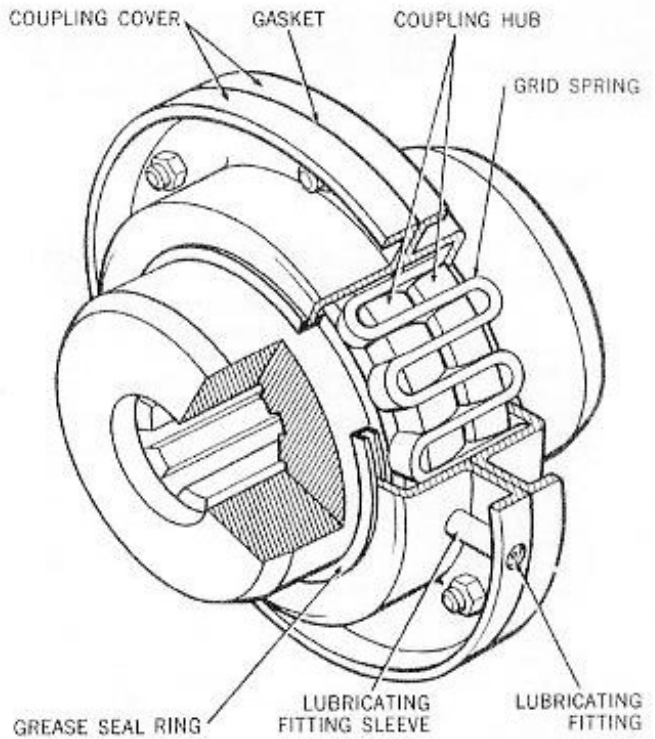


Figure 7-9. Projectile Ring Drive Motor to A-end Coupling, Cutaway View

Auxiliary pump data.

Speed, revolutions per minute	1200
Delivery, gallons per minute	510
Pressure, pounds per square inch	100
Rotation	counterclockwise
Weight, pounds	36

Motor to A-end coupling. The electric motor to A-end coupling is shown in figure 7-9. The coupling

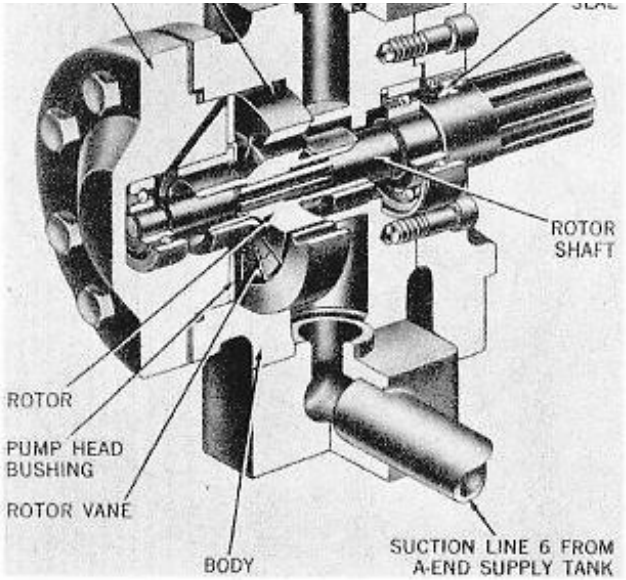


Figure 7-8. Auxiliary Pump Assembly, Cutaway View

serves as a self-aligning, direct-drive connection from the electric motor rotor shaft to the A-end drive shaft. The coupling is a larger unit of the same design as the auxiliary pump coupling described in a previous paragraph.

A-end assembly. The A-end assembly consists of the components listed below. The type, arrangement, and functional purpose of these components are described in the following paragraphs.

Hydraulic pump
Safety relief valves
Case
Pump yoke
Timing and control mechanism
Manual control mechanism
Control shaft coupling
Control valve block
Oil filters
Oil filter relief valves
Neutral interlock switches

Hydraulic pump. The A-end hydraulic pump is a multi-piston, reciprocating, variable-stroke, rotating type. It is mounted horizontally at the end of the case adjacent to the electric motor, which drives it continuously at approximately constant speed. The pump drive shaft and the rotor of the electric motor

are directly connected by the coupling described in a previous paragraph and shown in figure 7-9. Mounted in a housing and yoke, the pump is provided with a special relief valve block. The rotating group is composed of a cylinder block, nine pistons and connecting rods, a universal link and pin assembly, and a drive shaft. The non-rotating assembly is a yoke, valve block with two relief valves, and a valve plate. The drive shaft has ball-bearing mountings in the pump housing. The cylinder block and piston assembly is ball-bearing-mounted and spring-held against the valve plate. The link and pin assembly is a ball-joint, mounted inside the cylinder block and drive shaft. This arrangement provides a flexible drive connection between the drive shaft and the cylinder block.

The pump regulates hydraulic motor speed as it is tilted or offset from neutral by its yoke. Pintle-mounted from the housing, the yoke is connected to the control devices and the manual control mechanism. The special relief valve block, mounted at the outer end of the yoke, encloses two valves which are arranged in the main pump ports, as described in the next paragraph. Piston cylinder ports in the cylinder block

stroke. When the yoke is at neutral stroke position, the cylinder block is also at neutral stroke, and the pump is not displacing hydraulic fluid. Movement of the yoke from neutral stroke causes displacement of hydraulic fluid to the B-end, and thereby causes projectile ring rotation. Movement of the yoke to the opposite side of neutral stroke reverses the flow of the hydraulic fluid, and also reverses the direction of projectile ring rotation.

Timing and control mechanism. The timing and control mechanisms are semiautomatic, projectile ring cycle-control devices. The mechanisms control projectile ring starting speed and operate automatically to stop ring rotation at the end of a cycle. The components of the timing and control mechanism are described in the following order.

Hand control shaft and holding brake
Control dashpot
Control link centering spring
Control shaft
Yoke link
Timing cam roller link

are aligned radially with semiannular ports in the valve plate and valve block. These are connected to the B-end through the valve block and yoke coring, pintles, and hydraulic pipe connections, by a closed hydraulic circuit. Fluid flows in a continuous cycle between the A-end and B-end. The only external connections are through replenishing check valves to compensate for normal internal leakage. Through the control mechanism, the cylinder has offset movement with relation to the axis of the main shaft. Rotation of the main shaft, together with offset of the cylinder block, causes reciprocation of the pistons and consequent pumping action through the valve plate ports. Zero reciprocation (neutral stroke) exists when the axes of the cylinder block and main shaft are in line. Maximum stroke occurs when the axis of the cylinder block is offset approximately 20 degrees in either direction.

Safety relief valves. The two safety relief valves are arranged in an opposed position in the valve block at the end of the pump yoke. A valve functions, to relieve the hydraulic transmission system, in each direction of projectile ring drive. Each valve is connected to either the intake or the pressure side of the transmission system, depending on the direction of yoke offset. The valves prevent excessive pressure rise in the transmission system which may be caused by a binding condition in the drive gear assembly or by the pump yoke being shifted too rapidly. The valves by-pass fluid from the pressure to the intake side of the pump, and are set to relieve at 2200 pounds per square inch pressure.

Case. The A-end case serves two purposes. The case provides support and housing for the A-end units, and it serves as a reservoir tank for hydraulic fluid for all circuits. The A-end units are mounted on cover plates bolted to the case to form its sides and top. The design of the case assembly aids in A-end disassembly, and provides a means of quick access for maintenance and adjustment of the timing and control mechanism and other components. A fill cap, drain plug, and two trycocks provide means for replenishing and maintaining a proper level of hydraulic fluid. Proper fluid level exists when fluid flows from the lower trycock. The capacity of the projectile ring hydraulic system at this level is approximately 25 gallons.

Pump yoke. The pump yoke is the component of the nonrotating A-end assembly through which pump reciprocation is varied from neutral stroke to full

Timing cam shaft

Hand control shaft and holding brake. The hand control shaft and holding brake assembly (fig. 7-10) is a shaft, pinion, and cam arrangement. The assembly transmits control action initiated by the projectile ring operator, through the manual control mechanism to the starting control valve and to the other timing and control devices. The holding brake assembly is

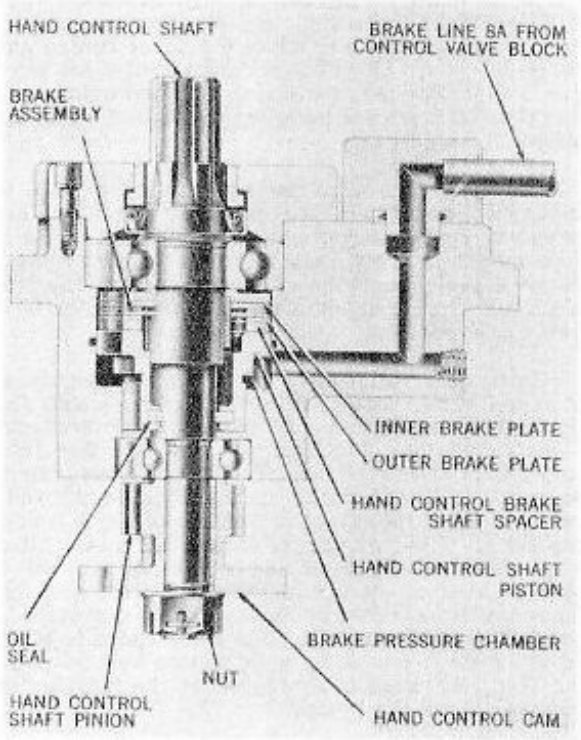


Figure 7-10. Hand Control Shaft Assembly, Sectional View

a hydraulically operated arrangement of brake discs. It acts to overcome the force of the control link centering spring to keep the hand control shaft in its initially offset position until the end of an operating cycle is reached. The holding brake is set when control pressure, ported from the control valve block, is applied to the underside of the brake piston at the beginning of the operating cycle. The control pressure is vented to the reservoir, the brake is released, and the handlever is automatically returned to neutral position when either the starting valve or control valve is in the stop position. The frictional force of the holding brake does not prevent manual operation of the handlever at any time.

Control dashpot. The control dashpot assembly (fig. 7-5) is composed of a piston, piston housing, and two ball check valves. The assembly prevents overload of the electric motor by limiting the speed with which the control handlever can offset the A-end pump yoke. The piston and the handlever connected to it can move only as fast as fluid can flow through a restriction in the dashpot piston. Fluid in the dashpot is continuously replenished by pressure from the auxiliary pump. The ball check valves permit fluid to be pumped to the suction side of the piston chamber.

Control link centering spring. The control link centering spring assembly (fig. 7-5) is a spring-type linkage which has two functions. The assembly permits full movement of the manual control handlever while the A-end pump is in neutral position. In addition, the control link centering spring assembly exerts a force which causes the timing cam link roller to follow the contour of its timing cam throughout the ring operating cycle, thus controlling the offset of the pump yoke and keeping the speed of the B-end under complete control.

Control shaft. The control shaft assembly (fig. 7-5) is composed of a shaft and lever arrangement which correlates the actions of the other timing and control devices. Mounted on the control shaft assembly is a neutral interlock switch link and cam which opens the interlock switch when the A-end pump yoke is offset from neutral.

Yoke link. The yoke link assembly (fig. 7-5) is composed of an adjustable turnbuckle and clevis arrangement which connects the control shaft to the A-end pump yoke. This assembly is adjusted to position the A-end pump yoke at neutral stroke when the control and timing mechanism is in the stop or between-cycle position.

Timing cam roller link. Two timing cam roller link assemblies, upper and lower, are mounted above and below the inner and outer timing cams respectively. Each assembly functions for only one direction of projectile ring rotation. The assemblies transmit cam action to the control shaft and thus permit the cams to control the offset movement of the A-end pump yoke. The timing cam roller link assemblies are attached to each other and to the control shaft by an adjustable turn-buckle and clevis arrangement.

is controlled from the B-end through the response mechanism. The cams include a control cam and two timing cams which are keyed to the cam shaft and turn one revolution for each cycle of ring rotation. Positioned to engage the cam link rollers, the timing cams control movement of the mechanical timing and control mechanism. The control cam is positioned to engage a control valve and through that valve to regulate operation of the hydraulic system. Contact between the control valve and control cam is made with a lever which engages a latch in the cam, thus ensuring positive engagement at the stop position.

Manual control mechanism. Manual control mechanism (fig. 7-5) of the upper and lower projectile ring drives is an arrangement of shafts, gears, and a hand control lever for manually actuating projectile ring control movement. Mechanism extends from the A-end assembly to the outer side of the projectile flat circular subdivision bulkhead. It is an assembly of shafts, bevel gears, universal joints, and couplings suspended from the projectile flat overhead by J-shaped brackets at each end, and two T-shaped brackets at the middle part of the assembly. Inner end of the shaft assembly is attached to the hand control shaft of the A-end assembly. A J-bracket mounted hand lever, which can be rotated 170 degrees in either direction to actuate projectile ring rotation, comprises the outer end of the shaft assembly. Direction of hand lever movement, limited by positive stops, is the same as ring rotation. Each outer J-bracket is provided with a spring-loaded locking plunger which engages a recess in the hand lever at neutral stroke to prevent the handlever from being accidentally moved.

Control shaft coupling. Shaft-to-shaft connections in the manual control assembly are made with self-oiling universal joints. These units permit the shafts to rotate at angles up to 22 degrees from alignment, and to facilitate installation and disassembly. Shaft connection arrangements of opposite ends of each universal joint are the same. The joint ends are splined to the shafts and pinned in position.

Control valve block. The control valve block is mounted at the upper left side of the A-end case, when viewed from the shaft end. It is a machined block which contains the valves and hydraulic passages that are necessary for circuit control. The auxiliary pump delivers fluid under circuit control pressure to the valve block. The following valves are contained in the control valve block.

VALVE NAME	VALVE SYMBOL
Starting valve	V1
Interlock valve	V2
Control valve	V3
Auxiliary pump relief valve	V4
Hydraulic motor by-pass valve	V5
Main system replenishing check valve	V6 and V7

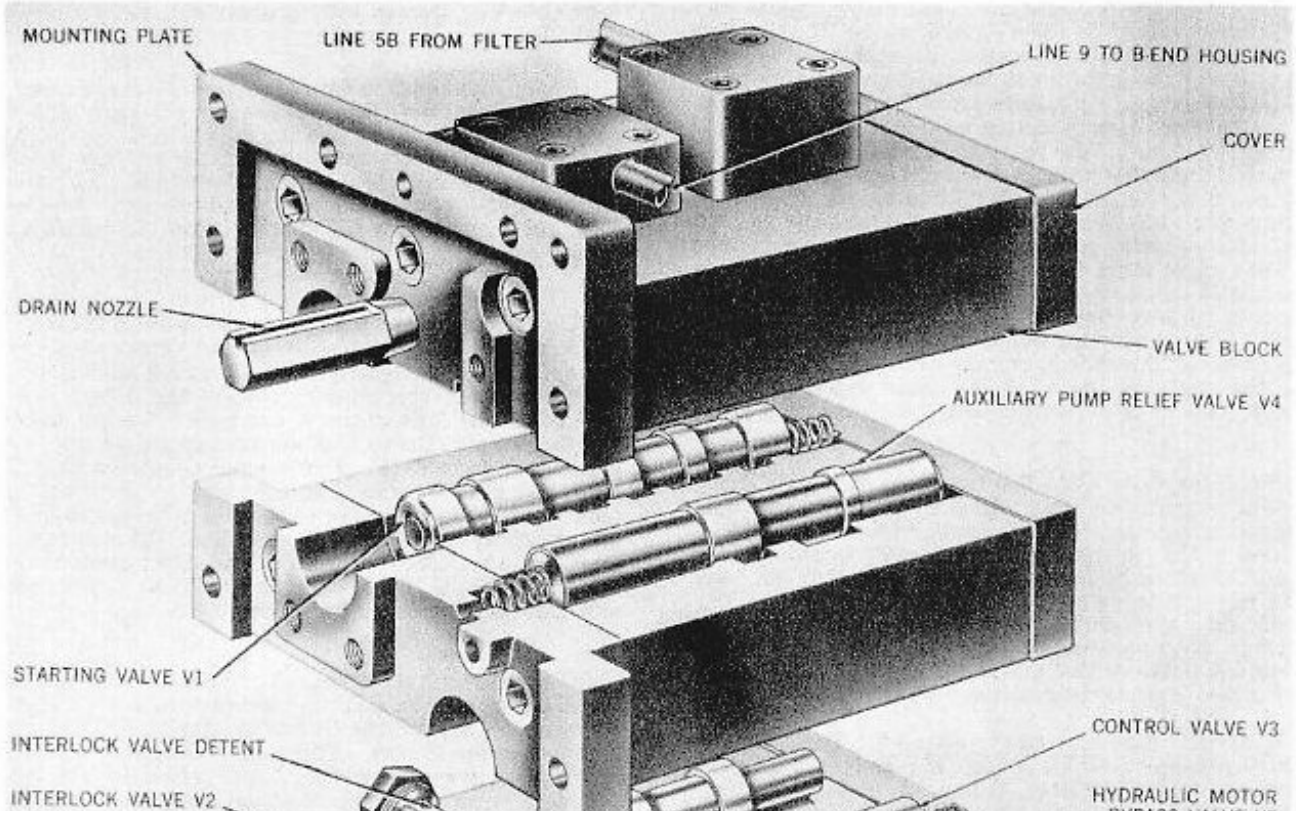
These valves are arranged as shown in figure

This permits a necessary clearance to be obtained between the cam link roller and its respective timing cam when the A-end pump yoke is in a neutral position. The clearance is equivalent to the starting offset movement of the pump.

Timing cam shaft. The timing cam shaft assembly is a cam and shaft arrangement with three cams which control the offset of the A-end pump yoke and return it to neutral stroke. Rotation of the cam shaft

7-11. The valves open or close the hydraulic passages in the valve block to provide drive control, system replenishment, circulation, and pressure relief. Their purposes and system arrangements are described in the following paragraphs.

Starting valve V1. The starting valve V1 is a spring-and-cam-actuated valve that operates, when ring rotation is begun, to port control pressure to the control shaft holding brake and the B-end shaft brake.



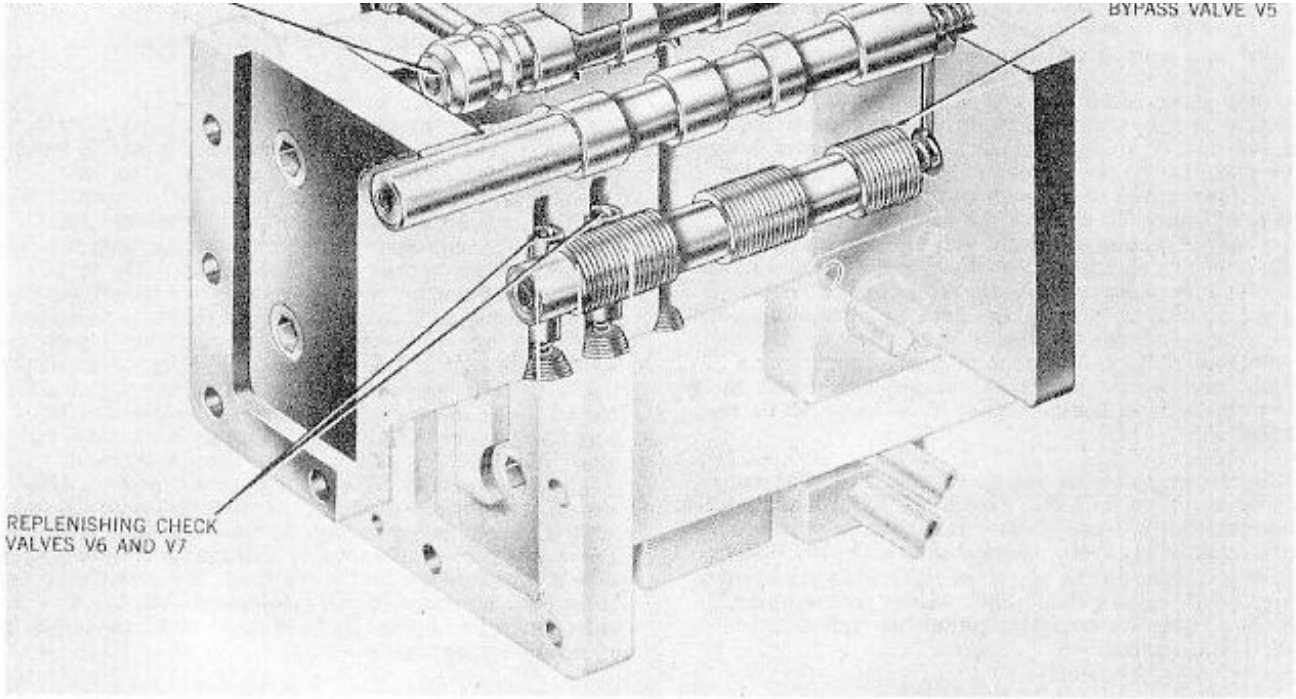


Figure 7-11. A-end Control Valve Block, Cutaway View

V1 also ports control pressure around the interlock valve V2 to the end chamber of the control valve V3. These actions of V1 are initiated by manual control mechanism movement of the starting cam C5. At the end of the drive cycle the valve spring returns V1 to a position to cut off its venting and pressure porting action.

Control valve V3. The control valve V3 is hydraulically operated from its stop to its starting position and is then cam-actuated to its running and stop positions. Hydraulic pressure from V1 moves V3 to its starting position by acting on the starting valve piston. V3 cuts off the port connections that vent the auxiliary pump pressure when the valve is in its stop position. In addition, V3 ports auxiliary pump pressure to shift the hydraulic motor by-pass valve V5 to its operating position. The control valve cam C3 and spring move V3 to its running position, where

Starting cam C5. The starting cam C5 is keyed to the hand control shafting. When the hand control operating lever is offset from neutral stroke in either direction, the lever acts through shafting and gears to rotate C5. As C5 rotates, it forces the roller on the end of the starting valve V1 out of the starting cam recess. This action positions the starting valve V1, against spring pressure, in its starting position.

Control valve cam C3. The control valve cam C3 is keyed to the B-end response input shaft to the control mechanism. When the B-end is in operation, B-end response acts through the input shaft to rotate the control valve cam C3. As C3 rotates, it forces the lever latch out of the control valve cam recess. This action positions the control valve V3, against spring pressure, in its starting position.

it remains for the rest of the cycle. In this position, V3 ports control pressure to return the interlock valve V2 to its starting position. V3 is moved to its stop or cutoff position by spring action. In this position, the pressure line to the by-pass valve V5 is vented, and V5 is permitted to move to the stop position.

Interlock valve V2. The interlock valve V2 is a pressure-operated valve, which is moved to its running position by hydraulic pressure from V3, as described in the previous paragraph. V2 is moved to its stop position by hydraulic pressure from V3, when V3 is in its running position. In both postions, V2 is held by a spring detent plunger. In its run position, V2 vents the piston end of V3; in its stop position V2 resets the port connections to the control valve piston for the next starting action.

Hydraulic motor by-pass valve V5. The hydraulic motor by-pass valve V5 is a spring-and-hydraulic-pressure-operated valve. It has two positions: operating and by-passing. V5 is pressure-actuated from V3 to move it to its operating position, as described in a preceding paragraph. In its operating position, V5 releases the B-end brake. When control pressure is vented at the end of the operating cycle, the valve spring shifts V5 to its by-pass position. In this position V5 cross-connects lines from the B-end valve plate to the two replenishing check valves V6 and V7 (described in the next paragraph). This by-pass position of V5 enables the high-pressure pipe of the main transmission lines to relieve and equalize to the lower pressure of the other main transmission line. The by-pass position thereby causes B-end rotation to stop by venting the brake piston and allows the spring to engage the B-end brake discs. During the interval that the B-end is at rest, the by-pass position enables the auxiliary pump supply to be delivered to both main transmission lines in order to replenish.

Replenishing check valves V6 and V7. The two main system replenishing valves V6 and V7 are spring check valves. V6 and V7 are arranged in opposed positions with separate oil passages and pipe connections that extend to the main transmission pipe ports of the B-end valve plate. Both valves are supplied with fluid from the auxiliary pump through an interconnecting passage.

Auxiliary pump relief valve V4. The auxiliary pump relief valve relieves auxiliary pump pressure to the fluid reservoir when the setting of the V4 spring is exceeded.

Oil filters. Two pressure-type screen filters in the auxiliary pump hydraulic circuit remove foreign material from the hydraulic fluid before it enters the control and operating circuits. The filters are located on the side of the A-end case. Design details and the duplex filter chamber arrangements are shown in figure 7-12. For normal operation both filters should be used simultaneously. However, a control valve is provided in the filter design to permit the individual use of either filter. This feature makes it possible to clean a fouled filter element without stopping the power drive. There is a relief valve in the discharge line of each filter.

Oil filter relief valves. The relief valves are in the discharge lines and function as safety devices to by-pass oil around the filters in case both filter elements become fouled. The valves are set to relieve at a higher pressure setting, approximately 120 pounds per square inch, than the auxiliary pump relief valves. This is to prevent the oil filter relief valves from opening during normal operation.

Neutral interlock switch. The neutral interlock switch (fig. 7-13) is an electric switch that is used in the electric motor starting circuit. Located on the top of the A-end case, the switch opens the starting circuit whenever the pump yoke is offset from neutral stroke. This prevents starting overload on the electric motor when the power drive is at a mid-cycle position with the pump yoke offset from neutral stroke. Design features include a plunger-operated, two-pole normally closed switch, with a watertight seat at the plunger stuffing box. The stuffing box gland houses a spring which, through a packing washer, maintains constant pressure against packing around the plunger. The packing does not bind the plunger, but permits free movement without leakage either by pumping action or capillary action. When lifted against the pressure of a plunger spring, the plunger moves an inner plunger assembly, The inner plunger assembly includes a shoulder which lifts a movable contact away from two stationary contacts that are mounted in a terminal board. The movable contact is normally held down in a closed position by a contact spring.

B-end assembly. The B-end assembly is mounted in the machinery space of the projectile flat, as shown in figure 7-1. The B-end is coupled directly, through its output shaft, to the projectile ring drive worm.

The B-end assembly is composed of the following:

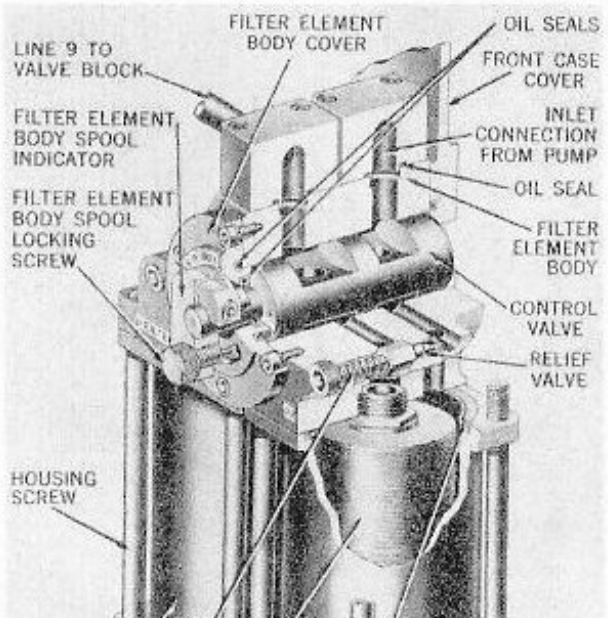
Hydraulic motor
Brake
Brake release lever
Response mechanism
B-end response coupling
B-end drive coupling

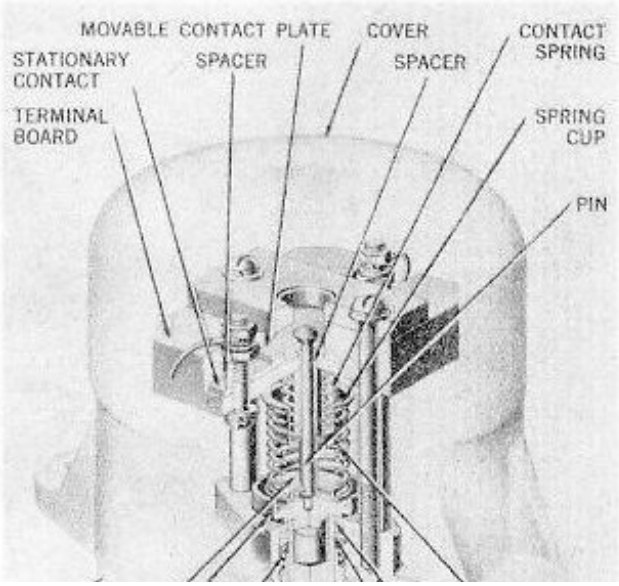
Hydraulic motor. B-end hydraulic motor is a multi-piston, fixed-stroke type, similar to the A-end pump except that its cylinder and valve plate have fixed offset position. Its driven main shaft is coupled directly to the worm of the gear reducer. Motor consists of a valve block, valve plate, a motor housing, and a rotating assembly of cylinder, pistons, piston rods, and a shaft connecting rod. Its housing is bolted to the B-end shaft housing. Rotating assembly is driven through a closed hydraulic circuit from the A-end pump, connected to the B-end valve block. Hydraulic motor speed and direction of rotation are determined by the direction and degree of the A-end yoke offset.

Brake. The B-end brake (fig. 7-15) is a friction disc-type, mechanical assembly which is spring applied and hydraulic pressure released. The brake is composed of multiple discs alternately attached to the B-end output shaft and to the brake disc retainer. The discs and the retainer are concentric with the B-end output shaft and are enclosed within the B-end shaft housing. A piston enclosed spring exerts sufficient pressure on the discs to cause their engagement and thus prevent the shaft from turning when the projectile ring drive is not operating. The brake is held in its applied position by this brake spring except when the ring is rotating, or when it is released by the manual brake release lever. During operation, control pressure from the auxiliary pump is ported through the control valve block to a brake release cylinder. This compresses the brake spring and disengages the brake discs to permit the output shaft to rotate. The brake holds the projectile ring in a fixed position in the intervals between cycling actions.

Brake release lever. The brake release lever operates a manual brake release assembly that disengages the brake when the projectile ring is to be turned by means other than by power. The assembly is a cam-operated release plate, engaged to the brake piston. The device is operated through a shaft arrangement by the manual brake release lever.

Response mechanism. The B-end response mechanism (fig. 7-14) is a worm, wormwheel, and response shaft. This mechanism is coupled to the A-end timing cam shaft as indicated on page 7-10. The worm of the mechanism is keyed to and rotates with the B-end output shaft and has a fixed value of 60 revolutions for each cycle of projectile ring rotation. The worm and wormwheel are lubricated by hydraulic fluid in the B-end housing.





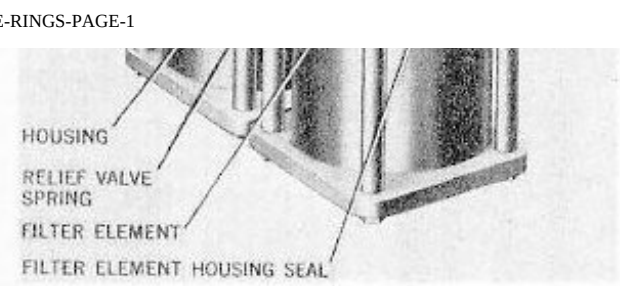


Figure 7-12. Filter Assembly, Cutaway View

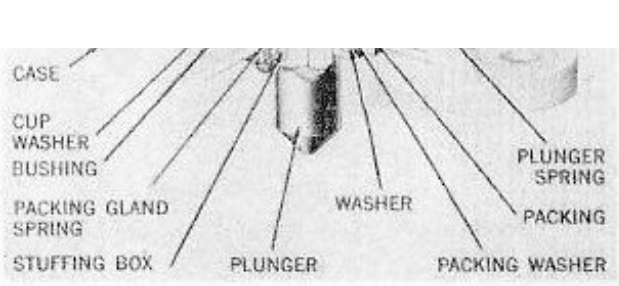


Figure 7-13. Neutral Interlock Switch, Cutaway View

B-end response coupling. The B-end response coupling (fig. 7-6) connects the response shaft to the control cam shaft. A floating center member, mounted between jaw flanges, is constrained to slide across the face of one flange on a line passing through the center, and across the face of the second flange in a direction at right angles to the first. The floating center member has special removable graphite-impregnated bearing strips, mounted between the center member and the flanges, together with a grease reservoir for lubrication.

B-end drive coupling. The B-end drive shaft coupling (fig. 7-17) is a direct-drive, self-aligning connection between the B-end output shaft and the gear reducer worm shaft. Composed of two identical hubs, male sleeve, female sleeve, sleeve gasket, and two oil seals, the coupling provides a flexible connection through meshing of the internal gears of hubs and sleeves. Openings for adding lubricant, which is retained by the oil seals and gaskets, are normally closed by oil plugs.

Hydraulic pipe installation. Details of the hydraulic pipe installations for the upper and lower projectile ring drives, connecting the previously described A-end pump, B-end motor, and valve block components, are identical. The hydraulic pipe installation for one projectile ring drive is shown in figure 7-25.

Projectile rings

Components. Each upper and lower inner projectile ring is composed of the following major units and subassemblies:

Carriage ring assembly

- Carriage ring weldments
- Rack
- Carriage securing devices
- Stowage fittings

Roller cage installations

- Roller cage
- Doubler plates

Pinion drive mechanism

- Gear reducer
- Drive coupling

Carriage ring assembly. The carriage ring assembly, arranged as shown in figure 7-18, rests on rollers of the roller cage installations (described on page 7-16). Secured against lifting by holding down flanges that are mounted on the circular bulkhead enclosing the machinery space, the carriage ring assembly is rotated on the rollers by pinion drive of the rack.



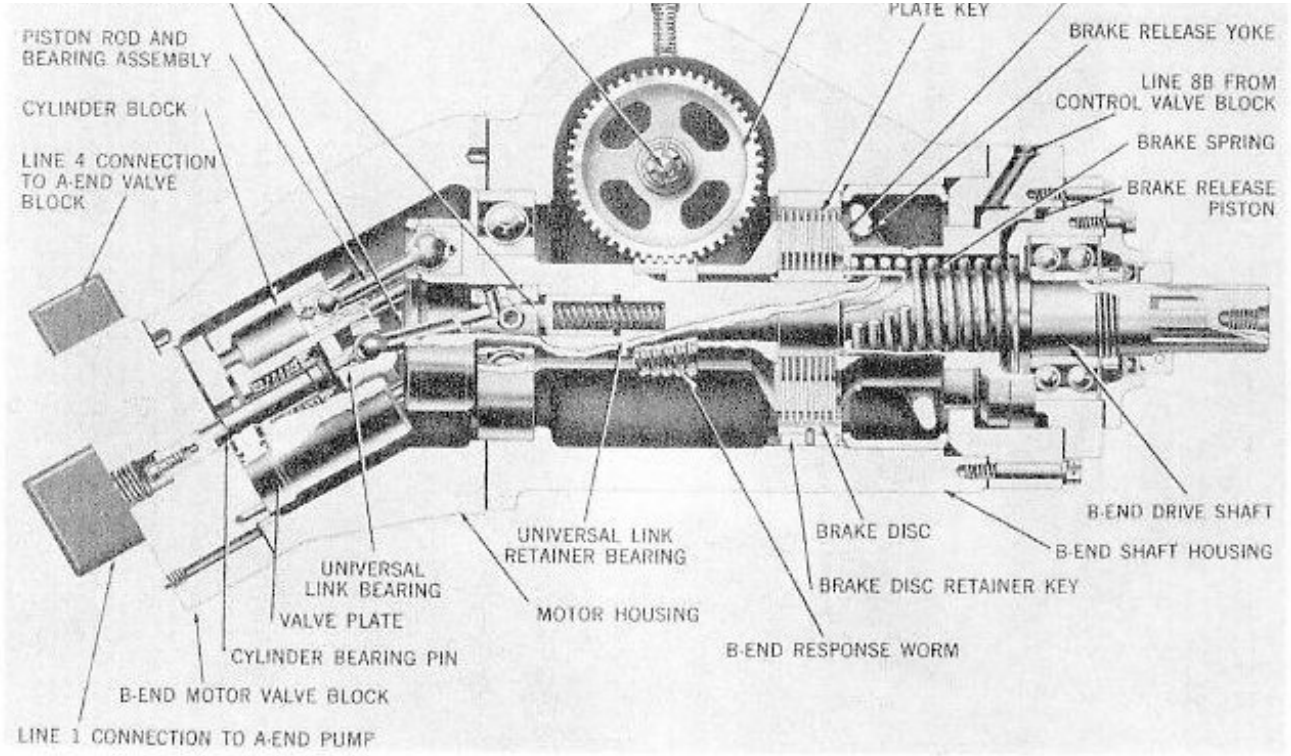


Figure 7-14. B-end Assembly, Sectional View

Carriage ring weldments. The projectile stowage rings (rotating) of both projectile flats are identical, with a platform diameter of 23 feet each. The platforms, each 36 inches wide, are welded assemblies of circular platform segments, two rings (designated rack retainer and outer track support), two other rings (designated inner and outer tracks), and a cylindrical coaming with a coaming flange.

Rack. Racks, large annular spur gear segments, are bolted on and keyed to the rack retainer to form a complete circular gear with internal teeth. Four similar 65-tooth segments give a total of 260 teeth in the whole rack. Pitch diameter of the rack is 208 inches. Identical drive pinions for both the upper and lower racks have 21 teeth with a pitch diameter of 16.8 inches.

ring carriage (fig. 7-18) stow the rotating ring and relieve the rack, pinion, and pinion drive from stress, when the rings are not in use. The centering pins are located 180 degrees apart at 15 degrees and 195 degrees from the turret longitudinal centerline. Mating sockets for the pins are bolted in position in the assembly of fixed roller cages. Each pin is a screw type which is retracted by a special wrench. The wrenches are stowed close to each socket.

Stowage fittings. The projectile stowage details of the rotating and fixed stowage rings of both projectile flats are similar. Each rotating ring is provided with a coaming flange which is equipped with uniformly spaced projectile lashings. The fixed stowage spaces are equipped with similar lashings which are secured to uniformly spaced securing plates. These

Carriage securing devices. In addition to the holding-down flanges, each ring is equipped with devices to prevent accidental rotation of the ring when it is not in use. Two centering pins in each plates are welded to the cylindrical foundation bulkhead. The lashings consist of roller chain devices that are similarly toggle-connected to the coaming flange and the securing plates, as shown in figure 7-18. All lashing chains are equipped with pelican type fasteners.

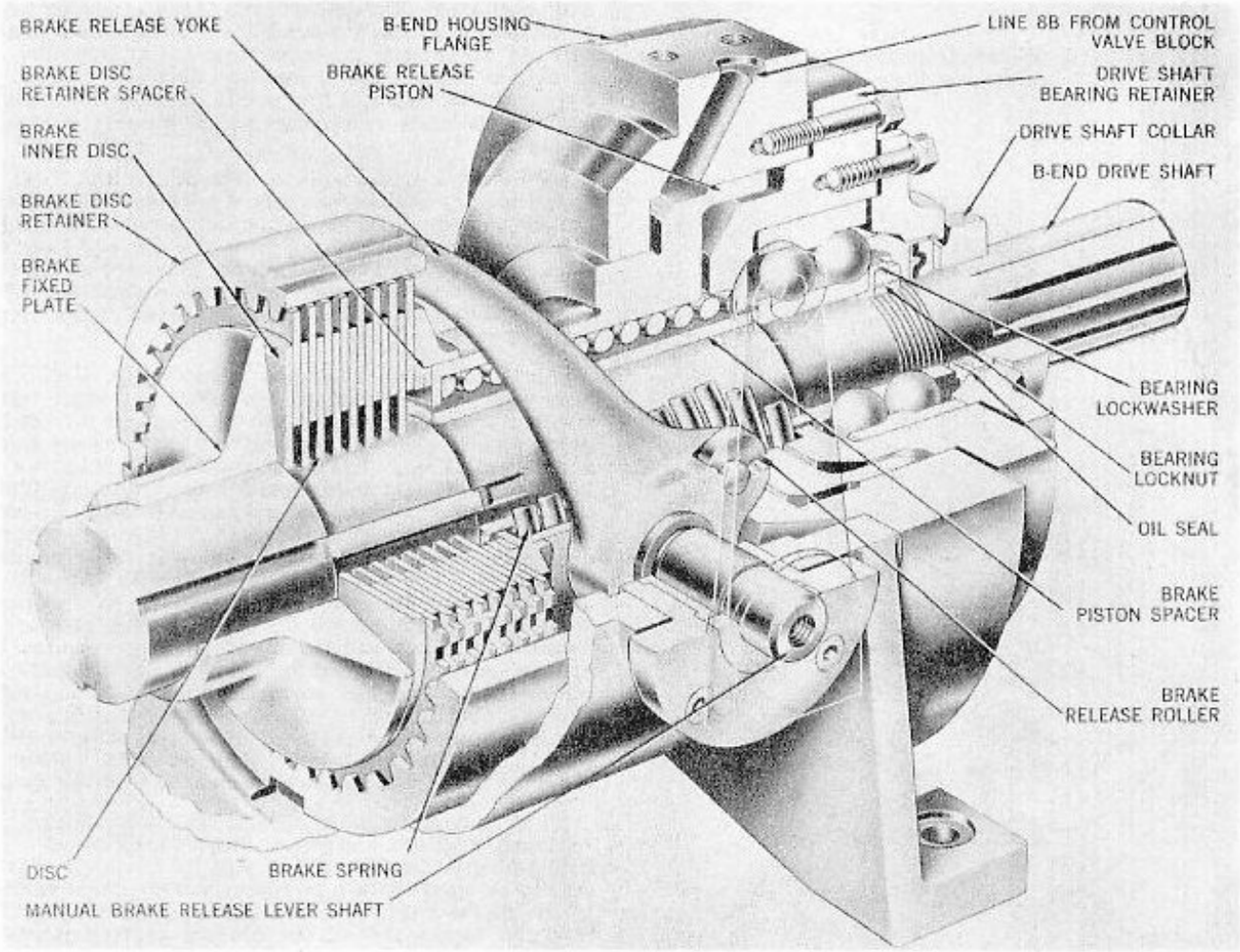


Figure 7-15. B-end Brake, Cutaway View

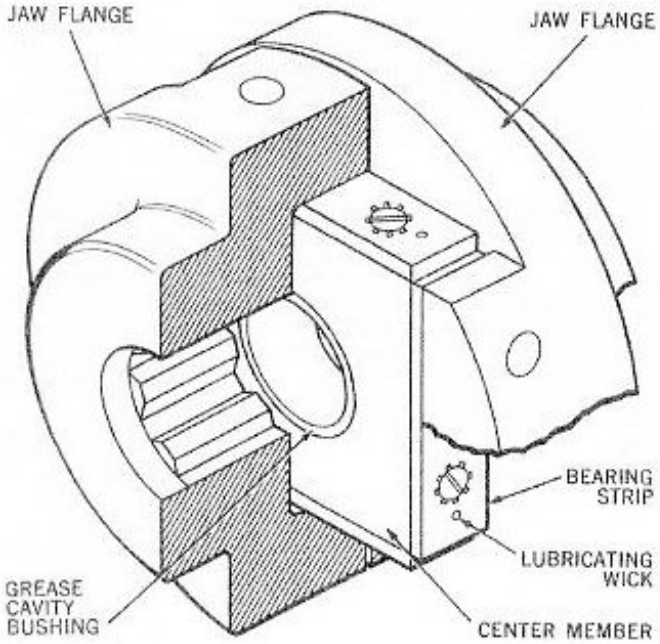
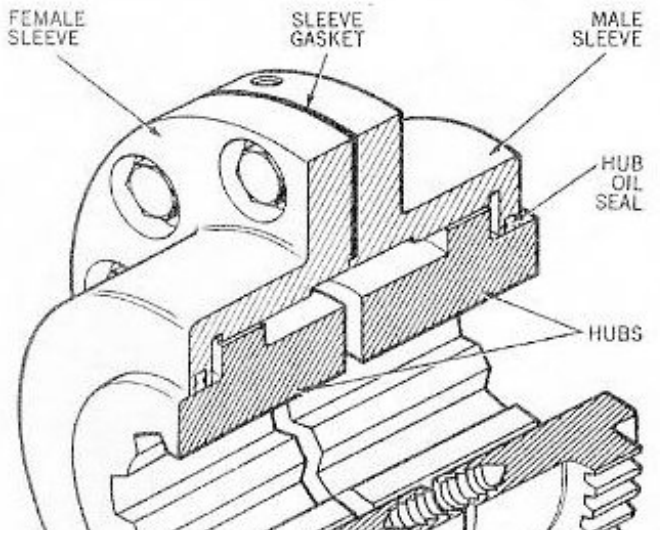


Figure 7-16. B-end Response Coupling, Cutaway View



Roller cage installations. The inner projectile stowage rings rotate on fixed roller cage installations. The cages are bolted in the projectile flat recesses and do not rotate with the carriage. Each carriage ring rotates on an inner and an outer roller cage assembly which supports inner and outer tracks of the carriage ring weldments. In addition to rollers for the tracks, the inner roller cage assemblies have equally spaced radial-thrust rollers. The inner and outer roller cage installations are each made up of 18 equal segments which are fitted together, end to end, to form two complete, concentric circles.

Roller cage. Each roller cage segment is a cast steel frame. The segments for the outer roller cage assembly are provided with pin bearings for four carriage supporting rollers. Each segment for the inner roller cage assembly is provided with pin bearings for four radial-thrust rollers in addition to the four carriage supporting rollers. The radial-thrust rollers confine the thrust movement of the rotating ring and accurately maintain uniform engagement between the pinion and rack. Each radial-thrust roller is mounted on an eccentric bolt so that all radial-thrust rollers of the inner roller cage assembly can be adjusted to center the carriage ring. In addition, this feature ensures the desired pitch-line contact between the pinion and rack.

Doubler plates. The doubler plates are flat inner and outer rings that are secured in the recesses beneath the roller cage assemblies. The doubler plates provide true planes for supporting and aligning the circles of roller cage segments. Each outer roller cage segment bears at five points on the doubler plates, while each inner roller cage segment bears at nine points.

Pinion drive mechanism. The pinion (fig. 7-4) is mounted on the output shaft of a housed mechanism called the gear reducer. This unit is mounted within the machinery space of the projectile flat and is positioned for correct engagement of the pinion with the rack. The unit is coupled to the drive shaft of the B-end assembly. Both the upper and lower pinion drive units of the turret are alike.

Gear reducer. Each gear reducer (fig. 7-4) is a heavy-duty worm, wormwheel, and pinion shaft drive assembly. It is arranged with the pinion at the bottom, below an oil reservoir housing that encloses the worm and driven wheel. The worm and wormwheel are a lap-fitted set, match-marked for correct mesh. These two components are not interchangeable with like parts of other ring drive gear reducers. The gear reducer design is a non-overhauling, double-thread, Hindley-type worm. The wormwheel is made with 72 teeth and has a pitch diameter of 31.5 inches. The worm has a pitch diameter of 5.0 inches. Both shafts are mounted in thrust-radial roller bearing groups that are non-adjustably fitted for correct alignment at

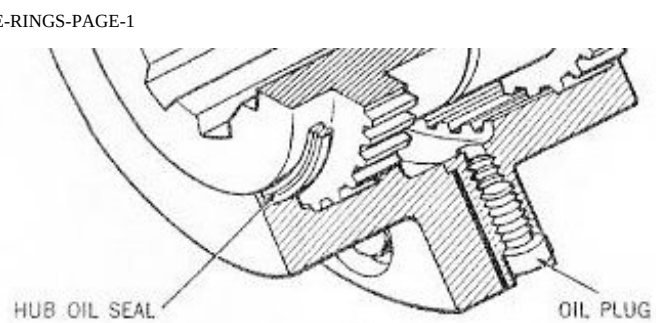


Figure 7-17. B-end Drive Coupling, Cutaway View

initial assembly. The wormwheel is keyed onto and drives a shaft together with a spur gear that is also keyed onto the same shaft. This spur gear is made with 13 teeth and has a pitch diameter of 10.4 inches. It drives the pinion gear which meshes with the rack.

The housing includes special details for filling, draining, venting, and gaging lubricant level. A filling plug is located at the top of the housing, adjacent to an open elbow pipe fitting that provides ventilation for the house mechanism and lubricant. Two trycocks in the side of the housing provide minimum and maximum oil level inspection points. Twelve gallons of a special high pressure lubricant designated Navy Symbol 5190, are required to fill to the upper trycock.

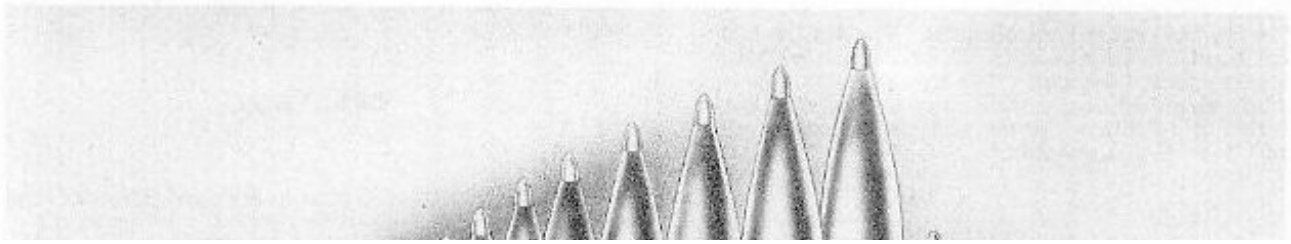
Drive coupling. The worm shaft of the gear reducer is coupled to the B-end shaft of the hydraulic power drive by a self-aligning flexible coupling of commercial design. This coupling is one of four special coupling devices included in the power drive. The coupling is shown in figure 7-17, and is described on page 7-14 of this chapter.

Projectile ring controls and interlocks

The projectile ring operating controls and interlocks include starting and stopping controls, a central interlock switch, manual control mechanism, timing and control mechanism, a manual brake release lever, and a projectile ring ready indicator. These control devices and their functions are described in following paragraphs.

Start-stop control. The master start-stop switch for the projectile ring controller of each of the upper and lower projectile flats is a conventional pushbutton type. The switch is of enclosed, watertight design with two buttons that are designated START-EMERG and STOP. The switch is similarly located on the center projectile hoist tube of each projectile flat. Each switch is normally open and is closed by pressing the START-EMERG button. The switch is opened by pressing the STOP button. The master start-stop switches described above are arranged in the controller starting circuit with another switch contact that must be closed to complete the circuit when the START-EMERG button is pressed. This switch contact is the neutral interlock switch which is closed when the A-end is at neutral stroke.

Pressing the START-EMERG button closes a normally open three-pole switch and energizes the coil of the main contactor. By the action just described, the three-phase power is connected to the main electric motor. Holding contacts on the relays maintain the power circuit connections when the START-EMERG button is released, and until the STOP button is pressed.



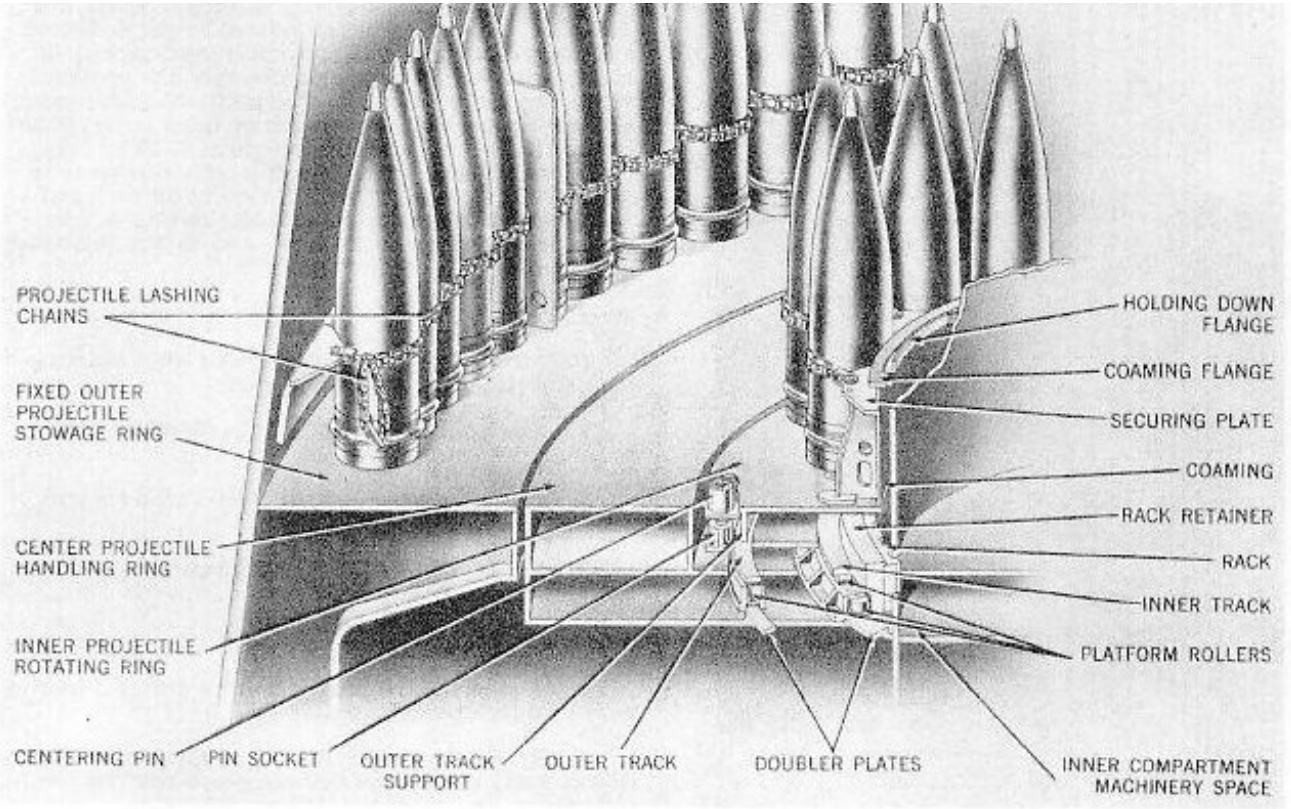


Figure 7-18. Projectile Stowage Ring, Sectional View

Stop pushbutton switches. Two emergency stop switches are provided for each projectile ring controller. These switches are of enclosed, watertight design with one pushbutton. The switches are similarly located on each projectile flat, one switch on each side of the projectile handling platforms, two switches on each projectile flat. The switches are the normally closed type and are opened by pressing the button designated STOP.

Neutral interlock switch. The neutral interlock switch is an electric switch that is used in the motor starting circuit. It functions to prevent starting overload on the electric motor when the drive is at mid-cycle position, with the pump yoke offset from neutral.

Brake release lever. The B-end mechanical brake is a friction disc type that is spring-applied and is normally released by hydraulic pressure. A piston-enclosed spring exerts sufficient pressure on the discs to engage them, and thus prevent the B-end output shaft from turning when the projectile ring drive is not operating. The brake is held in its applied position by the brake spring except when the ring is rotating, or when it is released by the manual brake release lever. The manual brake release lever is located on the side of the B-end, forward of the adjacent A-end assembly. The brake release lever is rotated through an arc of 36 degrees from an applied to a release position.

Projectile ring ready indicator. The upper and

Manual control mechanism. The manual control mechanism of the projectile ring drives of the upper and lower projectile flats is an arrangement of shafts, miter gears, and a hand control lever. The hand control lever is for manually actuating projectile ring control movement. The manual control mechanism extends from the A-end assembly in the inner compartment to the outside of the projectile flat circular subdivision bulkhead. The mechanism is described on page 7-10 of this chapter, and is shown in figure 7-19.

Timing and control mechanism. The timing and control mechanisms are semi-automatic projectile ring cycle control devices. The mechanisms control starting speed and operate to stop ring rotation at the end of a cycle. The mechanism is described on page 7-9 of this chapter.

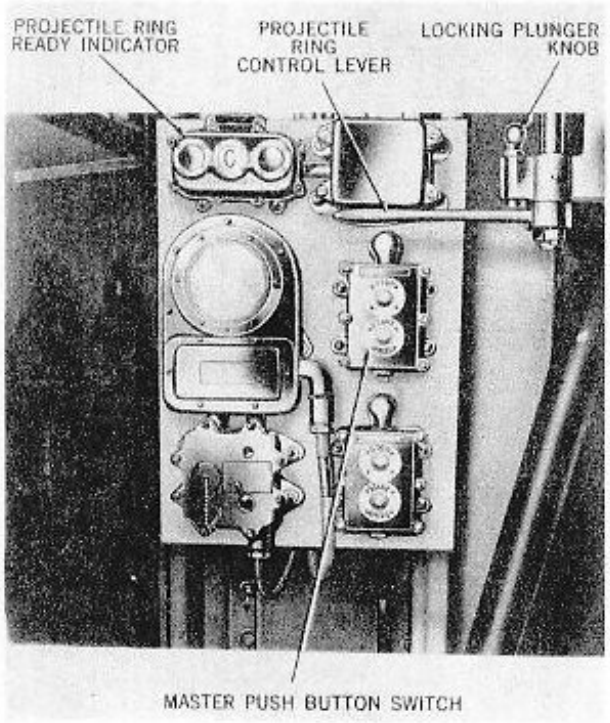


Figure 7-19. Projectile Ring Manual Control Mechanism

lower projectile handling flats are each equipped with an independent ready light circuit. The ready light circuit functions to notify the projectile ring operator as to when the rotating ring may be moved. Each ready light circuit is composed of three contact makers (one is located at each projectile hoist operator's station) and a three-dial indicator light (located at the projectile ring operator's station). The dial designations of the indicator light at L, C, and R, for the left, center, and right projectile hoists, respectively. Each circuit contact maker closes only the circuit to its respective dial on the indicator.

OPERATION

General

With both centering pins in a raised position, the projectile ring is free to be rotated in either direction. The control of starting, stopping, speed and direction of rotation is determined by the direction and degree of handlever movement, except when a ring station is reached, at which time the projectile ring stops automatically. The position of the control and timing mechanisms, resulting from initial offset of the handlever, is shown in figures 7-20 to 7-24, inclusive. These schematic diagrams illustrate in sequence the phases of circuit flow conditions and resultant movement of components during a complete operating cycle as described in the following paragraphs.

Starting

Perform the following operations when starting the projectile ring electric motor:

1. Place the controller circuit-breaker lever at ON.

2. Place the hand control lever at the neutral stroke position.

3. Press the START-EMERG button.

Stopping

When stopping the projectile ring drive, perform the following operations.

1. Rotate the projectile ring to the desired position of rest, so that the centering pins may be run in.

2. Place the hand control lever at the neutral stroke position.

3. Press the STOP button.

CHAPTER 7 PROJECTILE RINGS PAGE 2

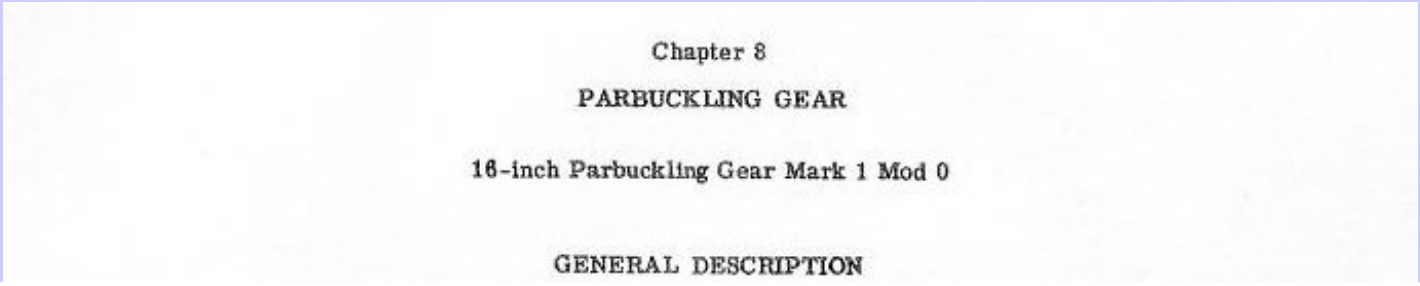
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CHAPTER 8 PARBUCKLING GEAR



Chapter 8

PARBUCKLING GEAR

16-inch Parbuckling Gear Mark 1 Mod 0

GENERAL DESCRIPTION

The upper and lower projectile flats, described in chapter 7, are equipped with identical parbuckling gear installations. The arrangement of the parbuckling gear installations, shown in figure 8-1, is the same in all turrets of the IOWA class battleship. All parbuckling gear installations are designated 16-inch Parbuckling Gear Mk 1 Mod 0.

Purpose

The parbuckling equipment fulfills two purposes: to transfer projectiles from the outer ring to the inner ring and then to the three projectile hoists during gun operation; and to transfer projectiles from the projectile flat strike-down hatches to the stowage rings when the projectile supply is replenished.

Type

The parbuckling gear is a constant-speed, electric motor-driven, multiple capstan mechanism. It is a mechanical assembly that provides positive-type drive of six capstans from a single electric motor. The capstans, designated gypsy heads, are arranged with manual snubbing ropes, rope hooks, and snatch blocks. The snubbing ropes are used to parbuckle projectiles with the aid of the rope hooks and snatch blocks.

Components

Each parbuckling gear assembly comprises the following components:

Electric motor
Electric controller
Controller start-stop circuit
Mechanical assembly
Gypsy heads (six)

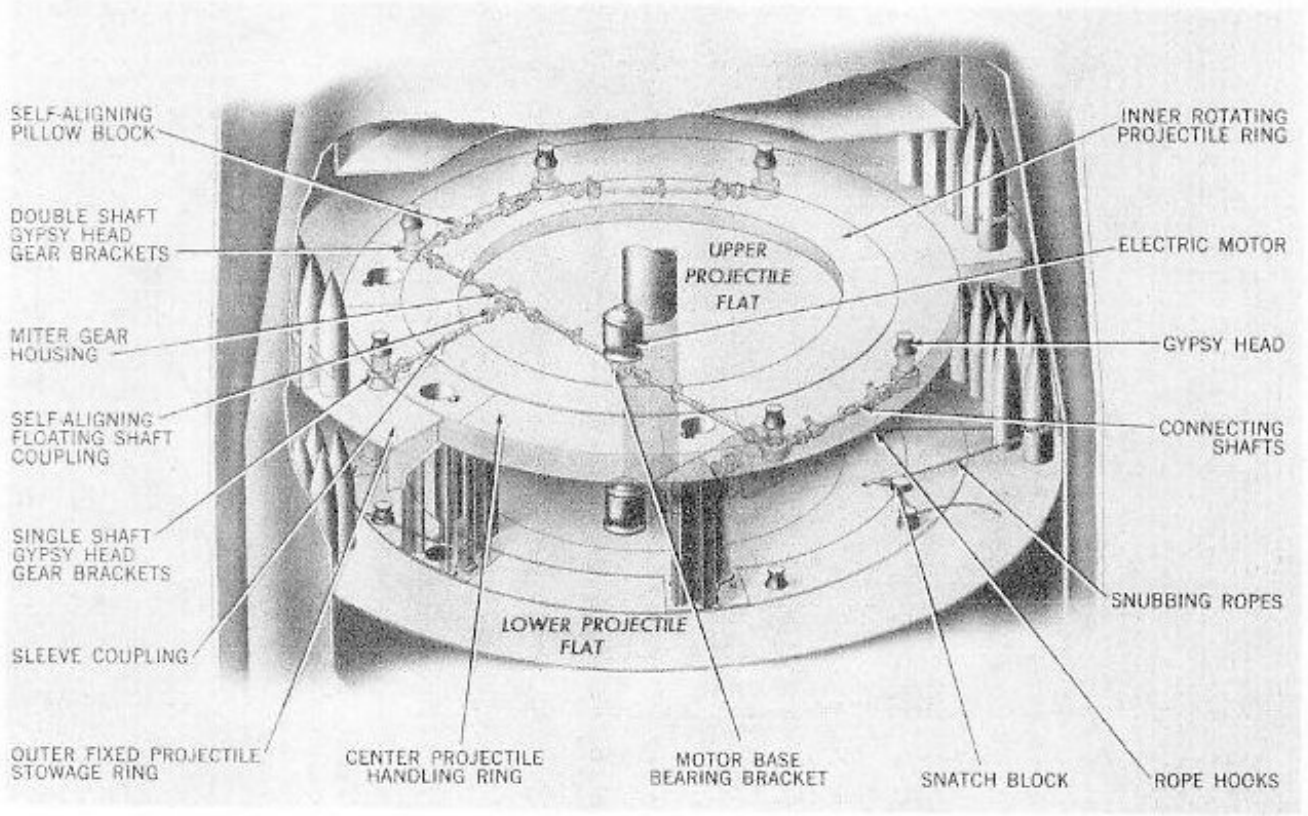


Figure 8-1. 16-inch Parbuckling Gear Mk 1 Mod 0. Upper and Lower Projectile Flats, General Arrangement

Locations

Component locations are the same for both projectile flats. The electric motor (fig. 8-1) is mounted on the floor of the machinery space of each projectile flat, adjacent to the right powder hoist trunk. The electric controller is mounted on the right powder hoist trunk above the motor. A master push-button station (start-stop control) is located at the center projectile hoist operator's station on each projectile flat. The mechanical assembly, consisting of housing-enclosed miter and bevel gears and connecting shafting, is attached to the underside of the projectile flat floor. The six gypsy heads are flange-mounted in the center ring of the projectile flat. On each flat, an emergency stop switch is located at the left and right projectile hoist operator's stations; a third emergency stop switch is located in the machinery space adjacent to the electric controller.

Mounting arrangements

The mounting arrangements of the parbuckling gear assemblies shown in figure 8-2 are the same for each projectile flat. The electric motor and the gypsy heads are mounted at floor level with their axes vertical. The mechanical assembly is bolted to the underside of the floor of the machinery space and center ring. Shafts connecting the units of the mechanical assembly are attached with floating, self-aligning couplings.

Design features

The important design features of the parbuckling gear, described in following paragraphs, are:

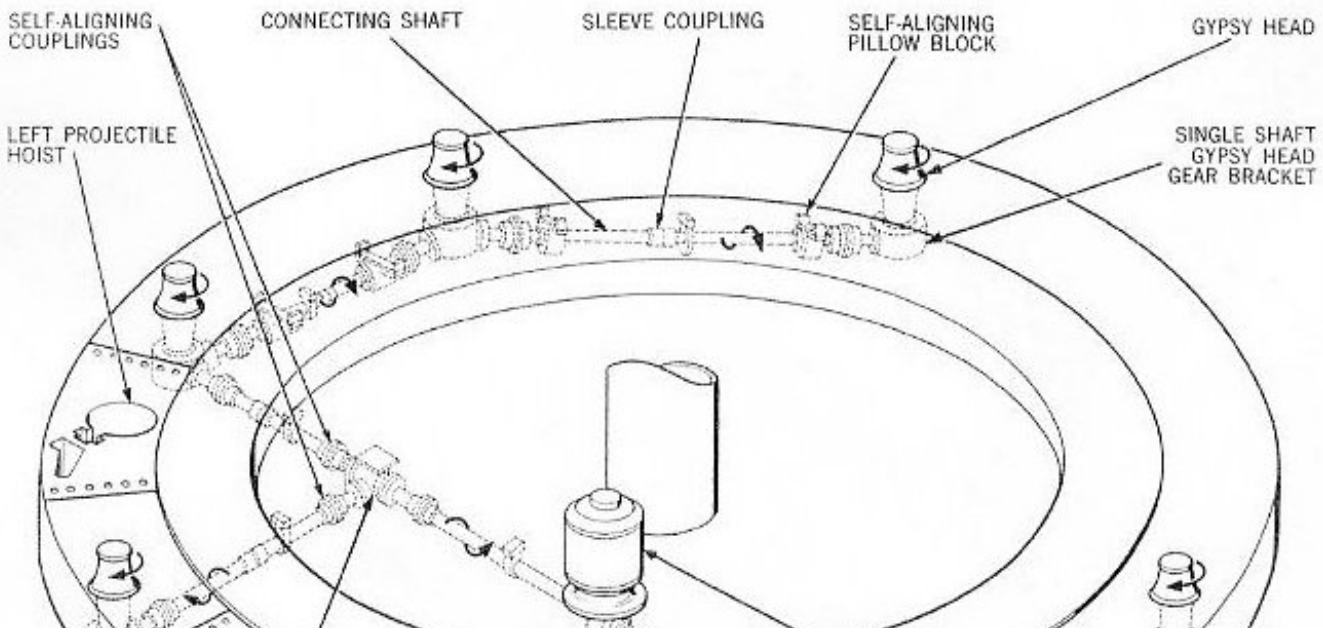
The multiple gypsy head arrangement which is driven by a single electric motor at a constant speed.

The positive-type drive of the gypsy heads through gear boxes and connecting drive shafts.

The adjustable slip clutch in each gypsy head.

Arrangement of drive shaft system

The drive shaft system (fig. 8-2) extends right and left from the motor base bearing bracket of the drive motor. Two gypsy heads are driven by the right-hand drive shaft through double shaft and single shaft gypsy head gear brackets. The left-hand drive shaft drives four gypsy heads through a miter gear unit provided with two output shafts. One shaft drives a single shaft gypsy head gear bracket, the other shaft drives two double shaft and a single shaft gypsy head gear bracket. Access to the system for maintenance is from the deck level immediately below the system.



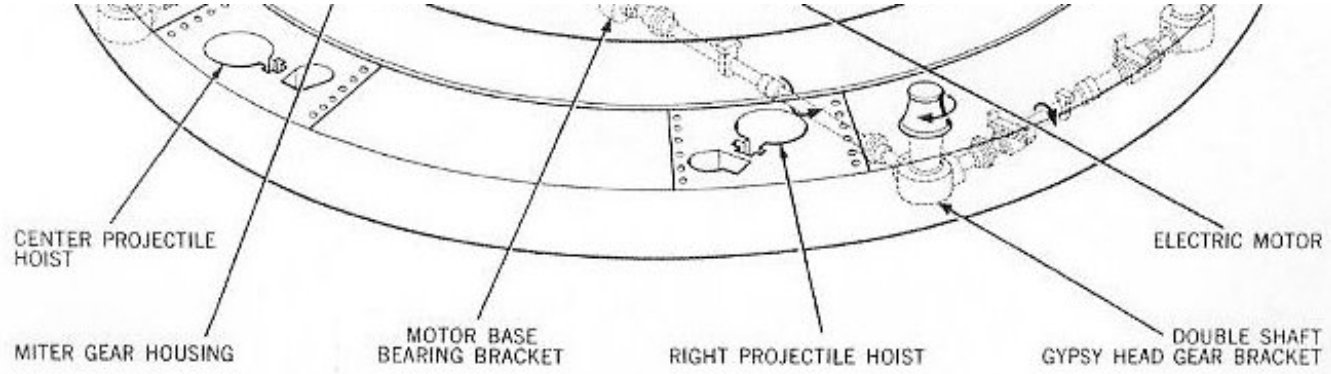


Figure 8-2. 16-inch Parbuckling Gear Mk 1 Mod 0, Schematic Arrangement

Number of gypsy heads

A gypsy head is adjacent to each projectile hoist loading aperture. This arrangement permits simultaneous transfer of projectiles from the inner ring to the three hoists. The remaining three gypsy heads are located at the forward part of the projectile flat and they provide parbuckling facilities for the transfer of projectiles from the outer, fixed stowage spaces to the inner ring. Any of the gypsy heads may be utilized to replenish the inner ring from the fixed stowage space.

Slip clutch

Each gypsy head assembly (fig. 8-8) is provided with an adjustable slip clutch, which permits the drive shaft to rotate independently of the gypsy head when an overload occurs. The slip clutch limits rope snubbing to the force permitted by the adjustment of the clutch.

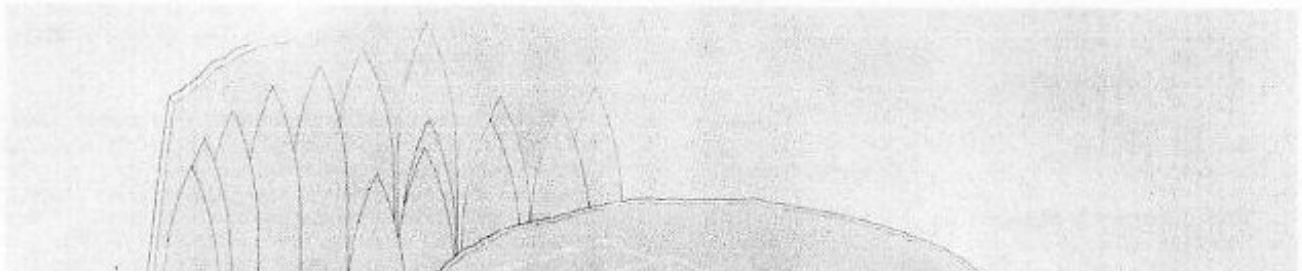
Data

All gypsy heads rotate in a clockwise direction (looking down) at a speed of approximately 90 revolutions per minute. Each gypsy head clutch is adjusted for parbuckling an armor piercing projectile (2700 pounds) against 15 degrees roll of the ship.

DETAIL DESCRIPTION

Power drive

Electric motor. The electric motor used in the power drive is an induction type of commercial manufacture and is identical for each assembly. Each motor is vertically flange-mounted on a motor base bearing bracket in the machinery space of the projectile flats, as shown in figure 8-3.



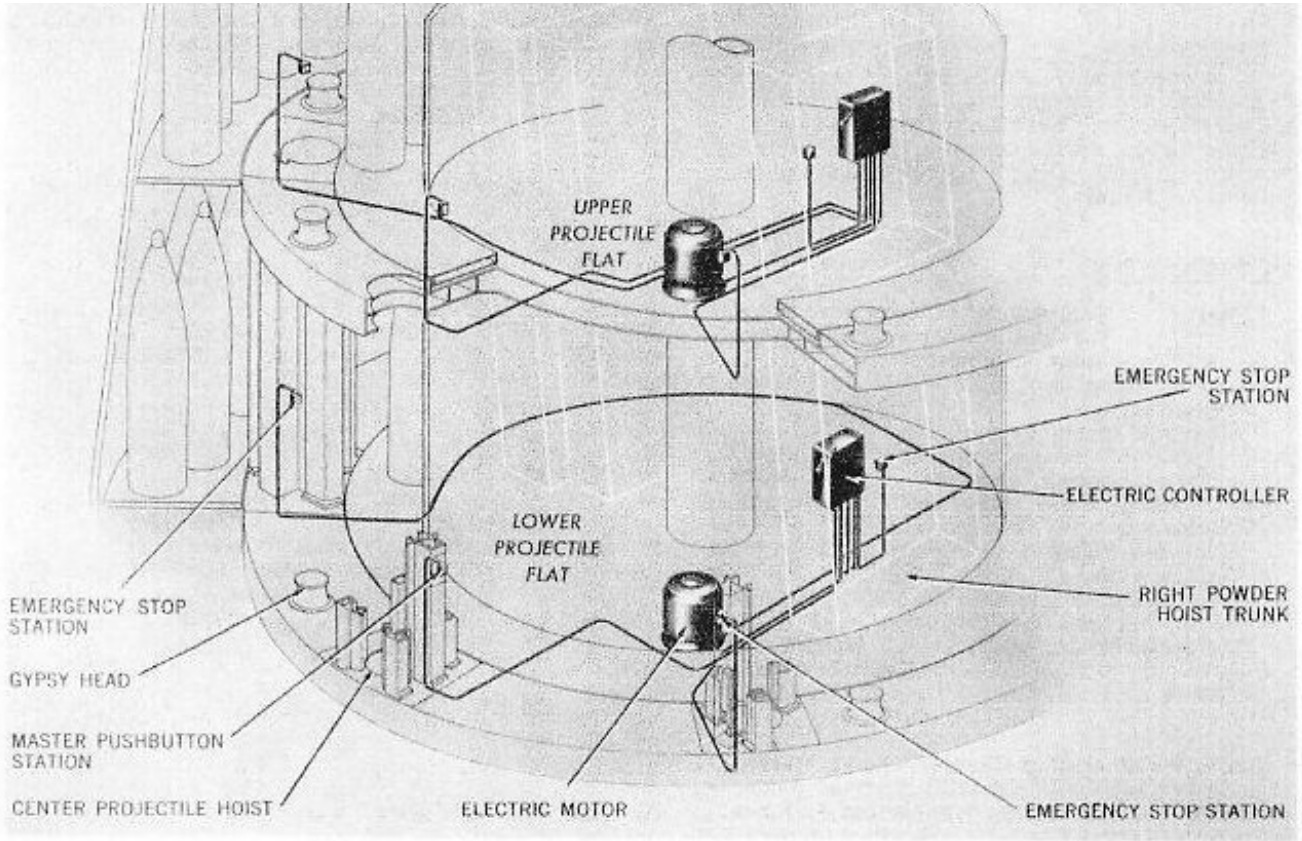


Figure 8-3. Parbuckling Gear Electric Installations, General Arrangement

8-3

The motor base bearing bracket (fig. 8-4) includes a circular cover plate beneath the motor which protects the motor from the splash of gear lubricant in the bracket housing. Other design features and specification data are listed below.

Motor data

Type	squirrel cage, induction
Design features . .	vertical mount, waterproof, fan cooling
Horsepower, ...	7.

composed of the following components: a motor base bearing bracket; a miter gear housing; single and double shaft gypsy head gear brackets; and connecting shafts and shaft couplings. The design features and arrangements of the mechanical assembly are indicated in the following paragraphs.

Arrangements. The components of the mechanical assembly (fig. 8-2) are mounted on the underside of the projectile flat floor beneath the machinery space and center ring. The motor base bearing bracket, mounted directly beneath the electric motor, has two output shafts. One output shaft is connected to a

Continuous	7.5
Intermittent	15
Revolutions per minute	
Synchronous	1200
Revolutions per minute,	
Full load	1155
Rotation (viewed from above)	counterclockwise
Speed class	constant
Voltage	440
Amperes, full load	19.9
Amperes, locked rotor	120.0
Phases	3
Cycles	60
Ambient temperature,	
Deg C	40
Torque class	normal
Weight, pounds	650
Manufacturer	Electro-Dynamic Works
Manufacturer's designation	AV-365-KNX
Drawing	231767

Electric controller. The electric controller (fig. 8-3) in each assembly is identical. It is of commercial manufacture, designed to control and protect the electric motor. Each controller has special starting-stopping switch controls, described in following paragraphs. Design and specification data are tabulated below.

Controller data

Type	semiautomatic, magnetic across-the-line starter controlled by remote push button
Ampere rating, full load	19.9
Protection:	
Overload thermal type:	
Adjustable range, amperes	23.6 to 28.3
Normal setting, amperes	25.0
Short circuit fuses, amperes	80.0
Undervoltage:	
Drop-out voltage	110
Sealing voltage	374
Shock rating	150
Weight, pounds	110
Manufacturer	Ward Leonard Electric Company
Drawing	231774

Controller start-stop circuit. The start-stop circuit is arranged with a master start-stop push-button switch and three stop push-button switches. The start-stop circuit is fully described on page 8-6.

Mechanical assembly. The arrangement of the parbuckling gear mechanical assembly is shown in figures 8-1 and 8-2. The mechanical assembly is double shaft gypsy head gear bracket, the output shaft of which is connected to a single shaft gypsy head gear bracket. The other output shaft is connected to the miter gear housing, which has two output shafts. One output shaft of the miter gear housing is connected to a single shaft gypsy head gear bracket. The second output shaft is connected to a double shaft gypsy head gear bracket, the output shaft of which is connected to a second double shaft gypsy head gear bracket. The output shaft of the second double shaft gypsy head gear bracket is connected to a single shaft gypsy head gear bracket. The housing-enclosed miter and bevel gear units are connected by self-aligning, flexible couplings.

Motor base bearing bracket. The motor base bearing bracket (fig. 8-4) is a housing-enclosed arrangement of oil-bath-lubricated bevel gears. Mounted on the underside of the machinery space floor, this unit provides a mounting base and power transmission for the electric motor (fig. 8-1). The gearing consists of a bevel spur gear that is spline-fitted on a ball-bearing-supported stub shaft. This output shaft is splined at each end. The bevel spur gear is

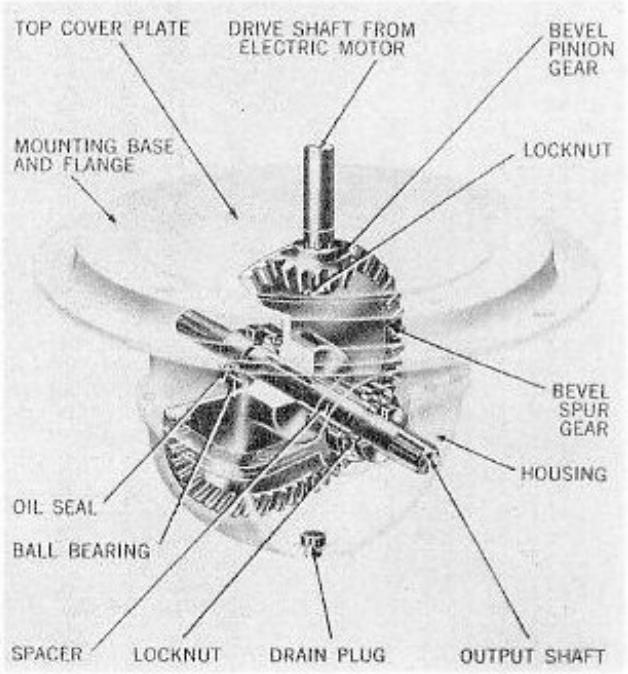


Figure 8-4. Motor Base Bearing Bracket, Sectional View

driven by a bevel pinion gear which is spline-fitted on the rotor shaft of the electric motor. Both gears are held in position on the shafts by locknuts. Oil seals, seated in retainers on each end of the output shaft, seal the lubricant within the housing. A cover-plate at the top of the bearing bracket protects the electric motor from oil splash. A plug at the bottom of the housing provides for oil drain. Fill plugs are located at the proper immersion level for the gearing.

Miter gear housing. The miter gear housing (fig. 8-5) is a housing-enclosed arrangement of oil-bath-lubricated miter gears. The housing is mounted on the underside of the machinery space floor adjacent to the center powder hoist trunk. The unit transmits power from the electric motor, through two output shafts, to four gypsy heads as shown in figure 8-2. The two output stub shafts and the input stub shaft are each ball-bearing-supported and are spline-fitted with identical miter gears, held in position on the shafts by locknuts. Oil seals, seated in retainers on each shaft, seal the lubricant within the housing. A cover plate at the bottom of the housing and the oil seal retainers provide access for maintenance. The immersion level of the gearing is limited by an oil plug hole in the housing which also provides a means for replenishing oil.

Single shaft gypsy head gear bracket. The single shaft gypsy head gear bracket (fig. 8-8) is a housing-enclosed arrangement of oil-bath-lubricated bevel gears. The three assemblies of this type are mounted on the underside of the center ring directly below their gypsy head as shown in figure 8-2. Power from the electric motor is transmitted to the gypsy heads through the single shaft gypsy head gear brackets. The input stub shafts and the drive shafts are each ball-bearing-supported and are spline-fitted with bevel gears, held in position on the shafts by locknuts. Oil seals, seated in retainers on the stub shafts seal the lubricant within the housing. A cover plate at the bottom of the housing together with the oil seal retainers provides access for maintenance. A normally plugged hole (not shown in figure 8-8) limits the immersion level of the gearing and provides a means for replenishing and draining oil.

Double shaft gypsy head gear bracket. The double shaft gypsy head gear bracket (fig. 8-6) is a housing-enclosed arrangement of oil-bath lubricated bevel gears. The three assemblies of this type are mounted on the underside of the center ring directly below their gypsy heads as shown in figure 8-2. Power from the electric motor is transmitted through the double shaft gypsy head gear brackets to the gypsy heads mounted above them and to other gypsy head gear brackets through output stub shafts. The gypsy head gear brackets at the first two locations have output stub shafts that are offset approximately 85 degrees from the input shafts. At the third location the gypsy head gear bracket has an output shaft that is offset approximately 49 degrees from the input shaft. Details of the gear housing are similar to those of the single shaft gypsy head gear bracket housing except for the additional output stub shaft in each assembly.

Connecting shafts. The stub shafts of the motor base bearing bracket, miter, and gypsy head gear bracket assemblies are connected by seven splined shafts (fig. 8-2) which are joined to the stub shafts by self-aligning, spline-fitted, flexible couplings. The shaft-and-coupling assemblies are identical except for length. The shafts, made of 1.5-inch solid-bar steel are splined at each end and cut in two at a point approximately midway between the ends. The shaft ends are reunited at this point through a sleeve-type coupling, which facilitate assembly and disassembly of the shafts in the limited space between the gear boxes. Three of the shaft assemblies are supported at each end by a Fast-type, floating, self-aligning pillow block. The shaft assemblies, with the couplings described below, provide full connections.

Shaft couplings

Sleeve type. Sleeve type couplings (fig. 8-2) located in the middle of each shaft assembly, join the ends of the cut shafts. Fitted over the shaft ends, the sleeves are keyed to both ends to ensure positive rotation of the shaft assembly. The sleeves are held in their assembled positions by taper pins which pass through the shaft and the ends of the sleeve. There are seven couplings of this type.



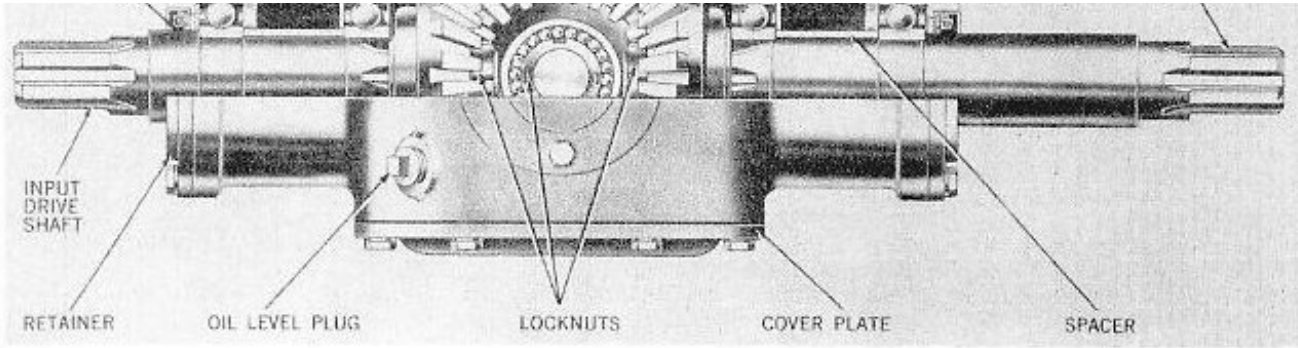


Figure 8-5. Miter Gear Housing, Sectional View

Self-aligning type. The fourteen couplings that connect the stub shafts of the gear box assemblies are floating, self-aligning, extended, fast-type couplings (fig. 8-7). Each coupling consists of a rigid half hub which connects to a flexible half sleeve. A flexible half hub has external teeth at the shaft end which mesh with the internal teeth of the flexible half sleeve. Both half hubs are spline fitted to their respective shafts. A slight clearance between the meshing teeth of sleeve and hub permits drive with small misalignment between the two shafts.

Gypsy heads. The design arrangement and mounting of the gypsy heads are shown in figure 8-8. Each gypsy head, a clutch-driven steel capstan drum, is approximately 11.0 inches in diameter at its widest part and 9.0 inches high. It is mounted on a bronze deck flange base and engaged to the gear bracket drive through a multiple-disc friction clutch. The drum is mounted on the gypsy head drive shaft upper ball bearing. An arrangement of alternately spaced steel and brass friction discs, keyed to the drive shaft and drum respectively, comprise the clutch enclosed within the gypsy head. Disc to disc pressure is maintained by a spring, adjusting nut, and a locknut mounted at the top of the gypsy head drive shaft. Adjustment settings are described on page 8-8 of this chapter. The clutch protects the power unit against overload and limits rope snubbing to the force permitted by the setting of the slip clutch.

Controls

Start-stop control. Each parbuckling gear electric motor is started and stopped through its electric contactor opens and remains open until the START-EMERG button is again pressed. An overload relay opens the circuit when current demand is too great. The electric motor is stopped by pressing the master STOP button or a STOP button at one of the stations described below.

Stop push-button stations. Three stop push-button stations are located at the left and right projectile hoists and in the projectile flat machinery space adjacent to the controller cabinet (fig. 8-3). Each station has a single button switch labeled STOP. Pressing the button opens a three-pole switch and de-energizes the coil of the main contactor to stop the electric motor. The electric motor can be started again only by pressing the START-EMERG button at the master control push-button station.

OPERATION

General

Parbuckling is the operation of transferring projectiles when the projectile rings are being loaded or unloaded or when the guns are being served. For ring loading, transfer is made from the projectile flat strike-down hatches to the stowage rings. For gun serving, transfer is made from rings to hoists. Before parbuckling, the electric power drive is started by pressing the START-EMERG push button.

Parbuckling

Transfer of projectiles is performed by looping

controller (described on page 8-4). The controller is remotely operated from four push button stations, as described below.

Master control push-button station. The master control push-button station is located at the center projectile hoist (fig. 8-3). It comprises a two-button switch with START-EMERG and STOP pushbuttons. Pressing the START-EMERG button closes a normally-open, three-pole switch and energizes the coil of the main contactor to connect power to the electric motor. Holding contacts on the relays keep the power circuit closed when START-EMERG button is released. In the event of a power failure, the main

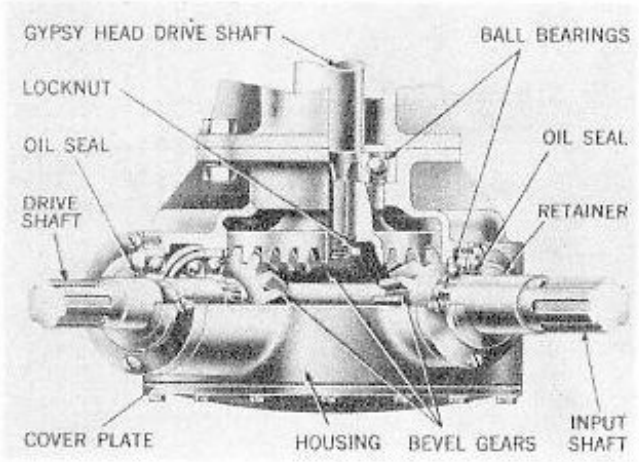


Figure 8-6. Double Shaft Gypsy Head Gear Bracket, Sectional View

Transfer of projectiles is performed by looping one end of the fixed snubbing rope around a projectile below its rotating band and by snubbing the other end around a gypsy head. Two snubbing loops and hand

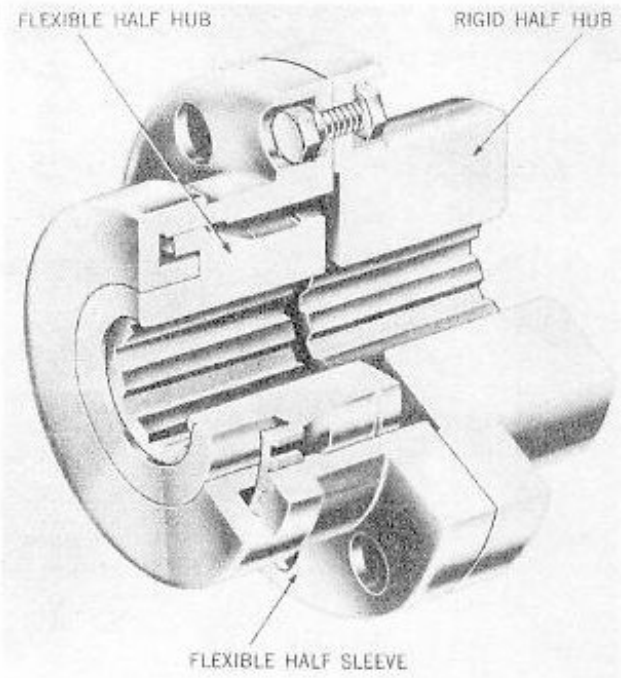


Figure 8-7. Drive Shaft Coupling, Cutaway View

pull on the free rope end provide sufficient snubbing action to slide the projectile into or out of the hoist. The operating technique for transfer of projectiles from fixed stowage to the rotating ring is similar. Hand guidance of the projectile is required.

Projectile ring movement

As the supply of projectiles on the rotating ring adjacent to the hoists is depleted, rotation of the projectile ring is required. Description of this operation is given in chapter 7.

directions of the following paragraphs. Maintenance includes adjustment, lubrication, service check, and periodic operation necessary to keep equipment in good condition.

Operating precautions

Observe the following precautions when preparing for parbuckling and when operating the equipment to serve the projectile hoists or to stow projectiles:

1. Transfer projectiles from the rotating ring to the hoist when loading the hoists, and from the

INSTRUCTIONS

General instructions

Each parbuckling gear assembly is to be operated and maintained in accordance with the regulations of the Bureau of Ordnance Manual and the specific

hoist to the rotating ring when unloading. Projectiles are never to be parbuckled directly from the outer ring to the hoist except in an emergency, such as failure of the projectile ring drive.

2. Turn the snubbing rope twice around the gypsy head for normal parbuckling. Never use more than three turns.

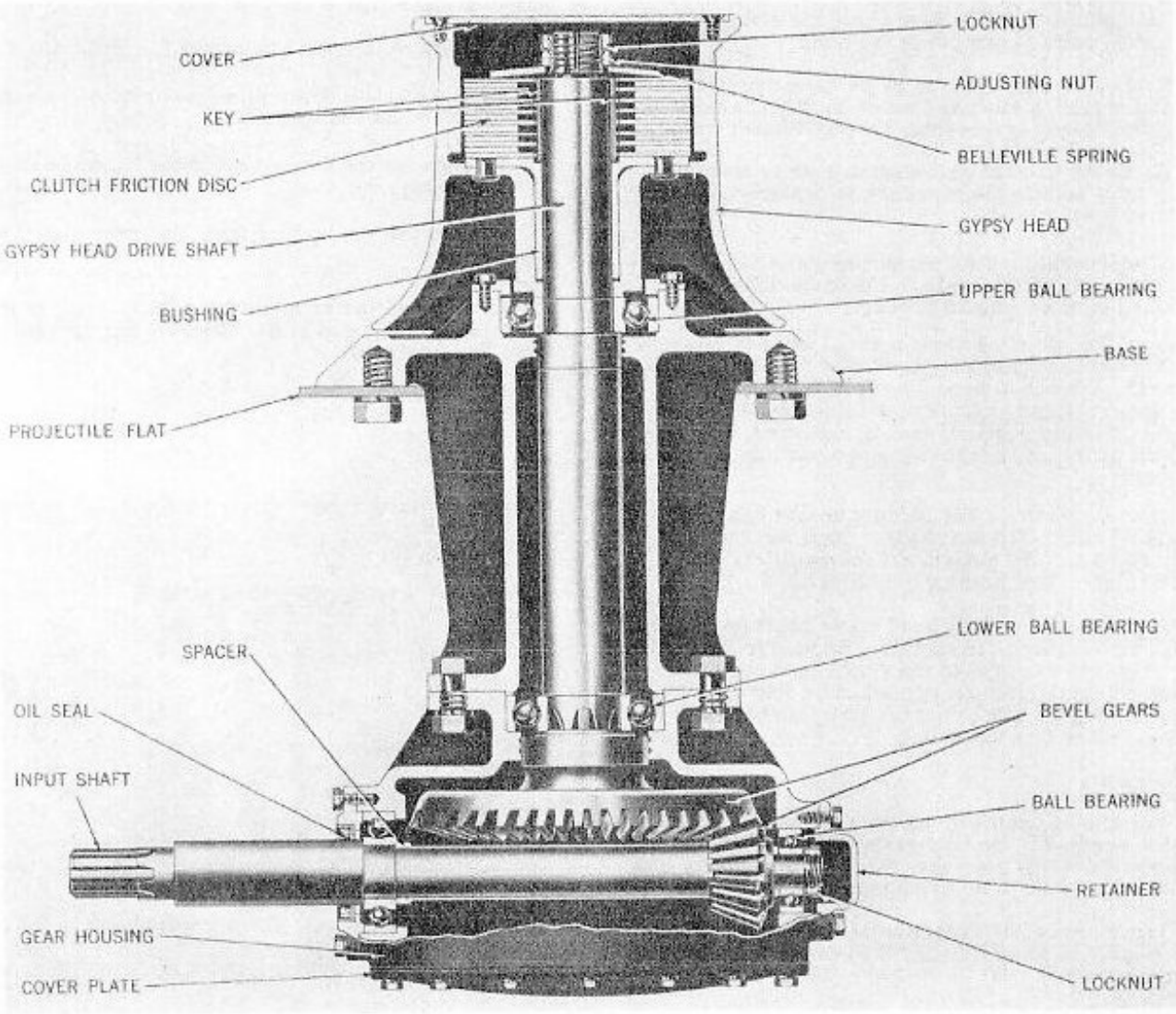


Figure 8-8. Gypsy Head Arrangement With Single Shaft Gypsy Head Gear Bracket, Cutaway View

3. Tighten the snubbing rope slowly on the gypsy head to "ease" the projectile into motion. Never start the snubbing action with a jerky, sudden movement.

4. Replenish the rotating ring as it is depleted by parbuckling from fixed stowage to the ring. Projectiles must be secured when in position.

5. Loop the snubbing rope under the copper rotating band, never above it.

6. Load the projectile hoists from the upper flat first. This is not compulsory, but is preferable.

7. Before parbuckling, make sure that the projectile hoist shutters swing freely.

8. Make certain that the loading door in the hoist is lowered before parbuckling on the upper flat. Before parbuckling on the lower flat, make certain that the hoist loading door on the upper flat is raised and secured.

9. Latch the projectile hoist shutters open before unloading a hoist. Never hold the shutters by hand when parbuckling out of the hoist.

10. Before parbuckling, make sure that each hoist operator is alert and ready to stop the hoist in an emergency by pressing the STOP push button.

11. Never use the parbuckling gear to snub auxiliary whip hoists; the assembly is designed for parbuckling only.

All parbuckling gear components are to be lubricated at the time intervals and with the lubricants specified on the lubrication chart.

Gear box units. Frequent check of gear boxes is necessary because of the possibility of lubricant loss. However, the actual need for replenishment should be infrequent. When frequent replenishment is required, a worn or faulty shaft oil seal is indicated. Replace such oil seals; do not attempt to correct the defect by shimming.

Electric motor. The electric motor bearings should be lubricated sparingly. Open the bearing drain tubes and the cage drain before filling the grease cups. Use bearing grease 0S1350.

Gypsy heads. Gypsy head upper shaft bearings should be repacked bi-monthly. Access to the bearings requires removal of the gypsy head cover, the spring locknuts, and the gypsy head. Use bearing

2. Place the spring in position over the top disc and turn down the adjusting nut until the spring makes contact with the top disc.

3. Turn the adjusting nut an additional three-fourths turn for final adjustment with a new spring. Re-use of the old spring may require additional compression.

DISASSEMBLY AND ASSEMBLY

General

Instructions for disassembly of components of the parbuckling gear are contained in the following paragraphs. Assembly is the reverse of disassembly. When disassembling the gear box units, mark spacer sleeves, shafts, bearings, and pinions for reassembly in their respective housings. Oil seals are properly reassembled with the taper inward.

Disassembly of gear box units

1. Disconnect the flexible couplings of the drive shafts at the sides of the gear box.

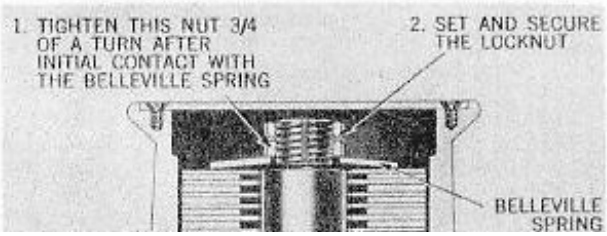
2. Remove the gear box from the projectile flat.

3. Remove the drain plug from side of housing and drain the lubricating oil.

4. Remove the cover and gasket from the bottom of the housing.

5. Remove the locknut from the inner end of the input shaft.

6. Remove the retainer from the housing at the outer end of the input shaft. Remove the oil seal from the retainer.



grease OS1350. The gypsy head slip clutch must be adjusted after this operation.

Adjustments

With the exception of the gypsy head clutch adjustment described in the next paragraph, all assemblies of the parbuckling gear have fixed arrangements and do not require refitting or adjustment.

Gypsy head clutch adjustment. The gypsy head clutch must be adjusted (fig. 8-9) for proper tension after lubrication.

To adjust the gypsy head clutch:

1. Reset and clean all friction discs at each lubrication. Dry discs thoroughly before reassembling.

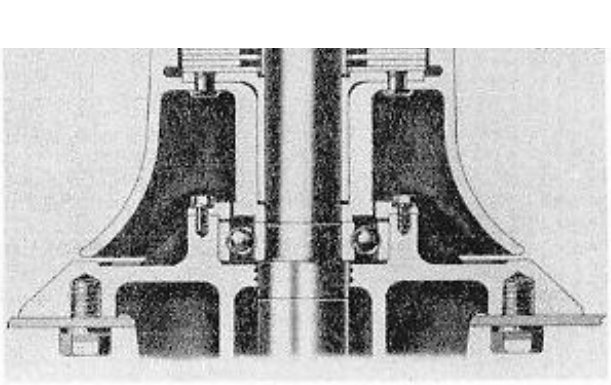


Figure 8-9. Gypsy Head Clutch Adjustment

7. Remove the locknut from the outer end of the input shaft.

8. Remove the input shaft from the housing and lift out the bevel (or miter) gear as the shaft is removed.

9. Slide the outer bearing from the input shaft.

10. Remove the output shaft by disassembling as described in operations 5, 6, 7, 8, and 9.

11. Remove bearings from the housing.

Disassembly of connecting shafts

1. Knock the taper pins out of the sleeve coupling.

2. Slide the sleeve coupling along the shaft until the shaft end is clear.

3. Remove the key from its doweled position in the shaft keyway.

4. Remove the shaft from the flexible coupling connection.

5. Open and separate the flexible coupling, if the shaft splines are seized, before attempting to force the shaft out of the coupling.

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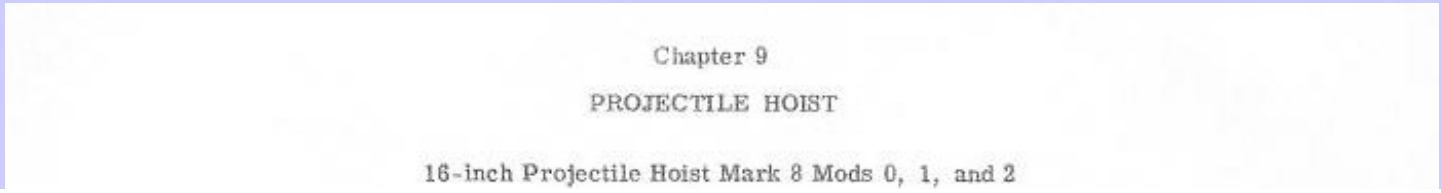
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CHAPTER 9 PROJECTILE HOIST

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Chapter 9

PROJECTILE HOIST

16-inch Projectile Hoist Mark 8 Mods 0, 1, and 2

GENERAL DESCRIPTION

The projectile hoist installation in each turret comprises an independent hoist assembly to serve each gun. The assemblies are virtually identical right, center, and left designs that are designated 16-inch Projectile Hoist Mk 8 Mods 0, 1, and 2, respectively. A right hoist arrangement is shown in figure 9-1.

Type

Hoists are hydraulic ram type assemblies. Each hoist assembly is a reversible, hydraulic power-driven, rack and pawl tubular lift, equipped with an independently controlled power-driven cradle assembly.

Purpose

The hoists supply projectiles to the cradle assemblies which deliver projectiles to the guns. When lowered (spanned), the cradle assemblies extend the rammer track to the gun breech as shown in figure 10-1.

Components

Each projectile hoist consists of the following principal units:

Power drive
Hoist components
Cradle assembly components
Hoist reversal system
Controls and interlocks

Component locations

The components listed above have similar positions in the turret with respect to the guns they serve. The three hoists, located in the rear of the turret rotating structure, are shown in figure 1-6. Identically arranged, the left and right hoist courses rise vertically from the lower projectile flat to a point above the electric deck (fig. 9-1). The courses curve toward the rear and upward to the projectile cradles. Straight all the way, the center hoist course rises vertically from the lower projectile flat to the projectile cradle.

The electric motor, reduction gear, solenoid brake, and hydraulic pumps are located on the electric deck (fig. 9-2). These power drive units for the left and right hoists are located to the rear of the elevating gear units for the left and right guns. The same units for the center hoist are located to the rear of the training gear units and the left and center powder hoist trunks.

The rack operating cylinder is vertically mounted between the lower and upper projectile flats (fig. 9-2).

The hydraulic (auxiliary) pump for the dual hoist reversal and cradle system is mounted on the electric motor housing (fig. 9-2).

The components of the cradle assembly, together with the cradle operating cylinder, are aligned between the rammer and gun in the gun room compartment (fig. 9-6).

The hoist control devices are arranged in duplicate. There is a manual control operating lever with indicators and interlock devices on each projectile flat adjacent to the hoist loading aperture.

Controls for the hoist reversal mechanism and for operating the cradle are located in the gun room compartments at the cradle operator's station.

Functional arrangement

In normal operation the assembled arrangement of the hoist, power drive, and cradle assembly delivers projectiles to the gun. Hydraulic pressure is delivered by the motor driven pumps to the rack and cradle operating cylinders. Projectiles are hoisted or lowered in equal stages through the reciprocating movement of the piston of the rack operating cylinder. The total projectile lift of five stages from the lower flat (four from the upper flat) is the same in all hoists. Final movement of hoist stroke delivers a projectile into the cradle above the cradle projectile latch.

After delivery of a projectile to the cradle assembly, the cradle is lowered by the cradle operating cylinder to permit ramming the projectile into the gun. After the gun is loaded, the cradle is raised and hoisting may be resumed.

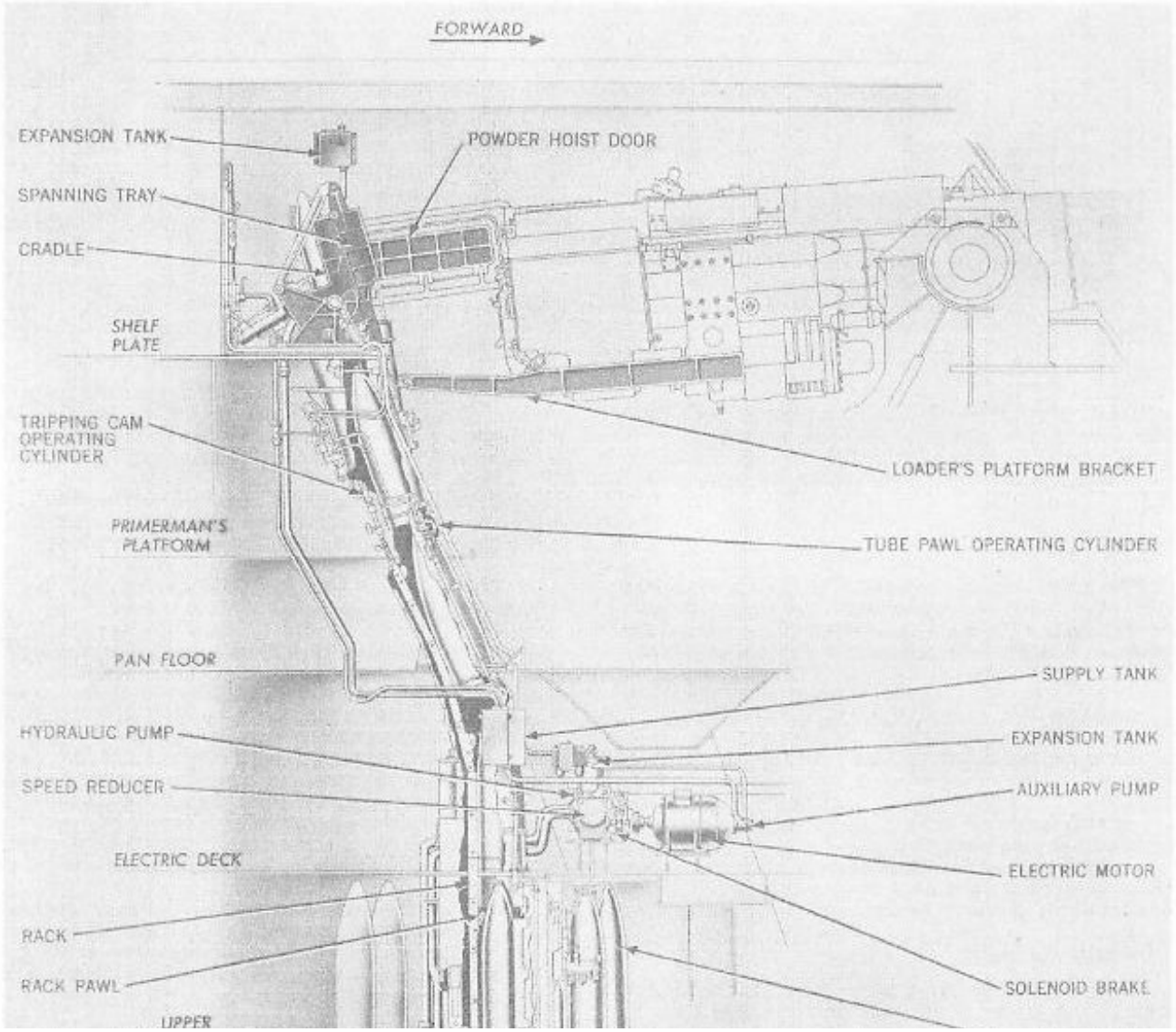
The hoist control mechanisms permit normal hoist operations to be stopped at any time with the cradle filled or empty.

The hoist reversal system, actuated through a function control valve, permits lowering projectiles.

Design differences

Hoists are of the same design, but differ in their course arrangements as described previously.

The arrangement of the electric motor, reduction gear, solenoid brake, and hydraulic pump (fig. 9-2) is identical for the left and right hoists. The same units for the center hoist are arranged in the opposite way. Shaft rotation of electric motors is clockwise for the center and left hoist power drive assemblies and counterclockwise for the right hoist assembly.


FORWARD
EXPANSION TANK
POWDER HOIST DOOR
SPANNING TRAY
CRADLE
SHELF PLATE
TRIPPING CAM OPERATING CYLINDER
LOADER'S PLATFORM BRACKET
PRIMERMAN'S PLATFORM
TUBE PAWL OPERATING CYLINDER
PAN FLOOR
SUPPLY TANK
HYDRAULIC PUMP
EXPANSION TANK
SPEED REDUCER
AUXILIARY PUMP
ELECTRIC DECK
ELECTRIC MOTOR
RACK
RACK PAWL
SOLENOID BRAKE
UPPER

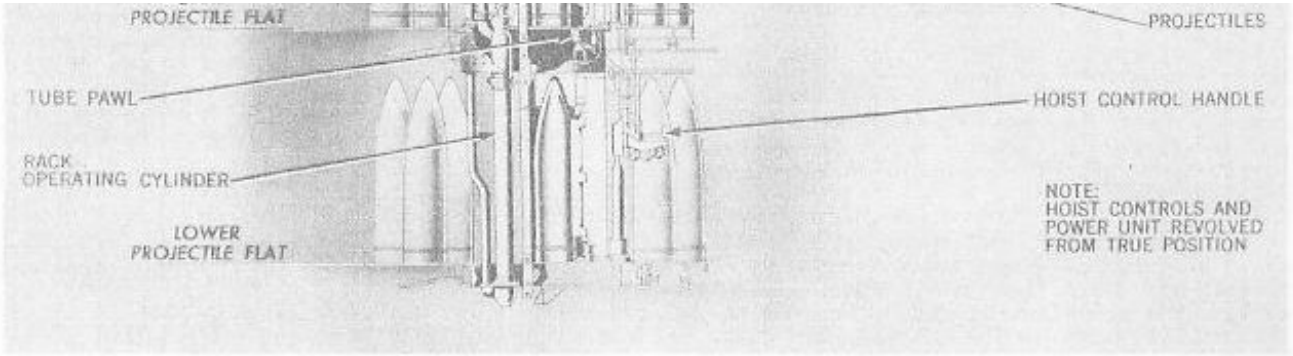


Figure 9-1, 16-Inch Projectile Hoist Mk 8 Mod 0 - General Arrangement, Sectional View

Design data

All hoists have the same projectile capacities, rate of delivery, and vertical lift of rack.

Hoist capacity	
Tube, HC or AP projectiles	5
Cradle, HC or AP projectiles	1
Rack loads, pounds	
Full load, AP projectiles	13,500
Full load, HC projectiles	9,500
Vertical lift, feet	
Upper projectile flat to the cradle opening	27.03
Lower projectile flat to the cradle opening	34.78
Spacing between rack pawls, inches	76.0
Stroke movement, inches	97.5

DETAIL DESCRIPTION

Power drive

The hoist and cradle power drive is an electric-hydraulic installation consisting of two motor driven pumps, two hydraulic operating mechanisms, and auxiliary elements for transmitting, interlocking, and controlling hoist action and for holding the rack against overhauling movement. The principal units and arrangement of a typical power drive are shown in figures 9-1 and 9-2.

Electric controller. Each electric motor is powered and controlled through a cabinet enclosed, across-the-line magnetic-type controller. Each controller contains a main contactor, overload relays, reset relays, and a hand operated circuit breaker. The controller is remotely controlled from a master push-button station mounted adjacent to the cradle operator's station in the gun room compartment. This switch, normally open, is closed by pressing the START-EMERG button. The switch is opened by pressing the STOP button at the master push-button station. In addition, the electric motor may be stopped from either of two stop push-button stations located at the hoist control stations.

Controller data.

Type	waterproof, semiautomatic, across-the-line magnetic starter, controlled by remote push buttons
Ampere rating, full load	95
Protection: -	
Overload: - Dashpot, magnetic relay, semiauto reset	
Adjustable range, amperes	99.5 to 134.5
Normal setting, amperes	113.5
Short circuit, circuit breaker	AQB
Undervoltage: -	
Drop-out voltage	50
Sealing voltage	370

Components. The power drive consists of the following:

Electric motor
Electric controller
Solenoid brake
Speed reducer
Flexible couplings
Rack operating hydraulic mechanism
Cradle operating hydraulic mechanism

Electric motor. The electric motor (fig. 9-1) is mounted on a structural foundation (fig. 9-2) that raises it slightly above the electric deck. The motor is positioned horizontally and is coupled to the solenoid brake and reduction gear units through self-aligning flexible couplings.

Motor data.

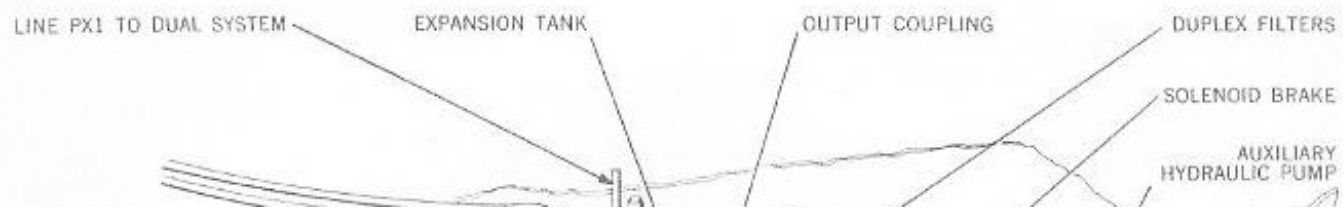
Type	squirrel cage, induction
Design features	waterproof, fan cooling, horizontally mounted, reduction gear drive
Horsepower	75
Synchronous speed, rpm	1800
Full load speed, rpm	1750
Rotation (center and left hoist)	clockwise
Rotation (right hoist)	counterclockwise
Speed class	constant
Voltage	440
Amperes, full load	95
Amperes, locked rotor	700
Phases	3
Cycles	60
Ambient temperature, deg C	40
Torque class	normal
Weight, pounds	1900
Manufacturer	Westinghouse Electric & Manufacturing Company
Manufacturer's designation	CS-FR-W-505
Drawing	268577
Shock rating	150
Weight, pounds	235
Manufacturer	Westinghouse Electric & Manufacturing Company
Drawing	268589

Solenoid brake. The solenoid brake consists of an actuating solenoid, brake drum, and brake band linkage. Assembled on a separate mounting base, the brake is mounted between the electric motor and reduction gear (fig. 9-2). The drum of the brake assembly is spline fitted to a shaft coupled to the motor output shaft through the input coupling described on page 9-5. Set mechanically, the brake prevents overhaul of the hoist in the event of mid-stroke power failure. When the supply circuit to the electric motor is closed, the brake is released through solenoid plunger stroke and the brake band linkage. The actuating solenoid is a 440-volt, 60-cycle, single-phase, continuous duty type. The brake develops torque of 125 pound-feet on an eight-inch brake drum.

Speed reducer. The speed reducer (fig. 9-2) is a case-enclosed unit mounted on a structural foundation of the electric deck. It is driven by the electric motor and is coupled to the main shaft of the hydraulic pump through the output coupling described on page 9-5.

Reduction gear data.

Type	enclosed worm and wormwheel
Output shaft (ratio 4.28 to 1.0), rpm	400
Rotation (output end) center and left	clockwise
Rotation (output end) right	counterclockwise
Lubrication	oil bath
Manufacturer	Michigan Tool Co.
Drawing	275600



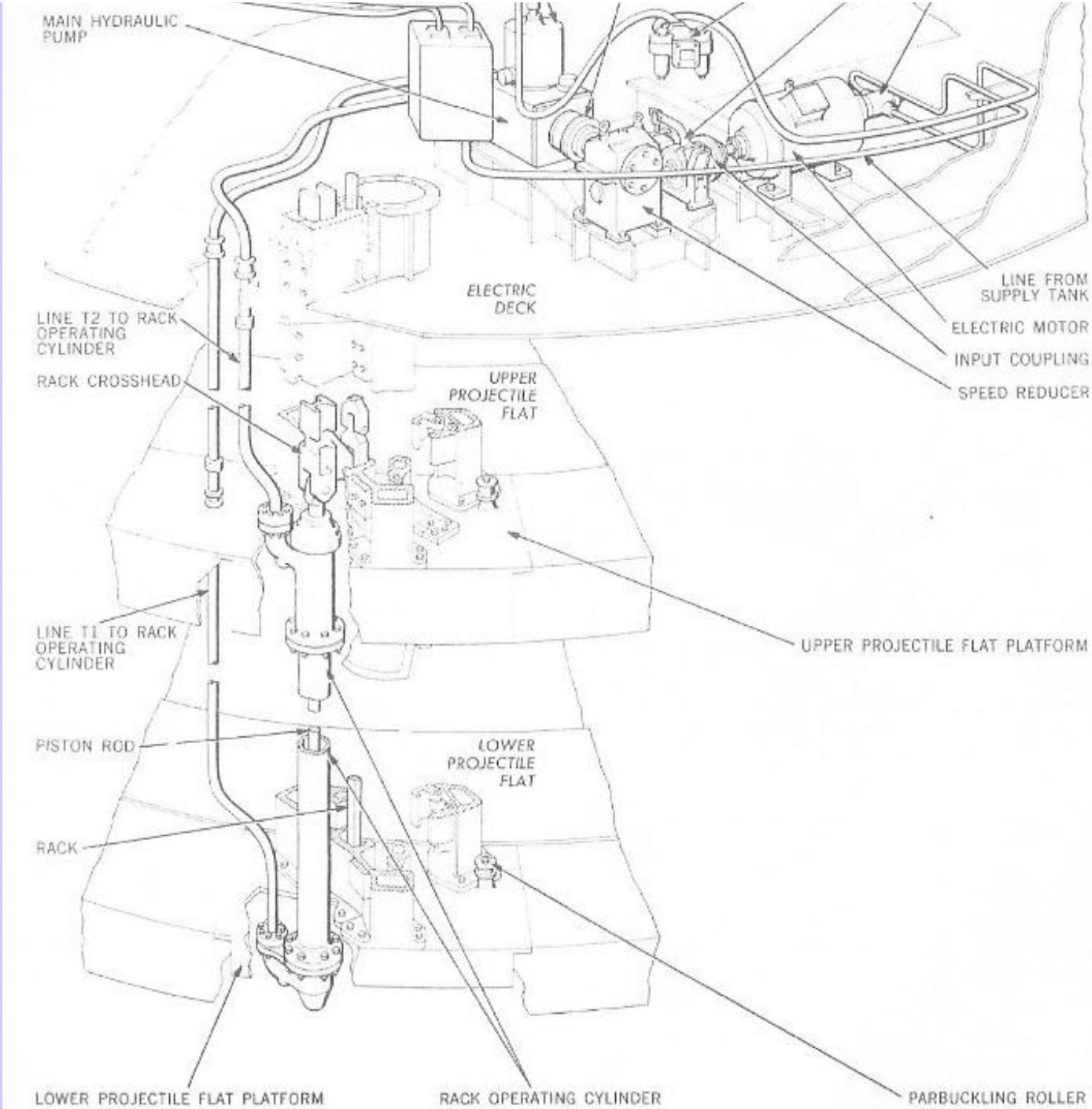


Figure 9-2. Projectile Hoist Power Drive Assembly—General Arrangement

Figure 9-2. Projectile Hoist Power Drive Assembly - General Arrangement

Flexible couplings.

Speed reducer input. The coupling between the electric motor and the speed reducer input (brake drum shaft) is of commercial design and manufacture. A direct-drive, self-aligning connection, it is identical to the coupling in figure 7-17. The coupling consists of two identical hubs, male sleeve, female sleeve, sleeve gasket, and two seals and provides a flexible connection through meshing of the internal gears of hubs and sleeves. Gear lubricant is added through plugs in the outer male sleeve, and is retained by oil seals and gaskets.

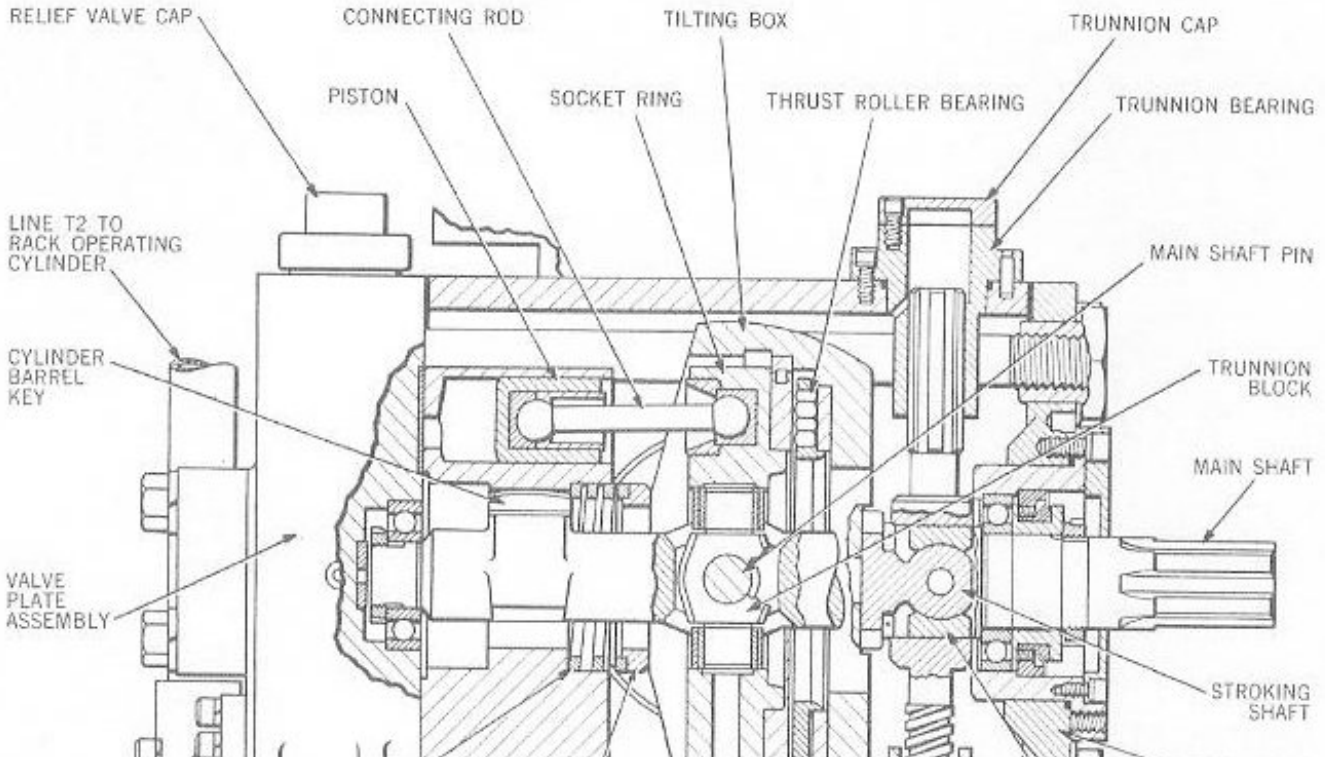
Speed reducer output. The coupling between the speed reducer and the hydraulic pump is the same as the coupling between the electric motor and the speed reducer input, except that it is slightly larger.

Rack operating hydraulic mechanism. The rack operating hydraulic mechanism comprises the following:

Hydraulic pump
Rack operating cylinder

Hydraulic pump. The hydraulic pump (fig. 9-3) is a case-enclosed multi-cylinder unit. It is driven by the electric motor through the reduction gear to which it is connected by the output coupling described above. It is a type K variable displacement pump of modified commercial design.

Mounted on foundation weldments of the electric deck, the main pumps are arranged with main shaft centerlines at right angles to the electric motor shaft centerlines.



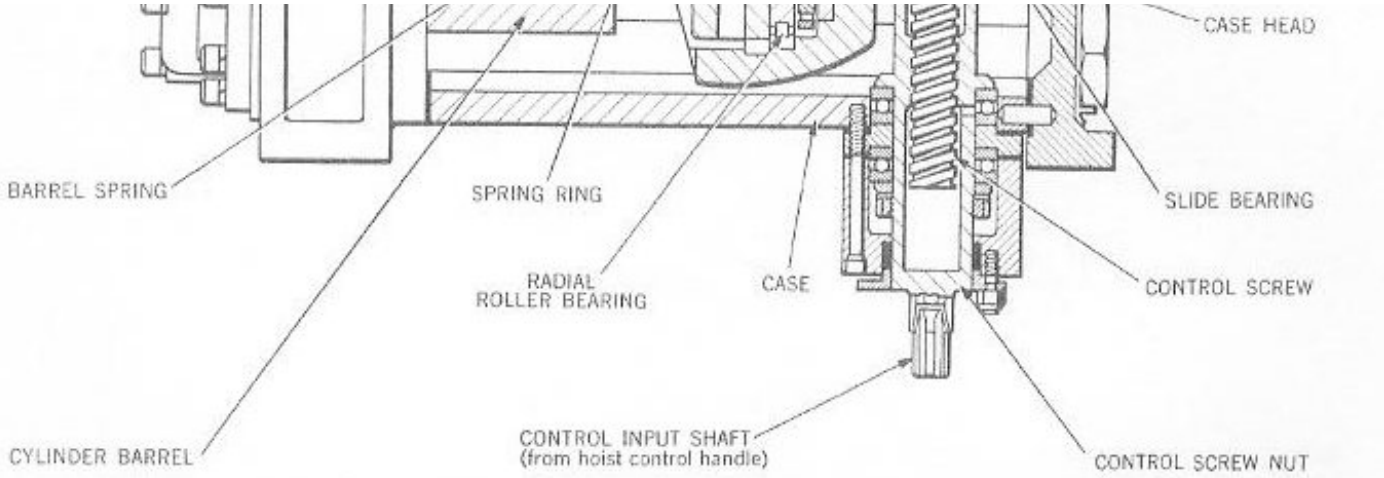


Figure 9-3. Projectile Hoist Main Hydraulic Pump - Sectional View

9-5

Case. A square, oiltight case encloses the hydraulic pump assembly. The case includes a valve plate, case head, case mounted tilting box control mechanism, trunnion cap, trunnion bearing assembly, and retainer. It forms a storage tank for hydraulic fluid in which the active parts rotate. The general arrangement of parts within the case is shown in figure 9-3. Mounting feet of the case are bolted to the pump foundation weldments.

Main shaft. The pump main shaft supports the rotating parts. At a point near the center of the pump case, the main shaft is made in the form of a closed yoke to support the universal-joint trunnion and pin. Ahead of the closed yoke, two keys are fitted in a section of the main shaft which supports the cylinder barrel. The main shaft forward end is supported by a ball bearing in the valve plate. The main shaft splined end is similarly supported by a ball bearing in the case head.

Cylinder barrel. The open center of the cylinder barrel has two keyways 180 degrees apart that run throughout its length and mate with the cylinder barrel keys fitted in the main shaft. The barrel is retained on the main shaft by a nut and is held against the valve plate by a barrel spring which backs up against a spring ring and a flange on the main shaft. The barrel contains nine cylinder bores which are of the same diameter throughout the length of the piston

Tilting box. The tilting box, a trunnion-mounted casting inside the pump case, varies the angle of the socket ring with relation to the main shaft, changing the length of piston stroke from zero to maximum. It contains two groups of roller bearings which take the radial and axial thrusts of the socket ring. Connected to the tilting box, a stroking shaft connects with the control screw of the control mechanism.

Valve plate. The valve plate and the case-head form the stationary ends of the pump case. The inner, or rear, surface of the plate is a finished surface against which the cylinder barrel rotates. This surface has two semiannular grooves, called valve-plate ports, through which hydraulic fluid flows when power is being transmitted. These ports connect with the power transmission pipes between the pump and the rack operating cylinder.

Between the valve plate ports are flat surfaces called lands. As the cylinder barrel rotates, the cylinder bores pass in succession over the lands. The lands are positioned so that they coincide with the end-of-stroke of each of the reciprocating pistons. There is no pumping action when the cylinder bores pass over the lands. The ball bearings for the main shaft are in the center of the valve plate.

Valves. The main relief, auxiliary relief, and replenishing valves, described in the following para-

travel. They taper sharply at the end to a small cylinder port outlet.

Pistons. Each cylinder bore is fitted with a piston ground and lapped to a smooth working fit. When the pump is delivering hydraulic fluid, the fluid being discharged by the pistons presses against the ends of the cylinder bores and forces the barrel against the valve plate to reduce internal leakage between barrel and valve plate. This sealing effect increases as hydraulic pressure in the system increases. A drilled hole in the center of the front face of each piston admits hydraulic fluid to lubricate the ends of the connecting rods.

Connecting rods. Nine connecting rods connect the pistons with the socket ring. Each connecting rod has two ball-shaped ends. One end seats in a socket in the piston and is held in place by a split cap, cap nut, and nut lock. Shims are placed between the cap and piston surface to obtain proper clearance for the ball end. Each connecting rod is drilled throughout its entire length to provide for lubrication of the ball and socket.

Socket ring. The socket ring, a circular piece, contains sockets for the other ends of the connecting rods. Each rod is retained in its socket cap, socket cap nut, and socket cap nut lock. The socket cap is split to facilitate installation and removal. The back of the socket ring has a roller track with two faces, which bear against the bearings in the tilting box. Two slots, located about the center of the socket ring and 180 degrees apart, carry the main shaft trunnion bearing blocks of the universal joint.

Universal joint. Rotation of the main shaft is transmitted to the socket ring by a universal joint formed by a trunnion in the shaft yoke. The attached socket ring is free to rotate about the axis of the trunnion, giving a controlled variation in the length of piston stroke.

graphs, are housed within the hydraulic pump valve plate. Their arrangement is shown schematically in figure 9-5.

Main relief valve. The main relief valve, located in the upper part of the valve plate, is a spring-loaded plunger-type valve, operated by a similar type pilot valve. The valve is adjusted to relieve main pump high pressure in excess of 100 pounds per square inch during the hoist strokes.

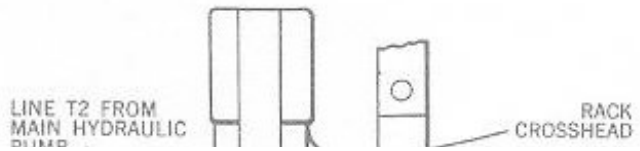
Auxiliary relief valve. The auxiliary relief valve, located in the upper part of the valve plate is adjacent to the main relief valve and is identical to it. The valve is adjusted to limit main pump pressure at 100 pounds per square inch during the lowering stroke.

Replenishing valve. There are two replenishing valves located in the lower part of the valve plate. They are identical spring-loaded plunger-type valves that replenish the hoist system hydraulic fluid through the transmission lines.

Expansion tank. The cylindrical 7.0-gallon hoist power drive expansion tank is 14.0 inches high and 12.5 inches in diameter. Mounted on top of the hydraulic pump case, it is a vented type with gravity feed connection to the replenishing valves of the hydraulic pump valve plate. Return lines lead to the tank from the main relief valve. The tank is equipped with a filler cap at its top and an inside strainer. Filled to the level indicated by the tank gages, it contains 5.0 gallons of hydraulic fluid.

Hydraulic pump data.

Driven speed, revolutions per minute	400
Oil temperatures	
Normal operating range, deg C	67-97(100-150F)
Maximum permitted, deg C	103(180F)
Displacement capacity	
Delivery, gallons per minute	200
Pressure, pounds per square inch	1000



Rack operating cylinder. The rack operating cylinder (fig. 9-4) is a hydraulic ram of 97.5 inches stroke. It comprises a cylinder, a piston assembly, and two cylinder heads. A seamless steel tube that weighs approximately 160 pounds, the cylinder has an inside diameter of 5.875 inches and a length of 101.425 inches. At a point 5.75 inches from the lower end, the cylinder is threaded and machined to attach a cast steel flange. The upper end is also threaded and machined to attach an identical flange 91.125

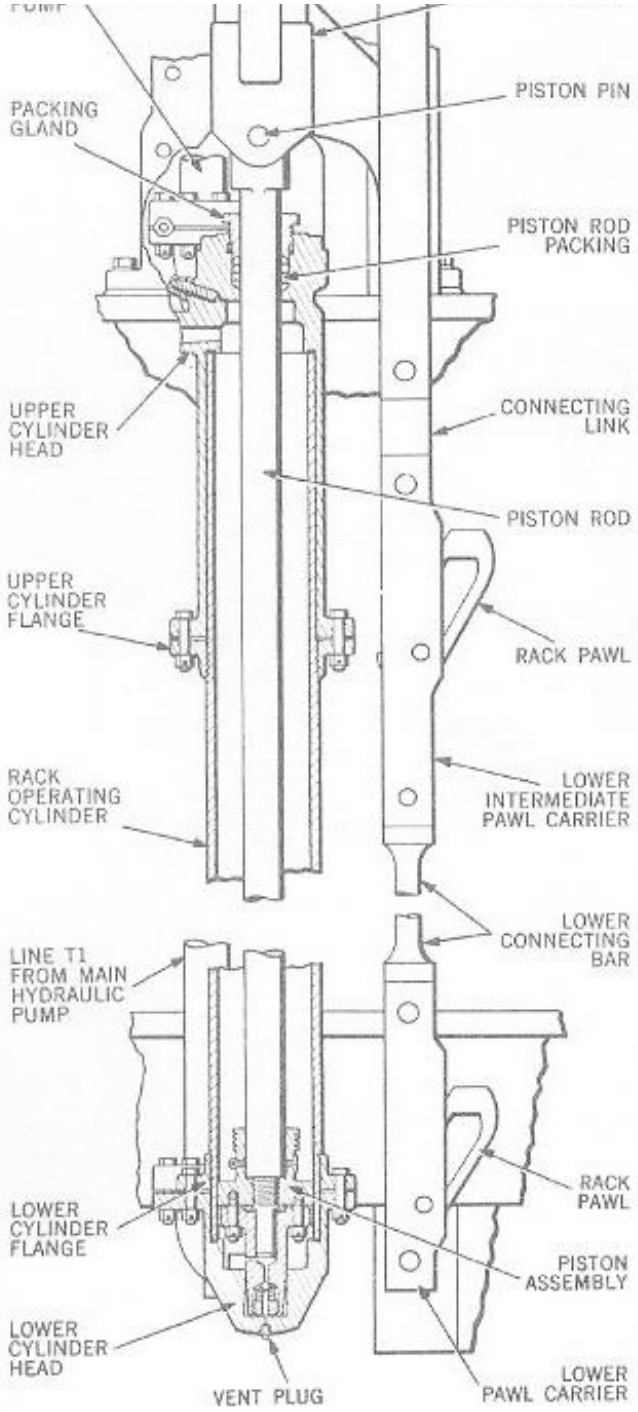


Figure 9-4. Rack Operating Cylinder and Rack-

ed and machined to attach an identical flange 21.125 inches from the top. Each cylinder flange weighs 22.5 pounds and has eight equally spaced holes for attaching the cylinder head.

Piston assembly. The piston assembly (fig. 9-5) housed within the rack operating cylinder, comprises a piston rod, piston, leather piston cup, and a piston follower. A round solid steel bar which passes through the upper cylinder head, the piston rod is 2.48 inches in diameter and 116.93 inches long. The upper end of the rod is rectangular in shape and is attached to the rack crosshead by a pin. A bronze casting 5.873 inches in diameter, the piston is threaded on the lower end of the rod. An integral grooved cylinder of smaller diameter at the top of the piston buffs the piston at the top of its stroke. The piston follower, shaped to prevent collapse of the leather piston cup, retains the cup and is bolted to the piston. Provided with a ball check valve and throttling groove, the lower end of the follower functions with an integral dashpot of the lower cylinder head to buff the piston on the downstroke.

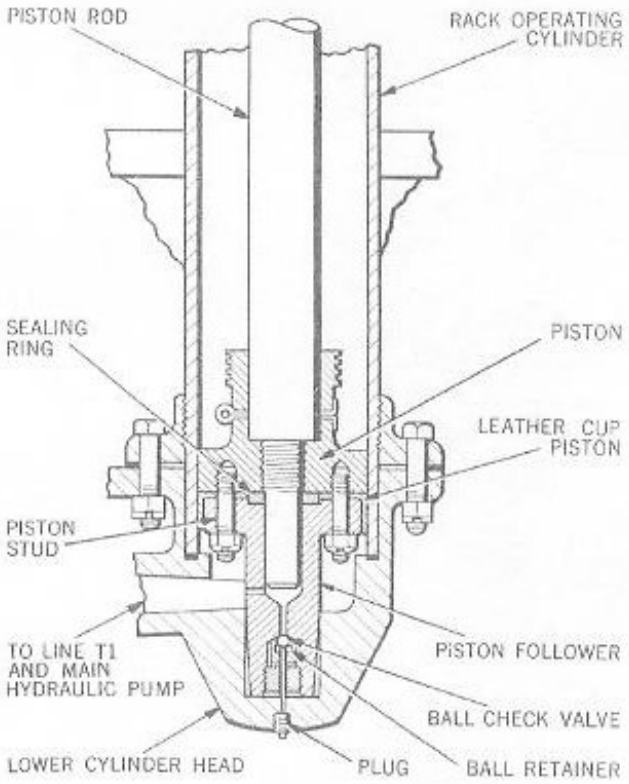
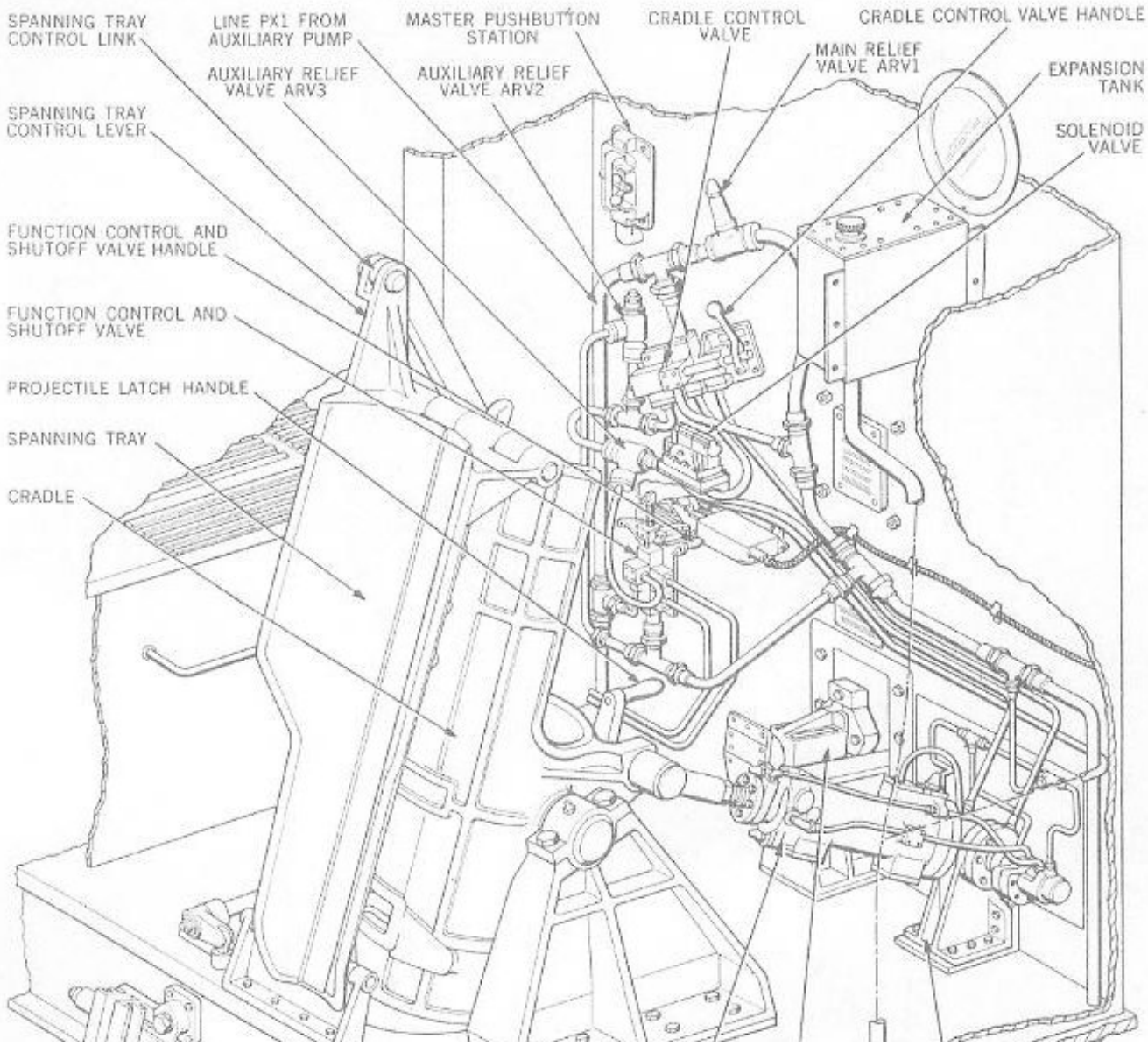


Figure 9-5. Rack Operating Piston and Cylinder-

Sectional View

Sectional View



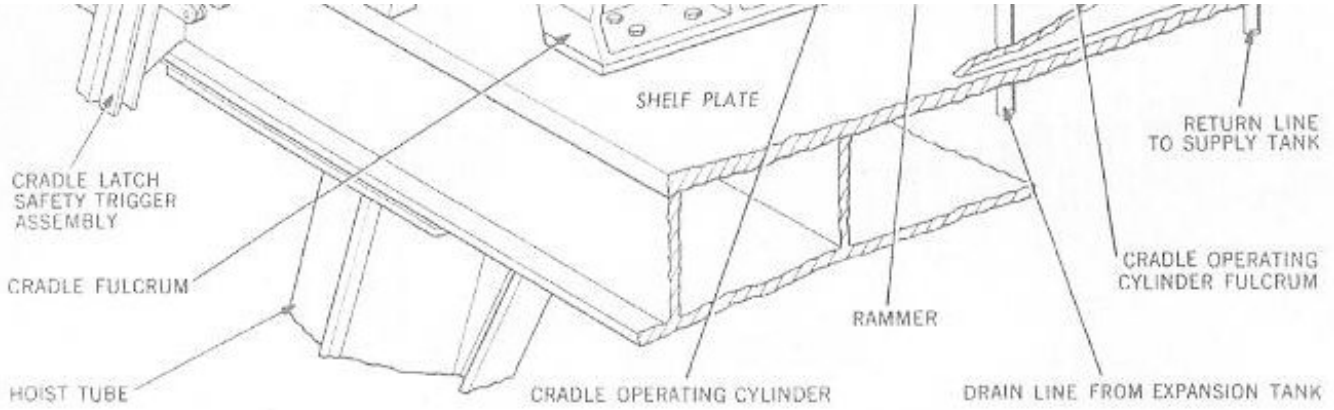


Figure 9-6. Projectile Hoist Upper End - General Arrangement.

Cylinder heads. Made of cast bronze, the cylinder heads are attached to the cylinder ends through integral head flanges. The upper cylinder head weighs 236.0 pounds. The lower head, which weighs 103.0 pounds, provides a dashpot for piston lowering movement. Both heads seat copper gaskets assembled between the cylinder and head. The piston rod passes through a garlock type packing retained in the top of the upper head by a gland nut. Both heads have pressure ports and integral mounting flanges to which the power transmission lines from the hydraulic pump are attached. There is a 0.188-inch vent hole in the upper head that is closed through a capped air valve. A similar hole in the lower head is closed with a threaded brass plug.

Cradle operating hydraulic mechanism. The cradle operating hydraulic mechanism comprises the following:

Hydraulic pump
Cradle operating cylinder

Hydraulic pump. The hydraulic (auxiliary) pump is directly driven by the projectile hoist electric motor. The rotary-gear constant displacement pump delivers hydraulic fluid at the rate of 30 gallons per minute (at varying pressures) to a dual hydraulic system described later on this page. The pump is mounted on an integral flange at the back end of the electric motor housing.

The steel tank body is box shaped, 14.0 inches high, 14.0 inches wide, and 9.0 inches deep. It is equipped with a cover, high- and low-level trycocks, filler cap, and an oil strainer inside the tank.

Supply tank. The 22-0-gallon supply tank for each cradle operating hydraulic mechanism is a non-vented type. It has a feed connection from the expansion tank and is interposed in the return line from the cradle operating and pawl control mechanism to the auxiliary pump. The return line, which passes through the tank, has two open T fittings assembled in it at 4.0 and 18.0 inches from the tank bottom. The tank is located between the pan floor and electric deck, to the rear of the power drive components. The steel tank body is box shaped 15.0 inches square and 24.5 inches high. It is equipped with pipe flange connections for the return and feed lines, a drain plug, and a side cover plate.

Dual system. The hydraulic (auxiliary) pump supplies hydraulic pressure for operating a dual system. This system includes the hoist reversal system (described on page 9-12) and the cradle operating hydraulic mechanism.

Cradle operating cylinder. The cradle operating cylinder (fig. 9-7) is a hydraulic ram. It is mounted in the rear part of the gun room compartment (fig. 9-6) with its piston connected to the cradle through a crank pin connector and crank pin. The cylinder as-

motor housing.

Valves. The main relief, auxiliary relief, and bypass valves, described in the following paragraphs, are arranged in the dual system as shown in figure 9-5.

Main relief valve. The main relief valve, ARV 1, located in the gun room compartment (fig. 9-6), is a spring-loaded plunger-type valve. It is adjusted to relieve auxiliary pump pressure in excess of 800 pounds per square inch during cradle lowering.

Auxiliary relief valve. The auxiliary relief valve, ARV 2, located in the gun room compartment (fig. 9-6), is a spring-loaded plunger-type valve. It is adjusted to relieve auxiliary pump pressure in excess of 400 pounds per square inch during cradle raising.

Bypass valve. The bypass valve, located in the duplex filter unit, is a spring-loaded plunger-type valve. It relieves auxiliary pump pressure in the event the filter elements become clogged.

Duplex oil filter. A pressure-type duplex oil filter, of commercial design and manufacture, is used to filter the hydraulic fluid delivered by the auxiliary pump to the dual hydraulic system. Located on the electric deck adjacent to the power drive assembly, the unit consists of two fine wire screen elements each in a filter sump attached to the unit body. For normal operation both filters should be used simultaneously. However, a control valve provided in the filter design permits the individual use of either filter. This feature makes it possible to clean a fouled filter element without stopping the power drive.

Expansion tank. The 7.0-gallon expansion tank (5.0 gallons capacity when filled to the upper trycock) for each cradle operating hydraulic mechanism is a vented type with a gravity feed connection to the supply tank. The tank, located in the gun room compartment, is at the highest point of the hydraulic system.

sembly consists of a cylinder fulcrum, a cylinder, and a piston.

Cylinder fulcrum. The cast bronze cylinder fulcrum is mounted on the shelf plate to the rear of the cradle fulcrums (fig. 9-6). It provides a mounting for the lower end of the cradle operating cylinder which is connected to the hydraulic swivel joints mounted in the fulcrum.

Cylinder. The cast bronze cradle operating cylinder (fig. 9-6) provides a 13.785-inch stroke ram, of 4.0 inches bore, and is 31.5 inches long overall. It is connected to the cylinder fulcrum through the cylinder head at its lower end. The cylinder head, together with the piston and cylinder valve port restrictions, buffs the folding action of the cradle. In the upper end of the cylinder, the piston rod passes through a chevron type packing assembly retained by a gland.

Piston. The nickel steel piston is lap fitted to the cylinder bore. It is 30.567 inches long including the dashpot plunger at its lower end. The upper end of the piston passes through the cylinder packing and gland and is attached to the cradle through a crank pin and crank pin connector.

Hoist components

The hoist components comprise the following:

Rack
Tube
Projectile flat platforms
Door and shutter brackets
Rack pawl
Tube pawl

Arrangement. The various hoist components listed above are shown in figure 9-1 and are similarly arranged for all projectile hoist installations. The hoist tubes form the courses through which projectiles are conveyed to (or lowered from) the cradle assemblies by reciprocating movement of the rack and rack pawls. Projectiles are supported at the end of a stroke by the tube pawls. The door and shutter brackets form the loading apertures for the hoist

rack, is arranged with a cam surface which actuates the tube pawl control valve cam mechanism described on page 9-13.

Tube. The hoist tubes (fig. 9-1) are flange bolted assemblies. The left and right hoist tube assemblies are similar but are oppositely arranged for left and right installations. The center hoist tube assembly differs from the left and right in that it is slightly

tubes. They are similarly arranged on both projectile flats with the projectile flat platforms forming the aperture bases.

Rack. The rack is an assembly of steel connecting bars, links, and pawls carriers joined end to end and connected to the crosshead. The assemblies for the left and right hoists are identical and differ slightly from the center hoist rack assembly. With curved rack casing tracks for their courses, the outboard hoist racks are 325.0 inches long. They are made up of 14 connecting bars, links, and pawl carriers with the crosshead arranged above the second pawl carrier. The center hoist rack, with a straight rack casing track for its entire course, is 318.0 inches long. It is an assembly of 9 connecting bars, links, and pawl carriers with the crosshead arranged above a connecting bar and the second pawl carrier. The crossheads, bronze castings, connect the rack to the rack operating cylinder (fig. 9-4) described on page 9-7. A connecting bar, located near the top of each

shorter due to its straight course. All hoist tube courses are formed by cast steel sections. These have integral tracks in which the racks operate, and integral flanges through which the sections are bolted together. The assembled tube structure is supported from the lower and upper projectile platforms. It is braced, by bolted and flanged attachment, at the shelf plate, pan floor, and electric deck through cast steel brackets. These, like the tube sections, have integral tracks for the racks. The cradle unit (fig. 9-1), aligned with the tube, is mounted on the shelf plate.

Projectile flat platforms. The projectile flat platforms, shown in figure 9-1, are the foundation components for the hoist tube assemblies, the door assemblies, and the rack operating cylinders. Machined steel castings, the platforms are arranged in the handling spaces of both projectile decks. Their tops are flush with the surfaces of the rotating rings and stowage areas. Left and right hoist platforms are similar but are arranged for left and right installations.

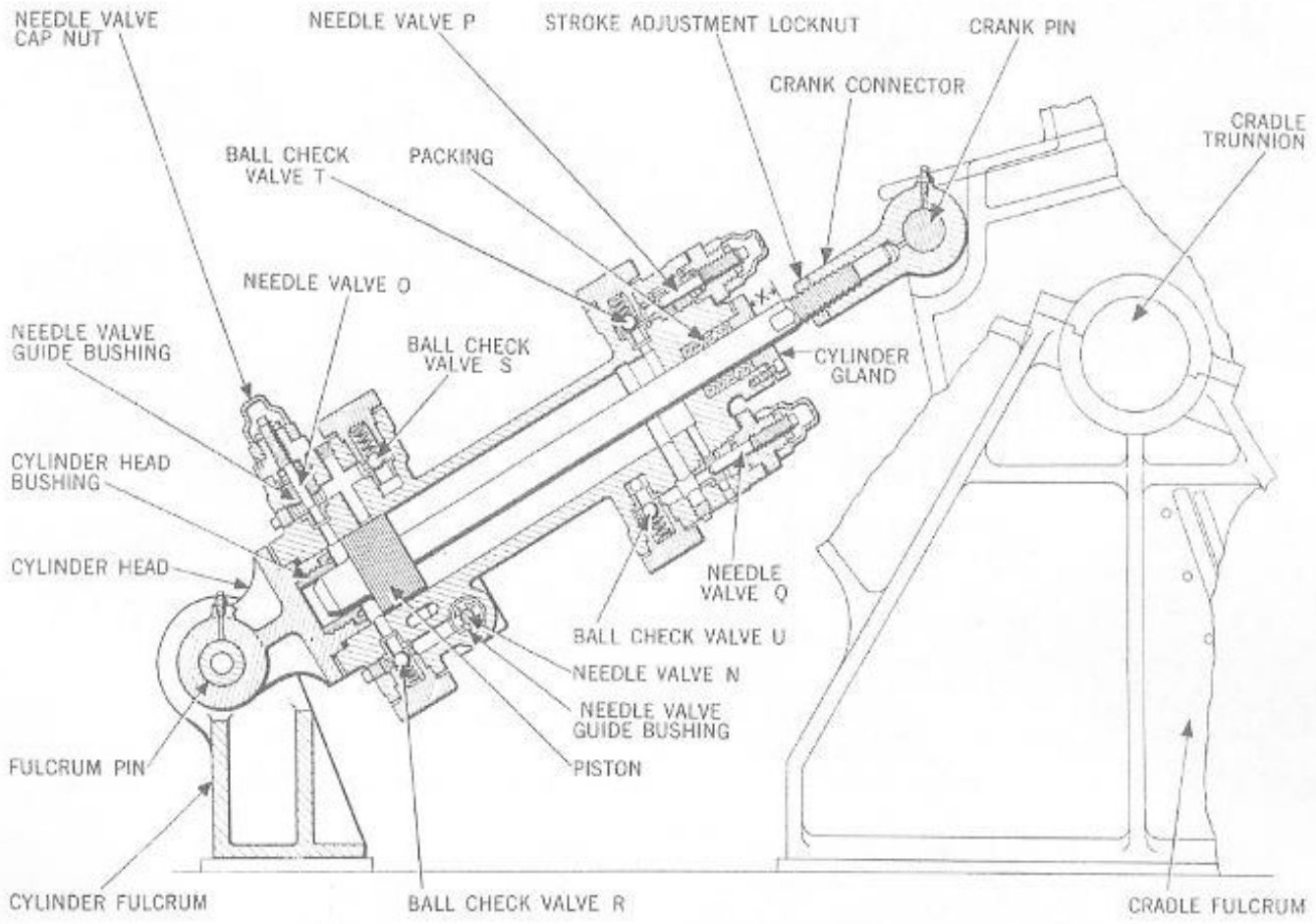


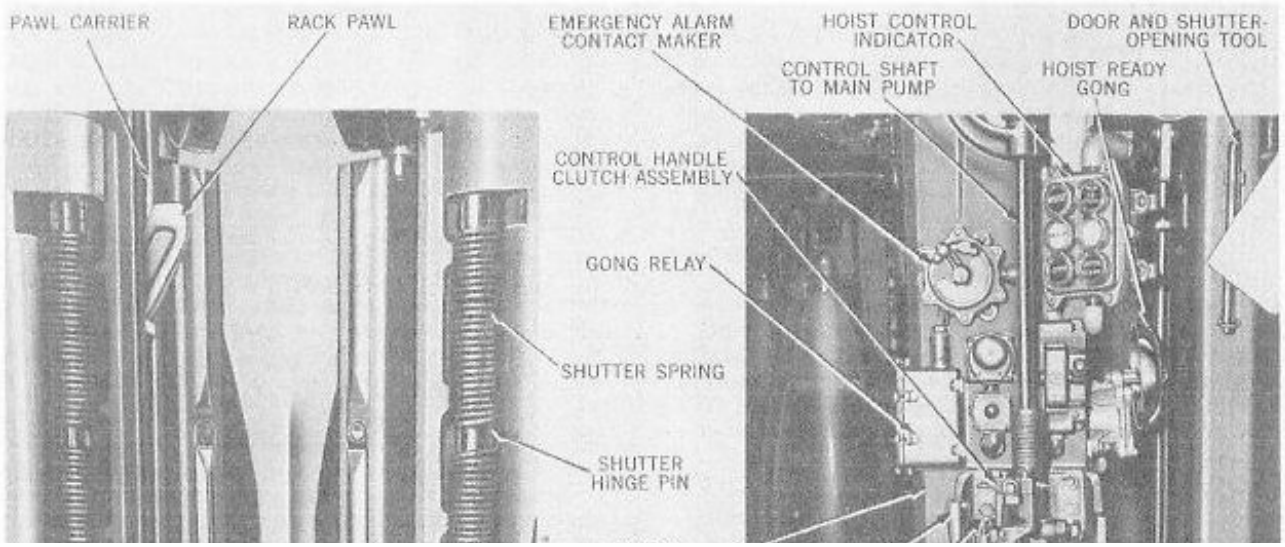
Figure 9-7. Projectile Hoist Cradle Operating Cylinder - Sectional View

Center hoist platforms differ slightly from the left and right. The upper flat platforms have integral provisions for the hoist tubes, the rack tracks, and the rack operating cylinder. The lower flat platforms differ in that they provide only for the rack track and the rack operating cylinder. All platforms are keyed to locate and secure the door and shutter brackets, hoist tube sections, and the rack operating cylinder.

Door and shutter brackets. The door and shutter brackets (fig. 9-8) help to support the hoist with its load of projectiles. Cast steel columns, the brackets are made with integral flanges through which they are secured in position to the projectile flat platforms and the electric deck bracket. The brackets are arranged vertically in the handling spaces with vertical full opening of the hoist apertures. All hoist apertures are fitted with spring-loaded doors and shutters that are hinged on the brackets (fig. 9-27).

Rack pawl. The rack pawls (fig. 9-4) are spring-loaded and pin pivoted and are seated in the pawl carriers of the rack assembly. Movement of the rack conveys projectiles, which rest on the pawls, through the hoist tube (fig. 9-26). The rack has five pawl carriers. These are the upper pawl carrier, upper intermediate pawl carrier, intermediate pawl carrier, lower intermediate pawl carrier, and lower pawl carrier. The pawls are spring-loaded to move into position for hoisting. When the rack descends after a hoisting stroke, each rack pawl is depressed by the projectile resting on the tube pawl at the next lower level.

Tube pawl. The tube pawls (fig. 9-1), spring-loaded and pin pivoted, are housed in hoist tube sections. Projectiles when lifted by the rack are supported at the end of each of the first four lifting strokes by the four tube pawls. These pawls are spring-loaded to move beneath the base of the projectile as it is hoisted on the rack pawls.



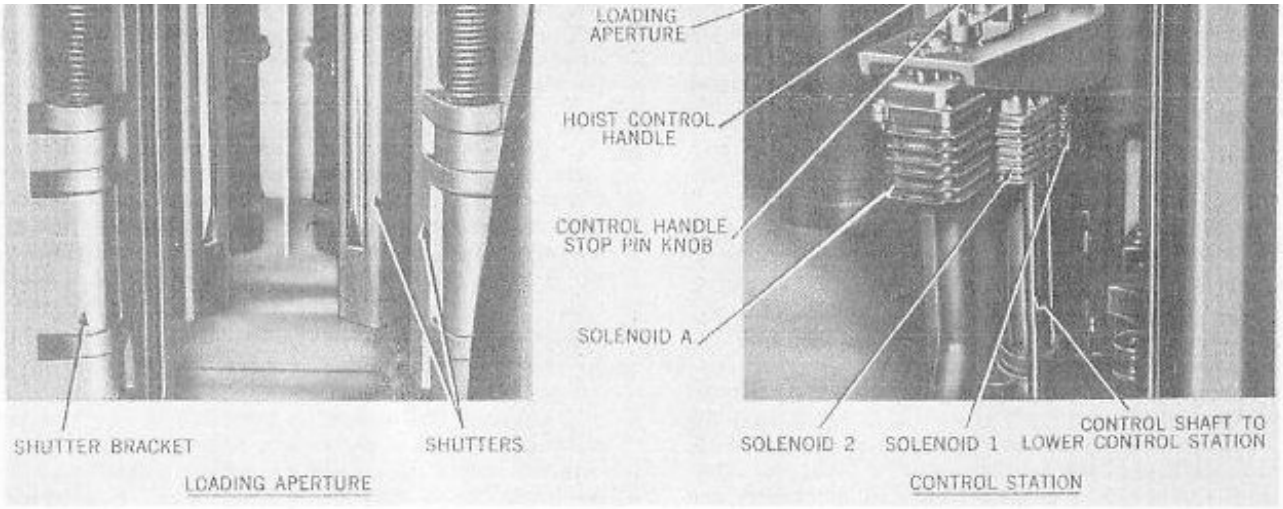


Figure 9-8. Projectile Hoist Upper Loading Aperture and Control Station - General Arrangement

Cradle assembly components

The cradle assembly comprises:

- Cradle and spanning tray
- Buffers
  - Cradle opening
  - Cradle folding
  - Spanning tray
- Cradle control valve
- Cradle solenoid valve
- Cradle latch
- Projectile indicator
  - Lever
  - Latch
  - Switch
  - Retainer

Arrangement. The cradle assembly (fig. 9-6) is mounted on the shelf plate above the hoist tube in the gun room compartment (fig. 9-1). Operated by the operating hydraulic mechanism, described on page 9-9, the cradle transfers a projectile from its vertical hoisting position to a horizontal position for ramming.

Cradle folding buffer. The folding action of the cradle is buffed by the cradle operating cylinder, described on page 9-9.

Spanning tray buffer. The spanning tray buffer is a rubber pad cemented in a recess in the bottom of the cradle. This pad buffs the contact between the spanning tray and cradle when the cradle assembly is folded.

Cradle control valve. The cradle control valve is flange mounted on the transverse bulkhead in the gun room compartment (fig. 9-6). It is a valve block arrangement of a spool-type, direction control valve and a valve operating lever (designated cradle control valve handle). Manually positioned, the valve directs auxiliary pump pressure to the chambers of the cradle operating cylinder. The valve is spring-loaded to return to neutral when released by the operator. The cradle control valve cannot lower the cradle to the loading position until the cradle solenoid valve (below) is operated by action of its solenoid to close a by-pass and open the hydraulic circuit to the cradle cylinder.

Cradle solenoid valve. The cradle solenoid valve is mounted as shown on figure 9-6. This valve

Cradle and spanning tray. The cradle and spanning tray (fig. 9-6), hinged together, are pivoted on integral trunnions of the cradle in the cradle fulcrums. A cast bronze trough 58.6 inches long with a tubular portion of 17.0 inches diameter bore, the cradle is 25.37 inches wide across its trunnions. Pivoted at the cradle bottom, the cast bronze projectile latch is spring-loaded to move beneath the base of a projectile that has been hoisted into the cradle. The spanning tray, a cast aluminum trough identical in cross section to the trough of the cradle, is connected to the cradle through the integral hinges of both castings. A control link, which connects the integral control lever of the spanning tray to the cradle fulcrum, unfolds the spanning tray when the cradle is lowered. The end of the tray opposite the hinge is tapered to enter the gun breech and extend across the screw box to the powder chamber. Machined grooves in the bottoms of the cradle and spanning trays provide a track for the rammer chain. Connected to the cradle operating cylinder through the crank connector and crank pin (fig. 9-7), the cradle and spanning tray assembly provide for delivery of projectiles to the gun by the rammer.

Buffers.

Cradle opening buffer. The cradle opening buffer is similarly mounted on the front of the cradle fulcrum in each assembly. It is a hydraulic buffer which throttles flow of the cylinder liquid past the plunger of the buffer piston, through grooves of variable depth in the buffer housing. Rapid return of the buffer piston to its extended operating position is ensured through a spring-loaded ball-check valve in the plunger. This valve permits the flow of liquid from the reservoir to the chamber beneath the plunger. The piston, which makes a 2.75-inch stroke with the gun at 5.0 degrees loading angle, contacts a phenol-fabric pad in the bottom of the cradle.

is controlled by an internally mounted solenoid which is operated by the interlock portion of Ready Light Circuit 1R (ch. 15). The cradle solenoid valve is in the cradle operating hydraulic circuit between the cradle control valve and the cradle operating cylinder and prevents operating the cradle by by-passing pressure to the tank until the gun is in battery and the breech is open and the gun bore is clear.

Cradle latch. The cradle latch assembly (fig. 9-13) consists of a guide plate, latch, latch connection piece, connecting rod, coil spring, and yoke. Free to move up or down in a vertical slot in the cradle fulcrum, the latch is retained in the slot by the guide plate. Screwed to the latch connecting rod, the latch extends through the slot to the inside of the cradle fulcrum and is positioned to contact an integral cam lug of the cradle. The connecting rod is attached to the foot pedal assembly (described on page 9-17)through the yoke. Moved upward by the coil spring, the latch secures the cradle in the raised or lowered position until forced down and released the foot pedal.

Projectile indicator. The projectile indicator assembly is pivoted in a bracket that is mounted on the shelf plate. Actuated by movement of a projectile into the cradle and by cradle movement, the assembly illuminates a danger signal at each projectile handling level. It also prevents hoist action when there is a projectile in the cradle or when the tray is spanned. It consists of a lever, a latch, a switch, and a retainer.

Lever. The projectile indicator lever, bracket mounted in front of the cradle assembly, is spline fitted to the connecting shaft. A hook shaped cam, the lever (fig. 9-13), projects through a hole in the cradle when the cradle is folded. Displaced by the projectile as it is hoisted into the cradle, the lever

actuates the indicator latch through the connecting shaft and actuating lever.

Latch. The projectile indicator latch (fig. 9-13), moved by the actuating lever and connecting rod, closes the projectile indicator switch. The latch is held in position by a retainer to keep the switch

level and interlocks the hoist control handle against movement toward HOIST.

Retainer. The retainer is mounted on the side of the cradle fulcrum and is moved up when a projectile enters the cradle. This action permits the integral retainer cam of the cradle to move under the

closed throughout the movement of the unfolding cradle by an arc-shaped integral cam of the cradle.

Switch. The projectile indicator switch is mounted on the side of the cradle fulcrum. The switch, when closed by the indicator latch, illuminates a danger signal at each projectile handling retainer lug while the cradle is being spanned.

Hoist reversal system

General. The rack pawls and tube pawls (described on page 9-11) are components of the hoist reversal system. They are arranged with operating mechanisms

which retract the pawls alternatively for lowering projectiles. This system, a part of the dual system described on page 9-9, controls the reversing action of the rack and tube pawls. The hoist reversal system, a semiautomatic control, operates independently of the cradle operating hydraulic mechanism.

Components. The hoist reversal system consists of the following:

Rack pawl operating cylinder
Rack pawl tripping cam mechanism
Tube pawl operating cylinder
Tube pawl control mechanism
Function control and shut-off valve
Tube pawl control valve
Tube pawl control valve cam mechanism

Rack pawl operating cylinder. The rack pawl operating cylinder is flange mounted on the hoist tube between the shelf plate and pan floor. Housed in a bronze casting, the cylinder assembly is a 1.25 inch stroke ram of 1.65 inch piston bore. It has hydraulic pressure connections with the function control and shut-off valve. The piston is threaded to the piston rod which passes through a chevron type packing retained by a gland in the bottom of the cylinder. Movement of the piston actuates the piston rod which is attached to the control rod linkage of the rack pawl tripping cam mechanism.

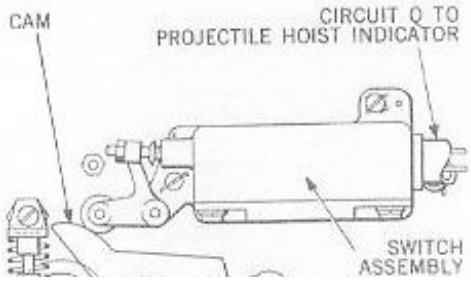
Rack pawl tripping cam mechanism. An assembly, the rack pawl tripping cam mechanism consists of a control rod linkage, tripping cams, tripping cam cranks, bearing brackets, sliding collars, and springs. The control rod linkage is mounted on the outside of the rack casing by the bearing brackets. Arranged in sets of one of each, the tripping cams and cam cranks are spline fitted on shafts mounted and pivoted horizontally in the rack casing. The cams located inside the rack casing retract the rack pawls at the bottom of the rack stroke when the hoist system is reversed to lower projectiles. The cam cranks located outside the rack casing are attached to and actuated by the control rod linkage. The cams are aligned with the four upper rack pawls when the rack is at the bottom of its stroke; they are simultaneously actuated through movement of the control rod linkage. When projectiles are lowered, the rack pawls are retained in retracted positions while the rack is near the top of stroke (either ascending or descending). As the rack descends, the rack pawls move back into the hoistway, beneath the bases of projectiles lowered from the next higher level.

Tube pawl operating cylinder. The tube pawl operating cylinder is flange mounted on the hoist tube between the shelf plate and pan floor. Housed in a bronze casting, the cylinder assembly is a 1.25 inch stroke ram of 1.65 inch piston bore. It has hydraulic pressure connections with the function control and shut-off valve. The piston is threaded to the piston rod which passes through a chevron type packing retained by a gland in the bottom of the cylinder. Movement of the piston actuates the piston rod which is attached to the control rod linkage of the tube pawl control mechanism.

Tube pawl control mechanism. An assembly, the tube pawl control mechanism consists of a control rod linkage, cranks, bearing brackets. Arranged in sets of one of each, the tube pawls and cranks are spline fitted on shafts mounted and pivoted horizontally in the hoist tube. The cranks are located outside of the hoist tube and are attached to and actuated by the control rod linkage. The tube pawls are simultaneously actuated by the cranks through movement of the control rod linkage. When projectiles are lowered, the tube pawls are retained in retracted positions while the rack is near the top of stroke (either ascending or descending). As the rack descends, the tube pawls move back into the hoistway, beneath the bases of projectiles lowered from the next higher level.

Function control and shut-off valve. The function control and shut-off valve assembly (fig. 9-9) is flange mounted, as shown in figure 9-6, on the transverse bulkhead. It is a valve block arrangement of a two-position spool-type direction control valve and a separate valve operating lever (designated function control and shut-off valve handle). Manually positioned, the valve directs auxiliary pump pressure to the rack pawl operating cylinder and the tube pawl control valve.

Tube pawl control valve. The tube pawl control valve assembly is flange mounted on the rack casing adjacent to the rack pawl operating cylinder. It is a valve block arrangement of a two-position spool-type valve. The valve passes through a packing in the lower end of the valve block and is connected to and positioned by the tube pawl control valve cam mechanism. When the function control and shut-off valve is positioned at LOWER PROJECTILES, the following action occurs:



movement of the control rod linkage. When projectiles are lowered, the tripping cam action is such that the rack pawls are retained in retracted positions until each rack pawl (with the rack ascending) passes the base of the projectile at the next higher level.

Tube pawl operating cylinder. The tube pawl operating cylinder (fig. 9-14) is flange mounted on the hoist tube section between the shelf plate and pan floor. Housed in a bronze casting, the cylinder assembly is a 1.375-inch stroke ram of 1.75-inch piston bore. It has hydraulic pressure connections with the tube pawl control valve. The piston is attached to the piston rod which passes through a chevron type packing retained by a gland in the bottom of the cylinder. The piston rod, actuated by movement of the piston, is attached to the control rod linkage of the tube pawl control mechanism.

Tube pawl control mechanism. An assembly, the tube pawl control mechanism (fig. 9-14), consists of a control rod linkage, cranks, bearing brackets, sliding collars, and springs. The control rod linkage is mounted on the outside of the rack casing by the

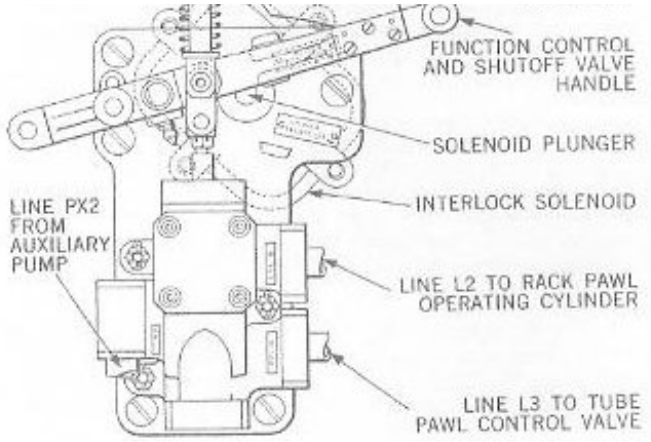


Figure 9-9. Function Control Mechanism - General Arrangement

Positioned and held up by auxiliary pump pressure, the tube pawl control valve directs auxiliary pump pressure to the top of the rack pawl operating cylinder to move the rack pawl tripping cams clear of the rack pawls.

Tube pawl control valve cam mechanism. This assembly consists of a cam lever, a cam lever bearing bracket, a control rod, and a collar. It is bracket mounted below the tube pawl control valve. Pivoted on a shaft mounted horizontally in the bearing bracket, the cam lever extends through a slotted hole in the rack casing in the way of the rack connecting bar cam. It is actuated by the rack connecting bar cam and is connected to and actuates the tube pawl control valve through the control rod.

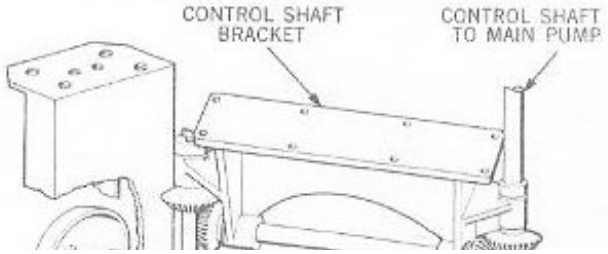
Controls and interlocks

The projectile hoist control and interlock arrangements for each hoist consist of:

Start-stop control
Rack operating controls
Hoist control indicator
Hoist controls
Limit switches
Solenoid operated interlock
Cradle operating controls

a clutch subassembly (fig. 9-10) mounted in the cast bronze body of the control handle. Both control handles are mounted on a common vertical control shaft. The control shaft is connected to the control handles through the clutch subassemblies and is coupled to the tilting box stroking control screw.

Function. Depending on the direction in which it is moved, the hoist control handle offsets the main pump tilting box from neutral stroke (through the control shaft and stroking control screw described above) to initiate a hoisting or lowering movement of the rack.



Neutral start interlock
Door and shutter interlock (parbuckling operation)

Start-stop control. Each projectile hoist power drive is started and stopped through its electric-power motor controller (described on page 9-3). The controller is remotely operated from three push-button stations, as described below.

Master control push-button station. The master control push-button station is adjacent to the cradle operator's station in the gun room compartment. It is a two push-button switch; one push-button is labeled START-EMERG and the other STOP. Pressing the START-EMERG button closes a normally open three-pole switch and energizes the coil of the main contactor to connect power to the electric motor. Holding contacts on the relays keep the power circuit closed when the START-EMERG button is released until the STOP button is pressed at this station or at either of the two stop push-button is pressed. An overload relay opens the circuit when current demand is too great.

Stop push button stations. A stop push-button station is located at each of the upper and lower projectile flat hoist operating stations. Each station comprises a single button switch labeled STOP. Pressing the STOP button at either station opens a three-pole switch and de-energizes the coil of the main contactor to disconnect power from the electric motor.

Rack operating controls. The rack operating controls comprise the hoist control handle and the function control lever interlock. The arrangements described below are similar for each hoist installation.

Hoist control handle. The projectile hoist is provided with a hoist control handle (fig. 9-8) adjacent to the hoist tube loading apertures on each projectile flat. Each control handle is an assembly that includes

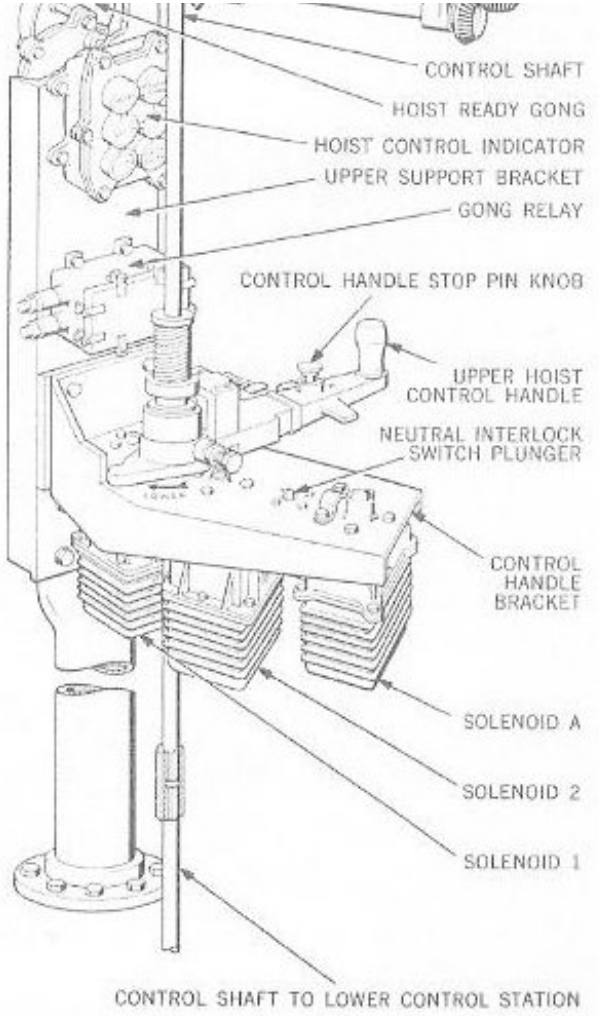


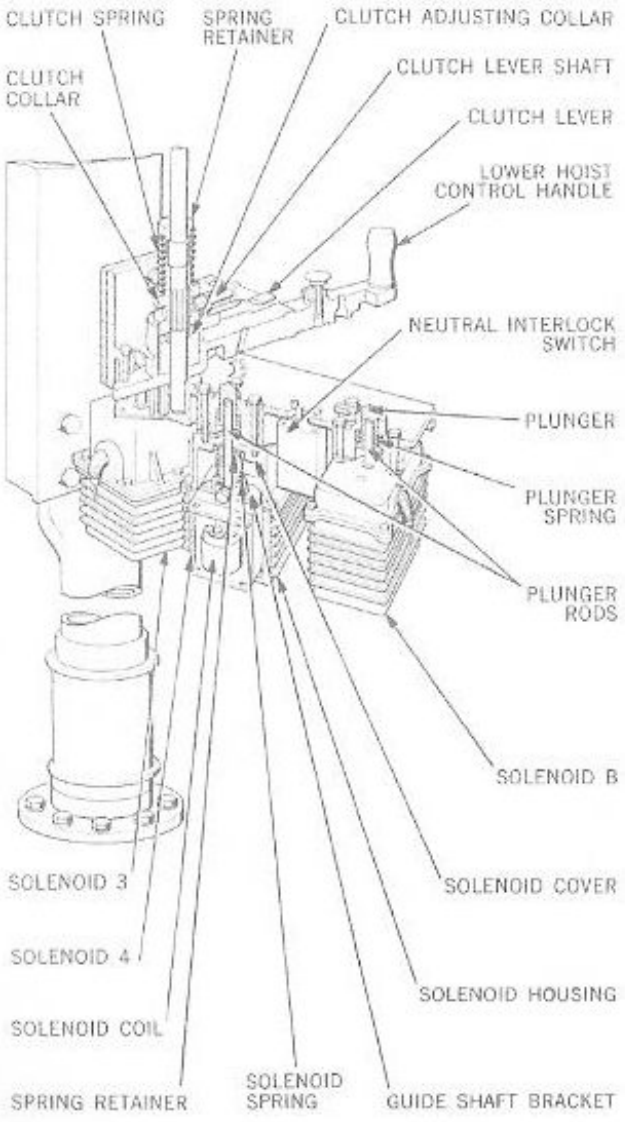
Figure 9-10. Upper Hoist Control and Interlocks

Either control handle may operate the hoist since each is independently engaged or disengaged through manually operated clutch levers (fig. 9-11).

Arrangement. The hoist control handle bracket at each hoist operating station is similarly equipped and includes an arrangement of four solenoid inter-

movement of the function control and shut-off valve to reverse the pawl mechanisms is blocked by an interlock solenoid through the interlock switch which is actuated by the control handle. The switches at both hoist operating stations, arranged in series, must be closed (by positioning the control handle at neutral stroke) in order to shift the function control and shut-off valve

and includes an arrangement of four solenoid interlocks and an interlock switch. Stops in the bracket limit maximum movement of the control handle each side of neutral stroke. One of the solenoid plungers automatically permits restricted movement of the control handle (indicated in the table below) to lower projectiles. The other two solenoids lock the control handle at neutral stroke when a projectile is being parbuckled into or out of the hoist, and block the control handle against hoisting (but permit lowering) when a projectile is in the cradle or the cradle is open. Except when the control handle is at neutral,



and shut-off valve.

Movement limits. The arcs of movement of the hoist control handles are identical. These movements from neutral stroke, and the equivalent tilt of the main pump tilting box, for each hoist control action are indicated below.

Hoist control handle limits

Control operation	Handle movement	Main pump tilt
Hoisting		
Rack up	62°	10° 42'
Rack down	116°	20°
Lowering		
Rack up	62°	10° 42'
Rack down	26°	4° 29'

Function control lever interlock. The function control and shut-off valve (described on page 9-13 is positioned through a separate operating lever (fig. 9-9) which is pivoted in an integral mounting flange of the valve. Provided with a spring-loaded locking pin, the valve operating lever is interlocked with the hoist control handles through an interlock solenoid.

The interlock arrangement is such that when the solenoid is de-energized, the valve operating lever is locked in its HOIST or LOWER position by the solenoid plunger. To release the valve operating lever, the solenoid is energized to retract the plunger by placing both hoist control handles at neutral stroke thereby closing the interlock switches.

Hoist control indicator. The hoist control indicator provides the projectile hoist operator with visual and audible signals which indicate safe or dangerous hoist conditions.

Visual. There are six lights in the hoist control indicator (fig 9-8) which when lighted illuminate the following legends:

HOIST. A green light. It indicates that the function control and shut-off valve handle is positioned at HOIST PROJECTILES, and that the cradle is empty and aligned with the hoist tube.

DANGER. A red light. It indicates that a projectile is in the cradle or that the cradle assembly is lowered.

LOWER. A green light. It indicates that the function control and shut-off valve handle is positioned at LOWER PROJECTILES.

TOP OF STROKE. A clear light. It indicates

Figure 9-11. Lower Hoist Control Interlocks - Sectional View

that the hoisting piston and rack crosshead have completed an upward stroke.

BOTTOM OF STROKE. A clear light. It indicates that the hoisting piston and rack crosshead have completed the downward stroke.

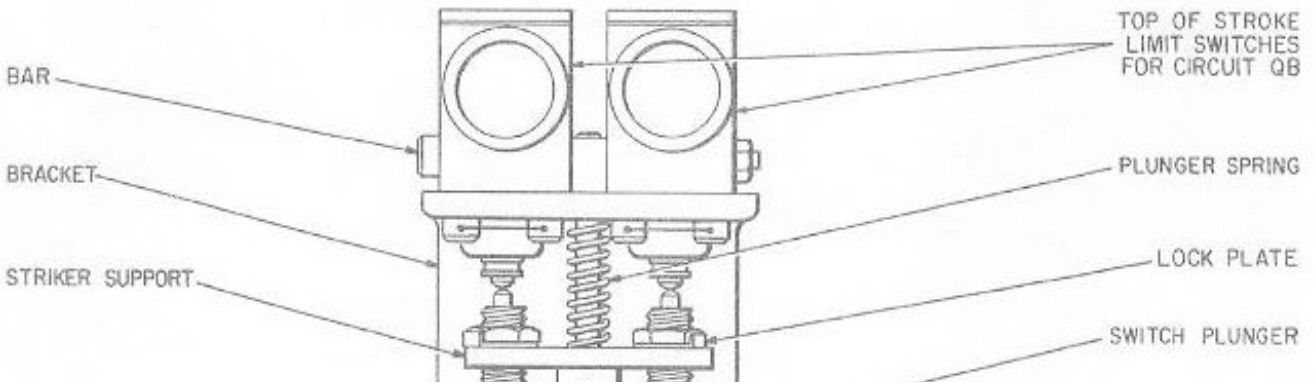
LATCH CLEAR. A clear light. It indicates that the function control and shut-off valve handle is positioned at LOWER PROJECTILES, and that the cradle projectile latch has been moved aside to release a projectile in the cradle.

Audible. The audible hoist control indicator is a single-stroke hoist-ready gong which is mounted at each hoist operating station. It sounds the instant HOIST is indicated on the visual indicator.

Hoist control clutches. Mounted with free bearing on a common vertical control shaft, the hoist control handles are engaged with the shaft through separate clutches. The clutch, a spring-loaded detent type assembly, consists of a clutch collar, an adjusting clutch collar, a spring, a spring retainer, and a clutch lever. Mounted on the hoist control shaft (fig. 9-11), the clutch is manually operated through the clutch lever which is held by a locking pin to lock the clutch in the engaged or disengaged position. Either control handle may be engaged with the control shaft and the other disengaged from the shaft to be locked at neutral stroke through the control handle locking pin.

Limit Switches. Four limit switches are installed in the projectile latch indicator system QB, for each hoist. Two of these four switches are installed on each hoist tube at the pan floor level. These switches are actuated by the crosshead when the hoist has completed its raising cycle. One switch operates the interlock solenoid on the control mechanism at the lower projectile handling level and one operates the top of stroke indicator lights. The other two limit switches are installed on the bottom of the lower projectile handling platform casting. These two switches are actuated by the rack bar when the hoist has completed its lowering cycle. One switch operates the interlock solenoid on the control mechanism at the lower projectile handling level and one operates the bottom of stroke indicator lights.

Solenoid Operated Interlocks. Each hoist is equipped with a solenoid operated interlock installed on the control mechanism at the lower projectile handling level. The solenoid operated interlock is operated by the top of stroke limit switch and the bottom of stroke limit switch upon completion of each cycle. This solenoid operated interlock locks



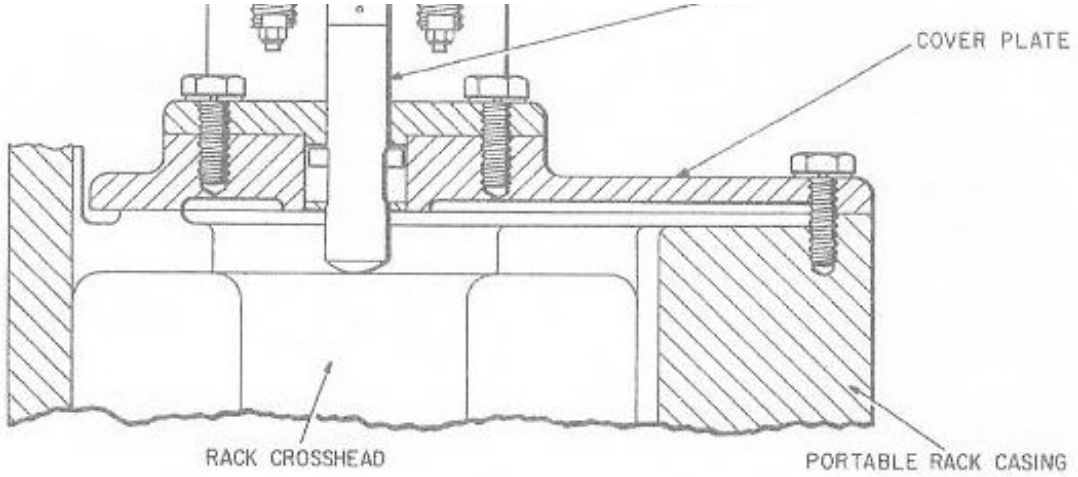


Figure 9-12. Projectile Hoist Top of Stroke Limit Switch - Sectional View

the control levers at Hoist or Lower, until the completion of the hoisting or lowering cycle. The hoist control levers cannot be moved from HOIST to LOWER, or from LOWER to HOIST, until the hoisting or lowering cycle is completed. The prevents inadvertent reversal of the projectile hoist which would cause the seating of projectiles on the nose of lower projectile.

Cradle operating controls. The cradle operating controls, similar for each hoist installation are:

Cradle control valve handle
Cradle latch
  Foot pedal
  Interlock (cradle alignment)
Cradle and spanning tray interlock limit switch
  Projectile indicator lever
  Interlock (projectile in cradle)

Cradle control valve handle. The cradle control valve handle, a bronze casting, is vertically pivoted in the cradle control valve mounting flange and is connected to the valve. Actuated when the valve handle is positioned toward RAISE CRADLE or LOWER CRADLE, the cradle control valve functions as described on page 9-12.

Cradle latch. The cradle latch assembly (fig. 9-13) is described on page 9-12. Located on the inside of the cradle fulcrum, it latches the cradle in a raised position through its contact with an integral cradle cam lug.

9-16A/B

Foot pedal. The cradle latch assembly is actuated to release (unlatch) the cradle through a foot pedal. Located near the cradle operator's station, the foot pedal is connected to the latch through shafting and the latch yoke. When depressed, the foot pedal moves the latch down against spring pressure to remove the latch from contact with the cradle cam

Cradle and spanning tray interlock limit switch. The cradle and spanning tray interlock limit switch is mounted on a bracket attached to the cradle fulcrum. The switch actuates an interlock solenoid in the elevating gear electric motor controller. A full description of the interlock limit switch and solenoid assembly is given on page 5-14 (chapter 5)

lug and permit the cradle to be raised or lowered.

Interlock (cradle alignment). The cradle latch interlock unit is mounted in the gun room compartment forward and below the cradle fulcrum. Connected by linkage to the foot pedal, the unit is arranged to interlock foot pedal operation of the cradle latch with the loading position of the gun. Locked at all other times, the foot pedal is released to unlatch the cradle when a bumper mounted on the loader's platform contacts (at five degrees elevation) a trigger pivoted in the interlock unit mounting bracket.

assembly is given on page 9-14 (chapter 9).

Projectile indicator lever. A hook shaped cam, the indicator lever, is displaced by a projectile as it enters the cradle. This actuates the indicator latch to close the projectile indicator switch.

Interlock (projectile in cradle). When closed by the indicator latch, the projectile indicator switch interlocks the hoist control handle against movement toward HOIST.

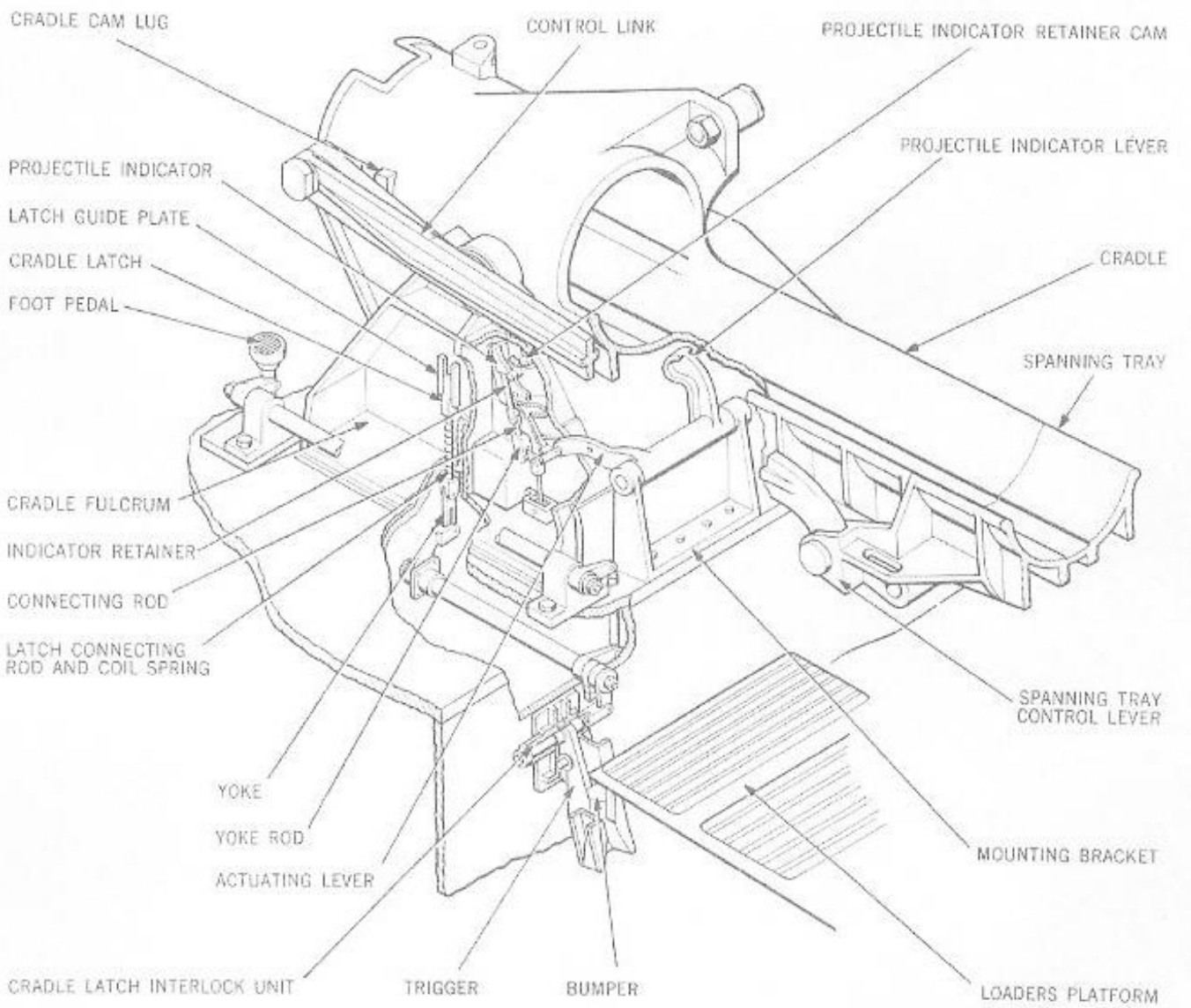
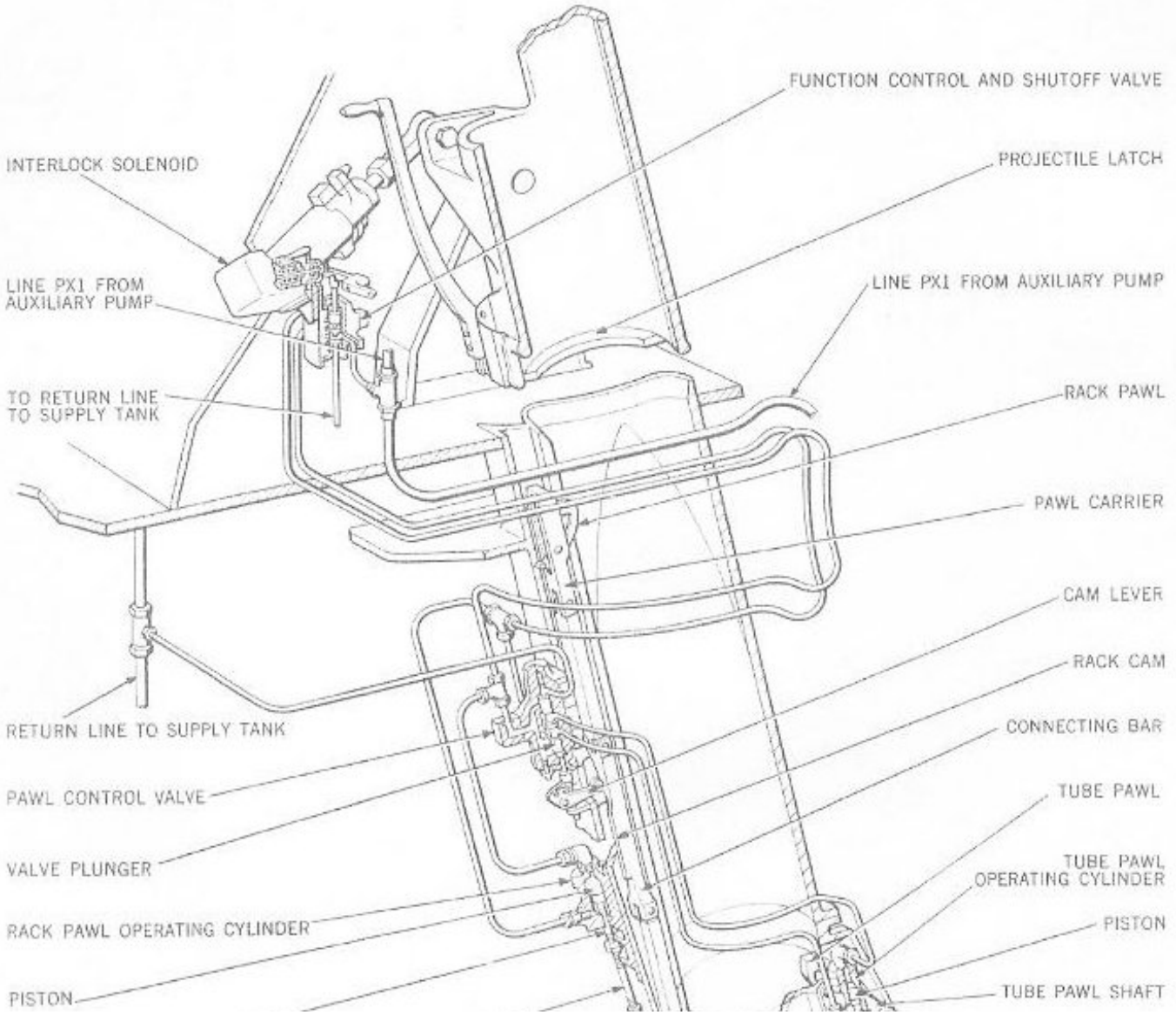


Figure 9-13. Projectile Hoist Cradle and Cradle Control Devices



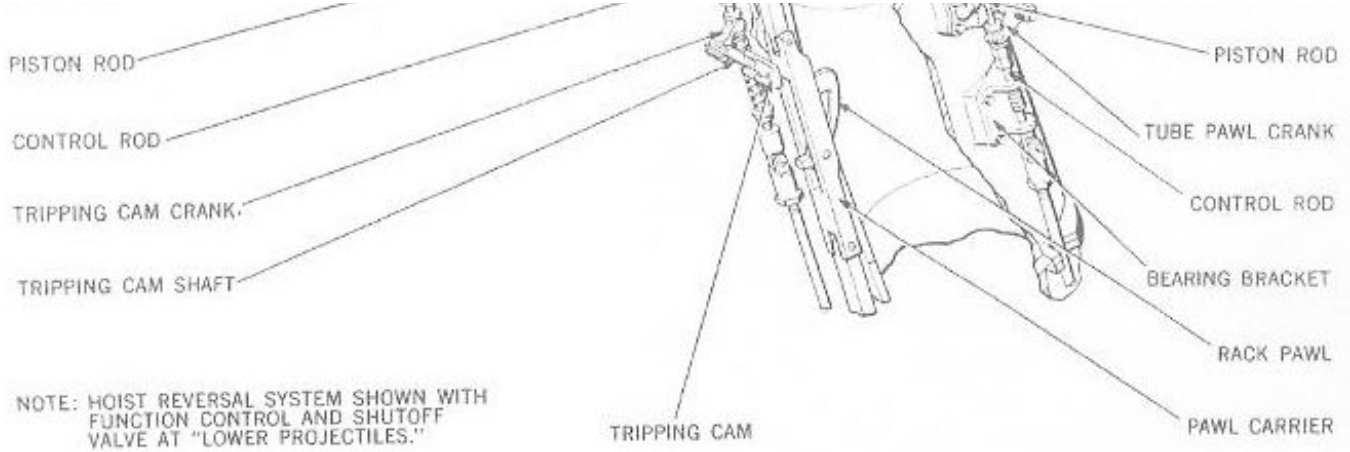


Figure 9-14. Tube Pawl and Rack Pawl Reversing Control Arrangement - Sectional View

Neutral start interlock. A neutral start interlock switch (fig. 9-19) is located on the underside of each hoist control handle bracket. It is plunger operated by a cam on the underside of the hoist control handle. The switches are connected in series in the controller starting circuit so that the proper drive motor cannot be started unless the switches are closed (by the control handles at neutral). In addition the switches are series connected with the function control and shut-off valve solenoid.

Function control and shut-off valve handle. The function control and shut-off valve handle is interlocked with the hoist control handles through a solenoid (fig. 9-19). The circuit arrangements prevent movement of the valve handle unless the hoist control handles are at neutral position. When the hoist control handles are at neutral, the neutral interlock switches are closed to energize and retract the solenoid to permit valve handle movement.

Door and shutter interlock (parbuckling operation). The projectile hoist uses eight door and shutter interlock switches, four at each loading level. Series connected, the switches open to de-

Reciprocating action of rack. The rack, connected to the piston rod of the rack operating cylinder assembly, has a similar reciprocating action while either hoisting or lowering projectiles. As a hoisting (or lowering) cycle is begun, the rack is raised by piston action until a full stroke (as indicated by TOP OF STROKE illuminated in the hoist control indicator) is completed. The rack is then lowered by piston action until a full stroke (as indicated by BOTTOM OF STROKE illuminated in the hoist control indicator) is completed. The next hoisting (or lowering) cycle may now be begun. The alternating up and down (reciprocating) action of the piston and rack to raise (or lower) projectiles to the next level is repeated until a projectile is in the cradle (or until the hoist is emptied if lowering projectiles).

Cradle lowering and raising. After a projectile has been lifted into the cradle in the final hoist cycle (as indicated by DANGER illuminated in the hoist control indicator) the rack is lowered through a full stroke. The cradle lowering operation, actuated by the cradle operating cylinder when permitted by the cradle solenoid valve, is now begun with the gun

energize solenoids A and B and prevent movement of the hoist control handle (fig. 9-19) when the shutters are opened and a projectile is parbuckled into the hoist. When the shutters close behind the projectile the switches close, the solenoids are energized, and the hoist control handle may be moved.

Operating handle. Located near the outer end on the underside of each operating handle (hoist control handle) bracket are the operating handle solenoids A and B (fig. 9-19). Connected in parallel, the solenoids are series-connected with the door and shutter interlock switches. When de-energized, the solenoid plungers extend upward through the handle bracket into a recess in the underside of the hoist control handle to lock it.

A solenoid operated interlock is installed on the control mechanism at the lower projectile handling level of each hoist which prevents the hoist control operating handle from being moved from HOIST to LOWER, or LOWER to HOIST, until the hoisting or lowering cycle is completed. This prevents inadvertent reversal of the projectile hoist which would cause the seating of projectile on the nose of lower projectiles. In the event of power failure, the manual retracting mechanism can be used to retract the solenoid plunger and the control operating handle may be operated.

OPERATION

General

The hoisting (or lowering) of projectiles and the raising or lowering of the cradle assembly are manually controlled, hydraulic power-driven operations. There are no provisions for manual operation of the hoist or cradle.

With the power on, operations of the hoist assembly are as follows:

elevated to its loading position, the breech opened, and the gun bore cleared. The cradle operator depresses the foot pedal (to unlatch the cradle) and positions the cradle control valve handle at LOWER CRADLE. The cradle operating cylinder then rotates the cradle and enters the spanning tray into the open gun breech. After the projectile and powder bags have been served to the gun by the rammer assembly (as described in chapter 10) the cradle operator positions the cradle control valve handle at RAISE CRADLE. The cradle operating cylinder then retracts the spanning tray from the gun breech and raises the cradle and spanning tray to a folded position.

Hoisting and lowering of projectiles. Projectiles are hoisted to the cradle or lowered from it by manipulation of the interrelated hoist controls. To hoist projectiles, the hoist control handle is positioned at STOP and the function control and shut-off valve handle at HOIST PROJECTILES. After a projectile has been parbuckled into the hoist, the hoist control handle is moved from STOP to HOIST. This inititates the hoist cycle and the rack is raised through a full stroke to lift the projectile to the next higher level. The hoist control handle is now moved from the HOIST to LOWER. This initiates the second half of the hoist cycle and lowers the rack so that the next hoist cycle may begin.

To lower projectiles, the hoist control handle is positioned at STOP and the function control and shut-off valve handle at LOWER PROJECTILES. This action ports auxiliary pump pressure to the hoist reversal system to cause pawl operation for lowering projectiles. The hoist control handle is then moved from STOP to HOIST; the rack moves up its full stroke to raise the projectile in the cradle just clear of the projectile latch. The projectile latch is then retracted manually to permit downward passage of the projectile. After the latch is fully retracted, the hoist control handle is moved from

PROJECTILE HOIST PAGE 2

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CHAPTER 10 RAMMER

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Chapter 10

RAMMER

16-inch Rammer Mark 5 Mods 0, 1, and 2

GENERAL DESCRIPTION

The ramming gear, shown in figure 10-1, is used in turrets of the IOWA class battleships. The rammer assembly for the right gun is designated 16-inch Rammer Mk 5 Mod 0, for the center 16-inch Rammer Mk 5 Mod 1, and for the left 16-inch Rammer Mk 5 Mod 2. All three assemblies are identically powered and controlled, differing only in the position and arrangement of some components, to seat projectiles in and to serve powder bags to the guns.

Type

16-inch Rammer Mk 5 is an electric-hydraulic mechanism that drives a folding chain through ramming and withdrawing movements. The mechanism is manually controlled from the rammer operator's station.

Design features

The three rammer assemblies of the turret are independently controlled by the rammer operators and have no interconnection. The assemblies have the same strokes, speeds, and degree of selective control.

The controls include automatic stops at the limits of chain movement which are adjusted to function ahead of positive limit stops. Ramming and withdrawing movements are manually controlled between the limit stops.

The A-end tilting box, manually offset to begin a ram or withdraw stroke, is automatically restored to neutral at the end of a withdraw stroke and at the end of a ram stroke when no projectile or powder is being served to the gun.

Components

The components of each rammer assembly are:

Power drive
- Speed reducer
- Coupling
- A-end (hydraulic pump)
- Coupling
- Auxiliary pump
- Stroking control mechanism
- B-end (hydraulic motor)
- Limit stop mechanism
- Supply tank and filter assembly

Rammer
- Casing
- Sprocket
- Sprocket bearings
- Sleeve coupling
- Chain buffer
- Chain
- Head link buffer
- Rammer switch

Controls
- Start-stop control
- Hand control gear
- Stroking control
- Neutral interlock switch

Component locations

The components have similar locations in the installed arrangements of the three rammer assemblies. The assemblies (fig. 10-1) are located to the rear of the transverse bulkhead of the turret officer's compartment. They are mounted on foundation weldments attached to the shelf plate over-hang, together with the casings of the folding rammer chains which are aligned with their respective guns. The operating hand lever (rammer operator's station) is just forward of the transverse bulkhead in the gun room compartment. The motor

Electric motor
Controller

controllers are located in the machinery space of the lower projectile flat, with the master pushbutton switch

located in the gun compartment at the rammer operator's station.

Functional arrangements

The power drive is an electrically driven hydraulic transmission. It drives the folding chain through a sprocket to ram projectiles to seated positions in the band slope and gun bore. The installed arrangement of the power drive is shown in figure 10-1.

The transmission is operated to ram or withdraw through the manually operated control linkage (fig. 10-10) which actuates the stroking control unit (fig. 10-5). The stroking control is a dual-purpose unit that provides for manually positioning the tilting box (fig. 10-2) and for automatically restoring the tilting box to neutral at the end of a ram or withdraw stroke.

Design differences

The left and center gun rammer assemblies are identical, except for the arrangement of some hydraulic pipes and the positions of components of the hand control gear. In the center gun installation, the linkage of the hand control gear is arranged to conform to the left side ram operator's position. For the left gun installation, the linkage is arranged for direct connection to the stroking control unit from the right side ram operator's position.

The right gun rammer assembly differs from the left and center installations as follows: the electric motor and A-end and the B-end are mounted in the opposite way from like units of the left and center installations, and the hydraulic pipes are rearranged to conform to this mounting. The linkage of the hand control gear is arranged for direct connection to the stroking control unit from the left side ram operator's position.

Performance data

The data are the same for all rammer installations.

Travel measurements:

Projectile travel, in.	226.43
Chain-to-projectile travel, in.	7.925
Chain-to-breech travel, in.	108.025

Weight of projectile:

AP Projectile Mk 8, lb	2700

Rammer chain speed:

Acceleration, full power, ft/sec/sec	22.2
Maximum velocity, fps	13.9
Time of ram stroke, sec	1.7

DETAIL DESCRIPTION

Power drive

Components. The components of each rammer assembly are:

Electric motor
Controller
Speed reducer
Coupling
A-end (hydraulic pump)
Coupling
Auxiliary pump
Stroking control mechanism
B-end assembly
B-end (hydraulic motor)
Limit stop mechanism
Supply tank and filter assembly

Electric motor. The electric motor is a squirrel-cage induction type. It is mounted on a structural foundation (fig. 10-1) that raises it slightly above the shelf plate. The motor is horizontally aligned with its integrally housed, flange-mounted speed reducer directly coupled to the A-end.

Motor data:

Type	squirrel cage, induction
Design features	waterproof, fan cooling, horizontally mounted, reduction gear drive
Horsepower	60
Revolutions per minute, synchronous	1800
Revolutions per minute, full load	1750
Revolutions per minute, reduction output, full load	501
Rotation (reduction output)	counterclockwise
Speed class	constant
Voltage	440
Amperes, full load	83.5
Amperes, locked rotor	560.0
Phases	3
Cycles	60
Ambient temperature deg C	40
Torque class	normal, low starting current
Weight (including reduction gear), lb	1750
Manufacturer	Reliance Electric Engineering Co.
Manufacturer's designation	Type AA
Drawing	231523

Contactor. Each electric motor is powered and controlled through an across-the-line, magnetic-type controller. Each controller contains a main contactor, overload relays, reset relays, and a hand-operated circuit breaker. The controller is operated from a master push button at the rammer operator's station. This switch is normally open and is closed by pressing the START-EMERG push button. The switch is opened by pressing the STOP push button.

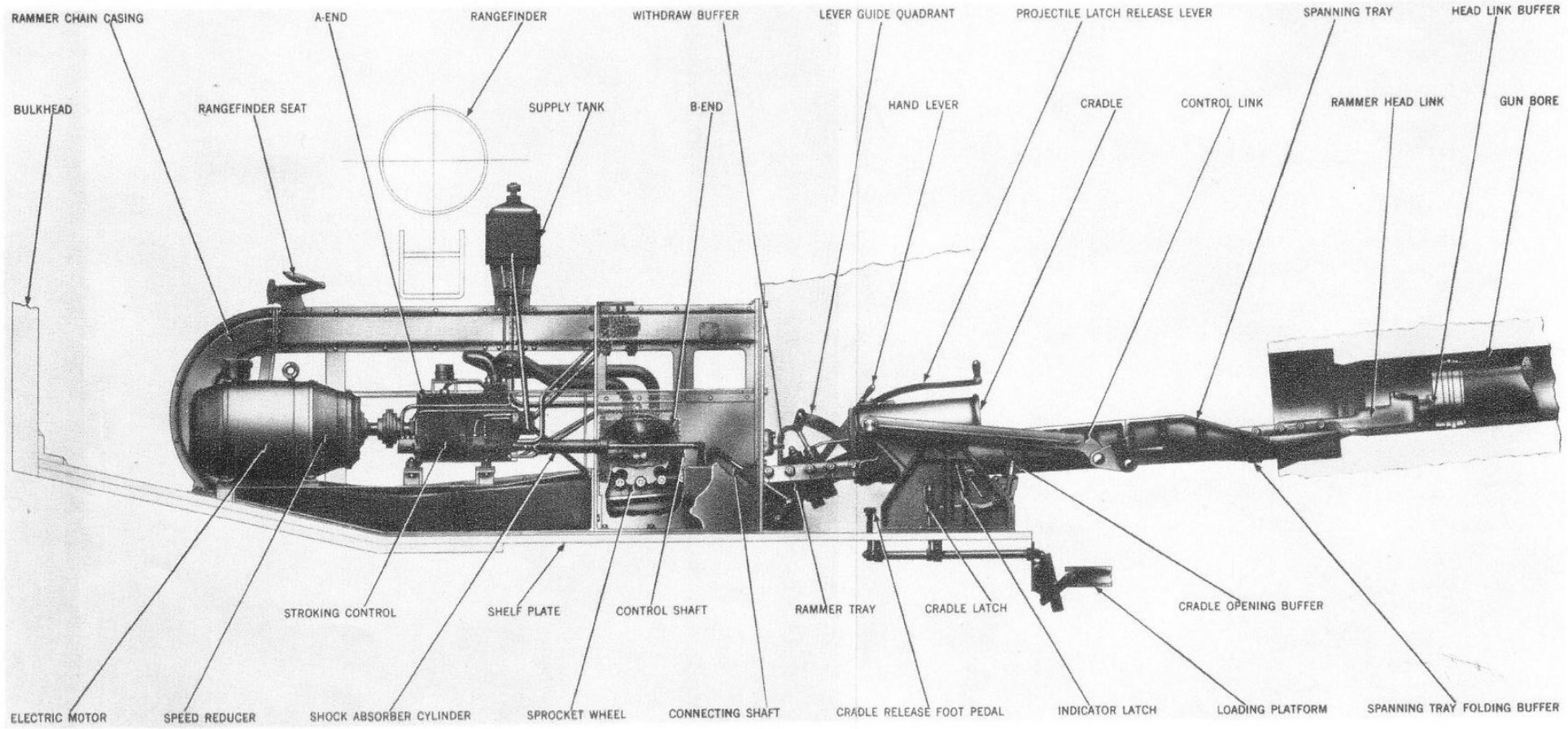


Figure 10-1. 16-inch Rammer Mk 5 Mods 0, 1, 2 - General Arrangement

Controller data.

Type	waterproof, semiautomatic across-the-line starter, controlled by remote push button
Ampere rating, full load	83.5
Protection	
Overload, thermal type	
Adjustable range, amp	78 to 95
Normal setting, amp	92
Short circuit, circuit breaker AQB, amp	675
Undervoltage	
Drop-out voltage	44
Sealing voltage	352
Shock rating	50
Weight, lb	165
Manufacturer	Cutler-Hammer
Drawing	273545

Speed reducer. The speed reducer is directly driven by the electric motor and is bolted to the motor case through an integral flange of the speed reducer housing. The housing encloses a spur gear train which is immersed in an oil bath for lubrication. The unit requires 1.5 gallons of mineral oil, Navy Symbol 2250, for proper lubrication. The speed reducer output shaft is connected through a flexible coupling to the A-end

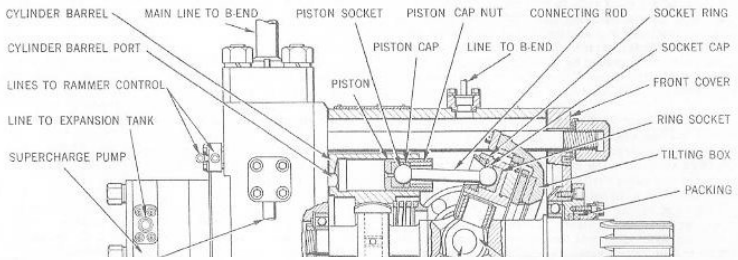
Coupling. The speed reducer-to-A-end coupling, designated Falk size 12FAS, serves as a flexible direct drive connection between the shafts of these two units. Similar to the coupling shown in figure 7-9, it consists of two identical steel hubs, a specially heat-treated and tempered steel alloy grid spring, and two identical steel shells which form the cover. The design gives drive connection through the grid spring, which is engaged in grooves milled in the outer flanges of the two hubs splined to the shafts. The hubs and grid spaces are packed with lubricant confined within the two shells by grease seals.

A-end assembly.

Components. The A-end (hydraulic pump), shown in figure 10-2, consists of the following:

Case
Main shaft
Cylinder barrel
Pistons
Connecting rods
Socket ring
Universal joint
Tilting box
Valve plate
Main valves

The A-end is a case-enclosed, multicylinder, type K, variable-displacement hydraulic pump of modified commercial design. It is connected to and is driven by the speed reducer through the



flexible coupling described in a previous paragraph.

Mounting. The A-end (fig. 10-1) mounted on a foundation weldment of the shelf plate overhang, is directly forward of its electric motor. These units are located on the right side of the rammer chain casings for the left and center gun installations, and on the left side of the casing for the right gun installation. The A-ends and electric motors are aligned with their common centerlines parallel to and 18.625 inches from the centerlines of the casings.

Pressure and tank connectings. In addition to the pipe connections of the main system, the A-end has a tank pressure connection with the B-end case. This connection functions for the circulation and drain of hydraulic fluid from the A-end to the B-end. There is also a connection from the tank to the supercharge pump which discharges through duplex filters to the A-end valve plate.

Case. A square oiltight case comprising a valve plate, case head, stroking control mechanism, trunnion cap, trunnion bearing assembly, and retainer encloses the A-end assembly. Forming a storage tank for hydraulic fluid in which the active parts rotate, the case has attached mounting feet that are bolted to the A-end foundation weldments. The general arrangement of parts within the case is the same as the training gear A-end shown in figure 6-5.

Main shaft. The main shaft of the A-end supports the rotating parts of the pump. At a point near the center of the A-end case, the main shaft is made in the form of a closed yoke to support the universal-joint trunnion and pin. Ahead of the closed yoke, two keys are secured in a section of the shaft which supports the cylinder barrel. The forward end of the main shaft is supported by a ball bearing in the valve plate. The splined end of the main shaft is similarly supported by a ball bearing in the case head.

Connecting rods. Eleven connecting rods connect the pistons with the socket ring. Each connecting rod has two ball-shaped ends. One end seats in a socket in the piston and is held in place by a split cap, cap nut, and nut lock. Shims are placed between the cap and piston surface to obtain proper clearance for the ball end. Each connecting rod is drilled throughout its entire length to provide for lubrication of the ball and sockets.

Socket ring. The socket ring is a circular piece that contains the sockets for the other ends of the eleven connecting rods. Each rod is retained in its socket by a socket cap, socket cap nut, and socket cap nut lock. The socket cap is split to facilitate installation and removal. The back of the socket ring has a roller track with two faces which bear against the bearings in the tilting box. Two slots, located about the center of the socket ring and 180 degrees apart, carry the main shaft trunnion bearing blocks of the universal joint.

Universal joint. Main shaft rotation is transmitted to the socket ring by a universal joint formed by a trunnion in the shaft yoke. The attached socket ring is free to rotate about the axis of the trunnion, giving a controlled variation in the length of the piston stroke.

Tilting box. The tilting box, a trunnion-mounted casting inside the A-end case, varies the angle of the socket ring with relation to the main shaft, changing the length of piston stroke from zero to maximum. It contains two groups of roller bearings which take the radial and axial thrusts of the socket ring. A shaft from the tilting box extends through a hole of the A-end case and is spline fitted to the control arm of the stroking control mechanism.

Valve plate. The valve plate, together with the casehead, form the stationary ends of the A-end case. The inner, or rear, surface of the plate is a finished surface against which the cylinder barrel rotates.

Cylinder barrel. The open center of the cylinder barrel has two keyways 180 degrees apart that run throughout its length to mate with the cylinder barrel keys secured to the main shaft. The barrel, retained on the main shaft by a nut, is held against the valve plate by a barrel spring which backs up against a flange and spring ring on the main shaft. The cylinder barrel contains eleven cylinder bores, which are of the same diameter throughout the length of the piston travel. They taper sharply at the end to a small cylinder port outlet.

Pistons. Each cylinder bore is fitted with a piston, ground and lapped to a smooth-working fit. When the A-end is transmitting hydraulic power, the fluid being discharged by the pistons presses against the ends of the cylinder bores and forces the barrel against the valve plate to reduce internal leakage between barrel and valve plate. This sealing effect increases as hydraulic pressure in the system increases. A drilled hole in the center of the front face of each piston admits hydraulic fluid to lubricate the ends of the connecting rods.

This surface has two semiannular grooves, called valve-plate ports, through which hydraulic fluid flows when power is being transmitted. These ports connect with the power transmission pipes between the A- and B-ends.

Between the valve plate ports are flat surfaces called lands. As the cylinder barrel rotates, the cylinder bores pass in succession over the lands. The lands are positioned so that they coincide with the end-of-stroke of each of the reciprocating pistons. There is no pumping action when the cylinder bores pass over the lands. The ball bearings for the main shaft are in the center of the valve plate. Two replenishing valves and a two-way relief valve are housed by the valve plate.

Main valves.

Replenishing valves. Each of two replenishing valves, a spring-loaded plunger type, is connected with a semiannular port of the valve plate. The valves operate under supercharge pressure to

separately supply each port of the closed system (whichever is the suction port) with fluid to replace that lost by seepage.

Two-way relief valve. The main system twoway relief valve (fig. 10-3) is located in the top of the A-end valve plate. A spring-loaded plunger type valve, it is operated by a spring-loaded plunger type pilot valve within the main plunger. The main valve, unseated when main system high pressure exceeds the pilot valve adjustment, bypasses the high pressure transmission line to the low pressure transmission line.

Coupling. The supercharge pump (fig. 10-4) is directly coupled to the end of the A-end main shaft through a flexible coupling. This unit, housed within the A-end valve plate, consists of two jaw flanges, a center member, and four bearing strips. The floating center member, mounted between the jaw flanges, is constrained to slide across the face of one flange on a line passing through the center, and across the face of the second flange in a direction at right angles to the first. The coupling has removable graphite impregnated bearing strips mounted between the center member and the flanges, together with a grease reservoir in the center member, to provide lubrication. The coupling is similar to the one shown in figure 7-16.

Auxiliary pump (supercharge pump).

Purpose. The auxiliary pump (supercharge pump), in addition to replenishing hydraulic fluid in the A- and B-end cases, provides forced circulation of fluid through the supply tank. This dissipates heat and keeps the temperature of the fluid nearly constant. The supercharge pump (fig. 10-4) is a constant-displacement, gear-type pump which discharges through a duplex filter to the supercharge relief and supercharge valves.

Mounting. The supercharge pump is flange-mounted to the A-end valve plate as shown in figure 10-2.

Relief valve. The supercharge pump relief valve is a spring-loaded, pressure-operated safety relief valve. It is interposed between the duplex filters and the supercharge valves to maintain a supercharge pressure of 50 pounds per square inch.

Stroking control mechanism. The rammer stroking control mechanism (fig. 10-5), a housing-enclosed unit, is mounted on the side of the A-end case as shown in figure 10-1. It is a dual-purpose unit through which the tilting box is positioned at stroke and which also acts to restore the tilting box automatically to neutral at the end of a ram or withdraw

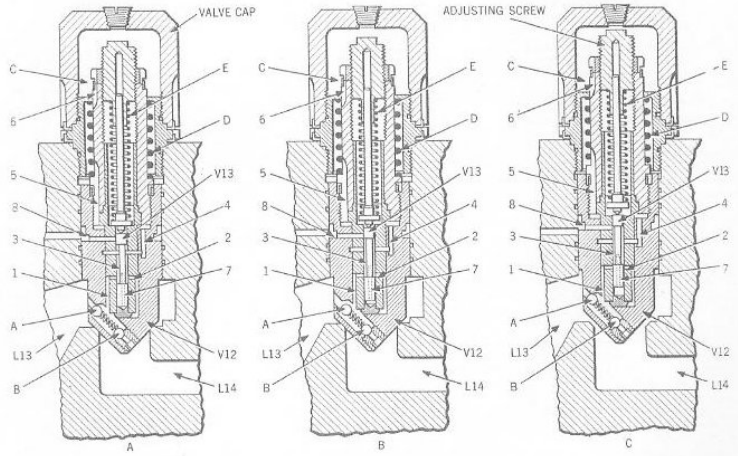


Figure 10-3. Two-way Main System Relief Valve, Sectional View

stroke. The stroking control mechanism is described in full detail on page 10-14, this chapter.

B-end (hydraulic motor).

Components. The B-end (hydraulic motor) consists of the following:

Case
Main shaft
Rotating group
Angle box
Valve plate

The B-end (fig. 10-6) is a case-enclosed, multi-cylinder, type K, fixed-displacement hydraulic motor of modified commercial design. It connects to, and drives, the rammer chain through the sprocket wheel described on page 10-10.

Mounting. The B-end, mounted on a foundation weldment of the shelf plate overhang (fig. 10-1), is forward of its electric motor and A-end. It is located on the left side of the rammer chain casings for the left and center gun installations, and on the right side of the casing for the right gun installations. Aligned parallel to and 29.0 inches from the transverse bulkhead of the turret officer's booth, the B-end centerlines are at right angles to the centerlines of the chain casings.

Pressure and tank connections. In addition to the pipe connections of the main system, the B-end has tank pressure connections with the A-end case and the supply tank.

Case. The valve plate and angle box of the B-end (fig. 10-6) are enclosed within a square case. Case, valve plate, and angle box are bolted together to form an oiltight assembly in which the torque-producing members rotate. The case has attached mounting feet that are bolted to the B-end foundation.

Main shaft. The B-end main shaft differs from the A-end shaft only in dimensions. An intershaft disc is located in the main shaft bearing recess formed in the valve plate. This disc compensates for any end play that results from allowable tolerances in the manufacture of other parts.

Rotating group. The rotating group of the B-end is basically the same as the rotating group of the A-end. It consists of the main shaft and universal joint, the cylinder barrel with its thirteen pistons and connecting rods, and the socket ring.

Angle box. The angle box in which the socket ring rotates forms an end plate of the B-end and is permanently tilted at an angle of 20 degrees. It forms an end plate of the B-end. The pistons and connecting rods therefore reciprocate through one full stroke each time the main shaft makes one full revolution. The socket ring rotates in a radial and thrust roller bearing assembly. The angle box holds the roller bearing assembly in which one end of the main shaft rotates.

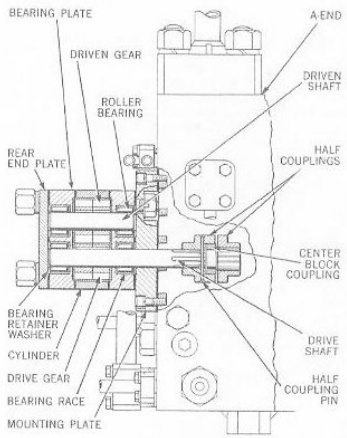


Figure 10-4. Supercharge Pump, Sectional View

Valve plate. The valve plate forms the other end plate for the B-end. It contains semiannular valve plate ports (similar to those of the A-end) which connect with the two power transmission pipes from the A-end, and it holds the roller bearing assembly in which the other end of the main shaft rotates. The cylinder barrel is held against the valve plate by a spring which backs up against a flange and spring ring on the main shaft. Hydraulic fluid is admitted into or is discharged from each cylinder through the two semiannular valve plate ports. In addition, the B-end valve plate contains the limit stop mechanism.

Limit stop mechanism. The rammer limit stop mechanism is shown in figure 10-7. It is built into the lower part of the B-end valve plate and is driven by the B-end drive shaft. The limit stop mechanism is a gear-driven, valve porting device that 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.

Components. The limit stop mechanism consists of the following:

Driven gear	Decelerate valves (two)
Driving gear	Reverse check valves (two)
Rocker arm	Flow cutoff valve
Striker pin	
Striker block	

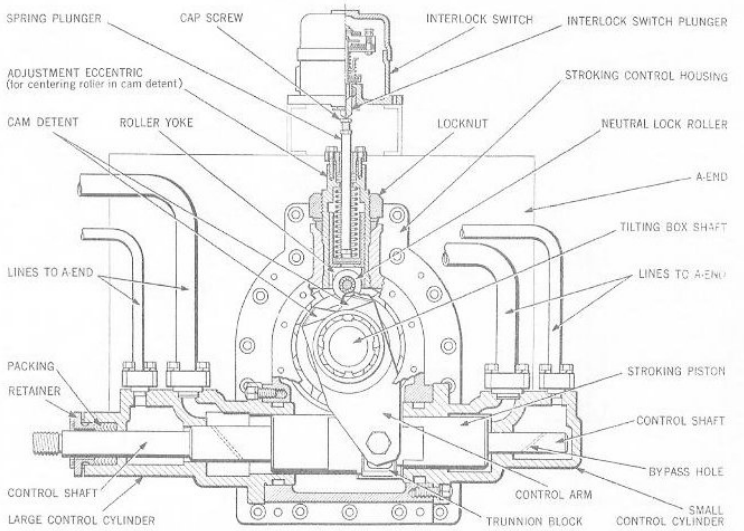


Figure 10-5. Rammer Stroking Control, Sectional View

Driven gear. The driven gear of the limit stop mechanism is an assembly that comprises a gear hub, a ring-gear with external teeth, a flat retainer plate, and six spring-loaded plungers. These components (fig. 10-7) are mounted in the gear hub which is keyed to a ball-bearing-mounted driven stub shaft. The spring-loaded plungers, equally spaced and arranged radially in the gear hub, fit into six detents in the internal surface of the ring-gear. The external surface of the ring-gear has 81 equally spaced teeth

Rocker arm. The rocker arm, a steel casting pivoted in a bronze bushing, has a pivot point that is in vertical alignment with and at a point midway between the driving gear and the driven gear stub shaft. At each end of the rocker arm and fastened to it is a striker block (fig. 10-7) which contacts either the ram or withdraw decelerate valve, depending on the direction of stroke. Movement of the rocker arm to contact a decelerate valve is actuated by rotation of the driven gear.

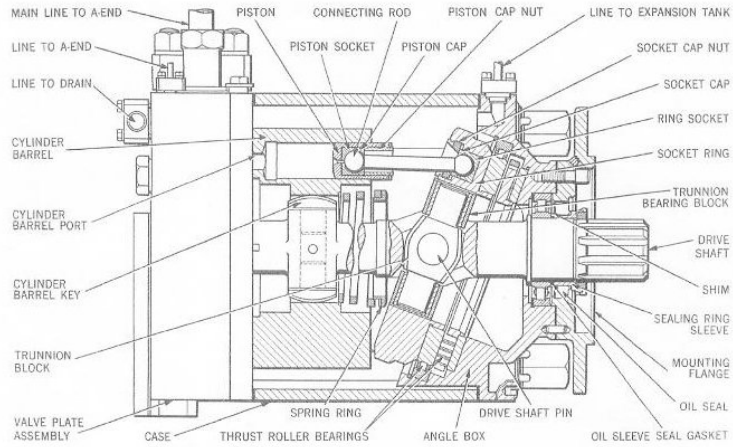


Figure 10-6. Rammer B-end, Sectional View

contact surface between the rocker arm and the decelerate valves.

Decelerate valves. There are two decelerate valves, one valve to control the deceleration of each of the ram and withdraw strokes. The valves are identical spool-type units. The lower wide land of each valve has a 0.828-inch taper per foot at the upper part. This taper provides the desired gradual deceleration toward the end of a stroke. The valves, spring loaded, are vertically positioned (fig. 10-7)

With the valve cap removed, the valve prevents loss of hydraulic fluid from the B-end case when a decelerate valve cap is removed to adjust the decelerate valve core.

Functional arrangements. The assembled arrangements of the components of the limit stop mechanism function together to decelerate and stop the movement of the rammer chain at its limits of ram and withdraw movement. The B-end rotates the driving gear which is meshed with the driven gear.

with the lower end of each in the path of a striker block in the end of the rocker arm. The timing of the limit stop action is adjustable through a valve core which is threaded into the decelerate valve body. The decelerate valve assembly, held down in an open position by a spring, is closed by contact of the rocker arm to throttle the B-end discharge.

Reverse check valves (two). Each of the two main transmission lines is provided with a reverse check valve (fig. 10-7) which is a spring-loaded ball. The check valves permit hydraulic fluid to pass in order that the B-end may rotate at the start of a ram or withdraw stroke when the respective decelerate valve is closed.

Flow cutoff valve. The spring-loaded flow cutoff valve is mounted in the top part of the B-end valve plate adjacent to the decelerate valve. It is held down in operating position by a valve cap (fig. 10-19).

The driven gear, with its attached striker pin, is turned by B-end rotation through 360 degrees for each full ram or withdraw stroke. Actuated by the driven gear, the striker pin contacts the striker block of the rocker arm, which in turn is actuated to contact a decelerate valve. The decelerate valve is closed against tension of its spring to cut off B-end discharge. Because of the tapered section of the valve, B-end rotation is brought to a gradual, decelerated stop.

Movement data.

Rammer chain movement	
To forward limit stop, full movement, inches	238.9
B-end shaft rotation	
Full rammer chain movement, number of turns	5.97
Decelerate valve, start	start of valve movement
Ram	in final 90 degrees
Withdraw	in final 90 degrees

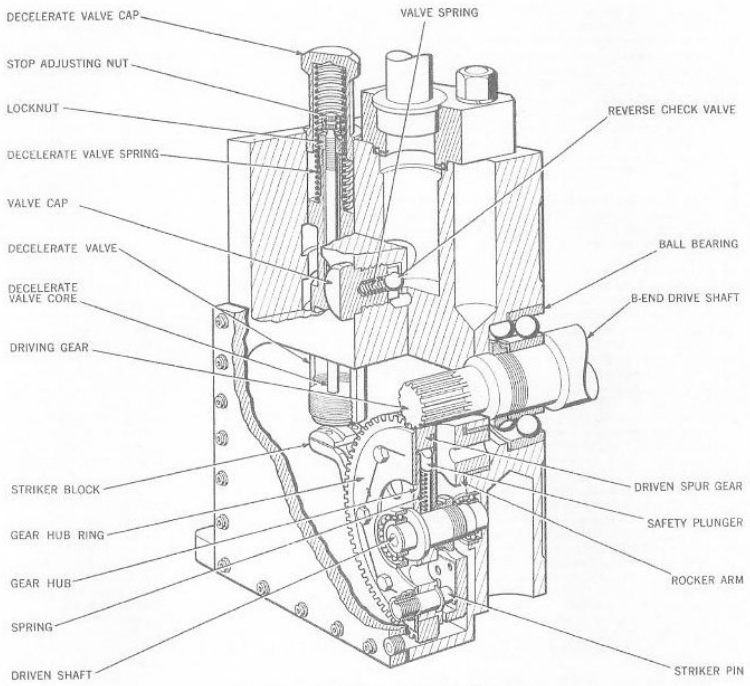


Figure 10-7. Rammer Limit Stop, Sectional View

Supply tank and filter assembly. The supply tank, a square-shaped container with a rounded dome-like top, is mounted on top of the rammer chain casing as shown in figure 10-1. The tank body, 10.5 inches high and 12.375 inches wide and deep, is mounted on a pedestal that is 7.0 inches high. The tank is drained through a plug at the bottom and filled through a vented filler cap on top. Full tank capacity is 7.0 gallons and tank capacity to the proper level as indicated on the tank gage is 5.0 gallons. Hydraulic fluid is supplied to the main transmission and supercharge circuits by the tank.

The duplex filters, a separate assembly, are mounted on the rammer chain casing adjacent to the supply tank. The filters are connected in the hydraulic line between the supercharge pump and the supercharge pump relief valve. The assembly removes foreign matter from the hydraulic fluid as it is recirculated to replenish the power drive from the supply tank.

Rammer

The rammer is the folding chain and chain housing assembly that is driven by the power drive unit. It consists of the following:

Casing	Chain buffer
Sprocket	Chain
Sprocket bearings	Head link buffer
Sleeve coupling	Rammer switch

Casing. The casing is a cast steel housing formed by five pairs of flange-bolted sections. It provides an enclosed U-course roller track for the chain link rollers. The casing, mounted on the shelf plate as shown in figure 10-1, is looped around structural elements of the rangefinder stand foundation. The forward sections of the casings enclose a bronze chain link guide, the sprocket and sprocket bearings, and the chain buffer. Circular covers, bolted to the casing over openings in the side, carry and cover the sprocket bearings, provide an opening for the drive shaft of the B-end, and receive any thrust from the drive shaft.

Sprocket. The chain is driven by a double-wheel sprocket which straddles the chain and meshes with the chain rollers, as shown in figure 10-9. It is an integral forged steel sprocket wheel and hub made with eight teeth with a chord of 4.87 inches on a pitch diameter of 12.73 inches. The hub is mounted in roller bearings enclosed within the sprocket bearing covers bolted to the casing. The drive coupling arrangement is a close-coupled, semi-floating quill type, driven through a splined sleeve coupling fitted into female splines of the hollow hub. This design, in addition to providing close coupling and self-adjustment for any slight misalignment, also facilitates coupling adjustment of chain position with respect to drive limit stops. The sprocket weighs 87 pounds and is 10.625 inches wide at the hub.

Sprocket bearings. The sprocket bearings are assemblies composed of three-piece cast bronze cages with specially hardened steel rollers. The outer diameter of the cage assembly is 8.85 inches, and it contains 30 equally spaced rollers. Two roller bearing assemblies (fig. 10-9) for each sprocket are arranged with an assembly seated in each sprocket bearing cover. The bearings are accessible by removing the portable sections of floorplate on either side of the casing and immediately to the rear of the transverse bulkhead. It is not necessary to remove the portable sections to lubricate the bearings. A grease manifold block, together with copper tubing leading to the sprocket bearing covers, has been provided for this purpose. The block mounted on the chain casing above the floor plates, has a grease fitting for each bearing.

Sleeve coupling. The sprocket is driven through a chrome-vanadium steel alloy sleeve coupling, as shown in figure 10-9. The sleeve is provided at one end with 10 male splines that fit into matching female splines of the sprocket hub. At its opposite end, the sleeve is provided with 10 female splines that fit onto the B-end drive shaft. The sleeve is 10.625 inches long and weighs 26.5 pounds.

Chain buffer. The chain withdraw buffer (a hydraulic type), mounted in the casing in front of the sprocket and above the chain link guide, is aligned with its plunger in the way of a lug on the chain head link (fig. 10-10). The buffer functions in the final three inches of chain withdrawing movement. Three throttling grooves of varying depths provide for graded fluid displacement from the rear to the front of the plunger piston. The plunger is restored to normal position by a coil spring within the buffer housing. There are two rawhide positive stops in the front face of the housing which prevent metal-to-metal contact. When the power drive assembly is properly adjusted, the withdraw limit stop device should stop the chain 0.75 inch from the rawhide stops. The plunger packing consists of three rows of graphite packing beneath a threaded gland, and is accessible at the front of the buffer. The filling hole (fitted with a plug) is placed at the top front of the buffer to permit servicing through the chain port.

Chain. The rammer chain, shown in figures 10-9 and 10-10, is a hinged-link, roller-type chain which extends from the driving sprocket as a rigid column. The chain, an assembly 297.25 inches long, is composed of a rammer head, head link, 26 male links, 25 female links, 53 link coupling pins, 108 rollers, washers, and a tail link. The head link, a leather-faced head, spring and hydraulic buffer assembly, has a buffer stroke of 2.5 inches. The tail link, a positive stop link, is designed to jam at the sprocket in the event of limit stop failure. When this occurs, the face of the head link extends 13.89 inches beyond the position of the base of a seated projectile. The chain rollers are arranged in pairs, one on each outer end of the link coupling pin. The rollers have free rotation on the pin, roll in engagement with the sprocket, and each roller is retained on its pin by a washer which is secured by peening over the pin rivet (except for the tail link pin). The male and female links are each 5.0 inches from pin center to pin center, and weigh approximately six pounds each.

Chain removal and replacement is provided by arrangements that give access to the tail link and tail link pin. A casing end cover plate, accessible in the gun compartment, and two small covers accessible in the turret officer's compartment provide access to these parts.

Head link buffer. The head link buffer assembly (fig. 10-10) is a fixed piston type that buffs the rammer chain as a projectile is seating. The head link, made of cast bronze, is 33.56 inches from the end of the buffer body to the pin center. The assembly acts to buff through compression of a coil spring and the throttled flow of fluid through three grooves of varying depth in the head. The plunger packing consists of three rows of graphite packing beneath a threaded gland. Buffer fluid is replenished through a normally plugged hole located at the top of the rammer head.

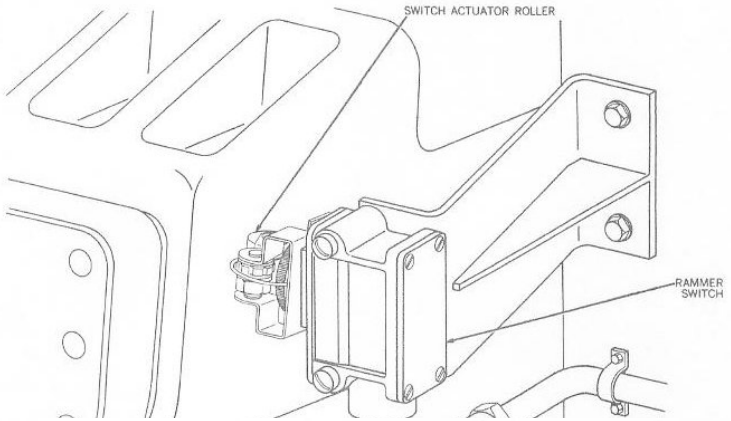
Rammer switch. Limit Switch Mk 6 Mod 1 with actuator and mounting bracket are bolted to the turret officer's bulkhead as shown in figure 10-8. This microswitch has one pair of normally open and one pair of normally closed contacts. The switch is positioned to be actuated when the rammer head link moves to within four inches of its fully retracted position. When the switch is actuated during the ramming stroke it energizes the coil of a Mk 5 Mod 1 relay. When the switch is actuated during the return stroke it closes its portion of Ready Light Circuit 1R (ch. 15) through the relay contacts to energize the powder door valve solenoid (ch. 11) and permit opening the powder unloading door.

Controls

The independent rammer control arrangements for all three installations of a turret consist of:

Start-stop control
Hand control gear
Stroking control

Start-stop control. Each rammer power drive is started and stopped through its electric-power motor controller (pages 10-2 and 10-3). The controller


SWITCH ACTUATOR ROLLER
RAMMER SWITCH

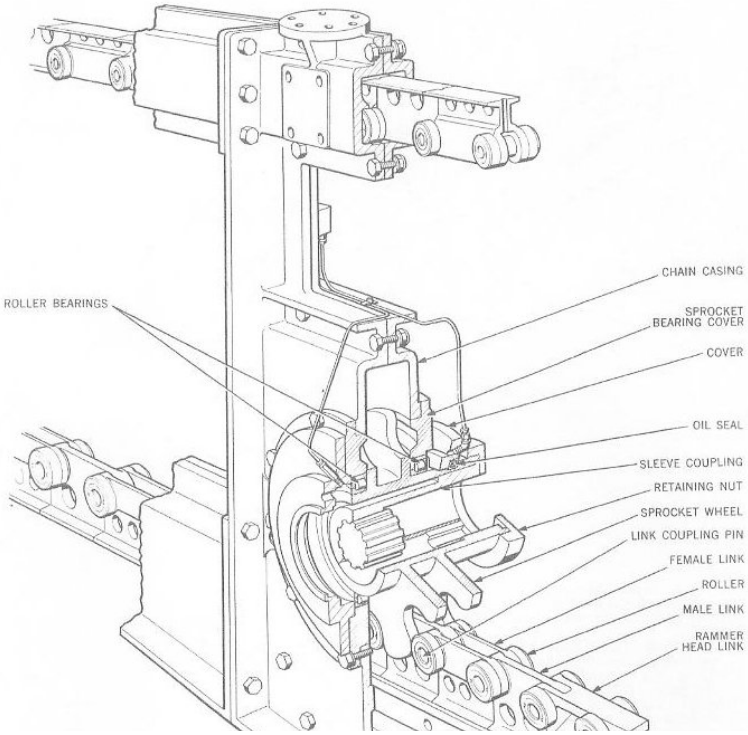

ROLLER BEARINGS
CHAIN CASING
SPROCKET BEARING COVER
COVER
OIL SEAL
SLEEVE COUPLING
RETAINING NUT
SPROCKET WHEEL
LINK COUPLING PIN
FEMALE LINK
ROLLER
MALE LINK
RAMMER HEAD LINK



Figure 10-9. Rammer Sprocket Coupling, Sectional View

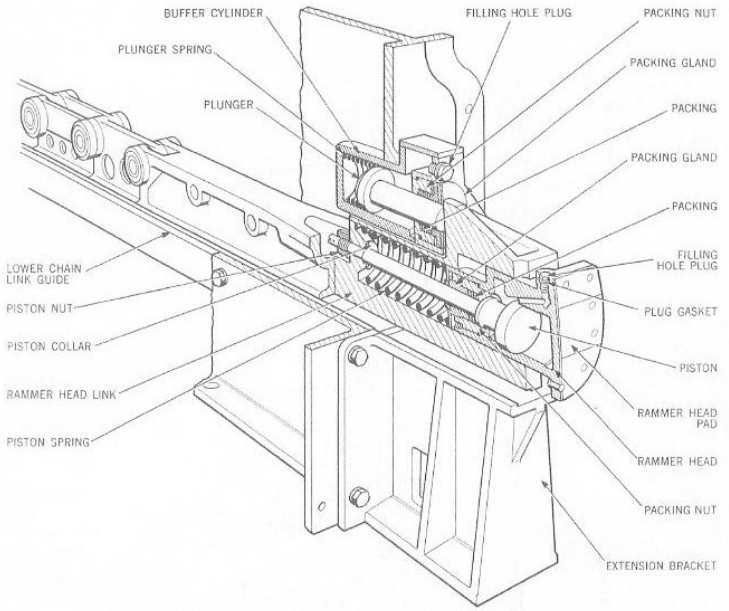


Figure 10-10. Rammer Chain, Head Link, and Withdraw Buffer, Sectional View

is remotely operated by two push buttons adjacent to the rammer operator's station. One push button is labeled START-EMERG and the other STOP.

Pressing the START-EMERG button closes a normally open, three-pole switch and energizes the coil of the main contactor to connect power to the electric motor. Holding contacts on the relays keep the power circuit closed when the START-EMERG button is released. In the event of power failure, the main contactor opens and remains open until the START-EMERG button is depressed. An overload relay opens the circuit when current demand is too great. The main contactor may be kept closed to keep the electric motor running in an emergency by holding the START-EMERG button closed. The electric motor is stopped by pressing the STOP button.

Hand control gear. The installed arrangement of the hand control gear is shown in figure 10-10. Its components are:

Hand lever
Lever pivot
Lever guide quadrant
Brackets
Shock absorber cylinder
Shaft linkage
Coupling

Hand lever. The hand lever, a flat steel bar approximately 33 inches long and 0.50-inch thick, is shaped and drilled for attaching a handle at its upper end and a lever pivot at its lower end. Mounted in the gun room compartment (fig. 10-1), the hand lever is the device which actuates the stroking control to initiate a ram or withdraw stroke. A spring detent, mounted on the upper end of the hand lever just below the handle, locates and retains the lever at neutral. It is an assembly consisting of a detent guide, a spring -loaded detent, and a roller mounted in the detent, which contacts the lever guide quadrant.

CHAPTER 10 RAMMER PAGE 2

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Chapter 11

POWDER HOIST

16-Inch Powder Hoist Mark 9 and

Mark 9 Mods 1 to 8, Inclusive

GENERAL DESCRIPTION

The turret powder hoist installation for each gun is similar to the arrangement shown in figure 11-1. The right, center, and left installations, designated 16-inch Powder Hoist Mk 9 Mod 0 and Mk 9 Mods 1 to 8 inclusive, are installed in turrets of the IOWA class battleships as tabulated below.

The 16-inch Powder Hoist Mk 9 is a car type vertical lift, electric-hydraulically driven, arranged for selective servo or manual control. All hoists are of the same general design and have identical power drives and controls.

Each powder hoist is a functionally independent assembly. It delivers a full service powder charge of six powder bags to a gun during each hoisting cycle.

Turret installation

Powder hoist installations, according to ship, turret, and position of each assembly are tabulated below.

Emplacement			Powder Hoist	
Ship	Turret	Gun	Mark	Mod
Iowa,	I	Right	9	0
	I	Center	9	1
New Jersey,	I	Left	9	2
	II	Right	9	3
Missouri,	II	Center	9	4
	II	Left	9	5
and	III	Right	9	6
	III	Center	9	7
Wisconsin	III	Left	9	8

Components

Each powder hoist assembly consists of the following components which are described in the following paragraphs:

Power drive
Powder hoist trunk
Trunk lower door assembly
Trunk upper door assembly
Powder car
Controls and interlocks

Component locations

units are located forward of the hoist trunks, above and within the gun girder box spaces, except for certain controls. The electric controllers are located in the machinery space of the upper projectile flat.

The powder hoist trunks extend from the powder handling room to the gun house roof. Left and center trunks are enclosed within the left gun girder box, the right trunk is similarly enclosed within the right gun girder box.

Powder hoist trunks are equipped with door assemblies arranged at the lower and upper ends. The lower door opens into the powder handling room and the upper door opens into the respective gun room compartment.

The powder car, mounted on rails, moves vertically within the hoist trunk between the lower and upper door assemblies.

Powder car and door actions are coordinated by a system of control and interlock devices located in the hoist trunk, on the powder car, and at the power drive units. The ON-OFF master pushbutton control is at the hoist operator's station.

Functional arrangements

Each powder hoist assembly is operated and controlled independently of the other powder hoists within the turret. Its power drive, an electrically driven hydraulic transmission, raises or lowers a powder car which is confined within the spaces of a trunk. The car is loaded through the trunk lower doors and is unloaded through the trunk upper door. The power drive controls automatically stop the car at the loading and unloading stations.

The trunk lower door arrangements provide for loading both powder car trays simultaneously from the powder handling room. The trunk upper door arrangements provide for unloading each car tray singly at two unloading stations. The upper door is hydraulically operated by pressure from an auxiliary pump mounted on the electric motor.

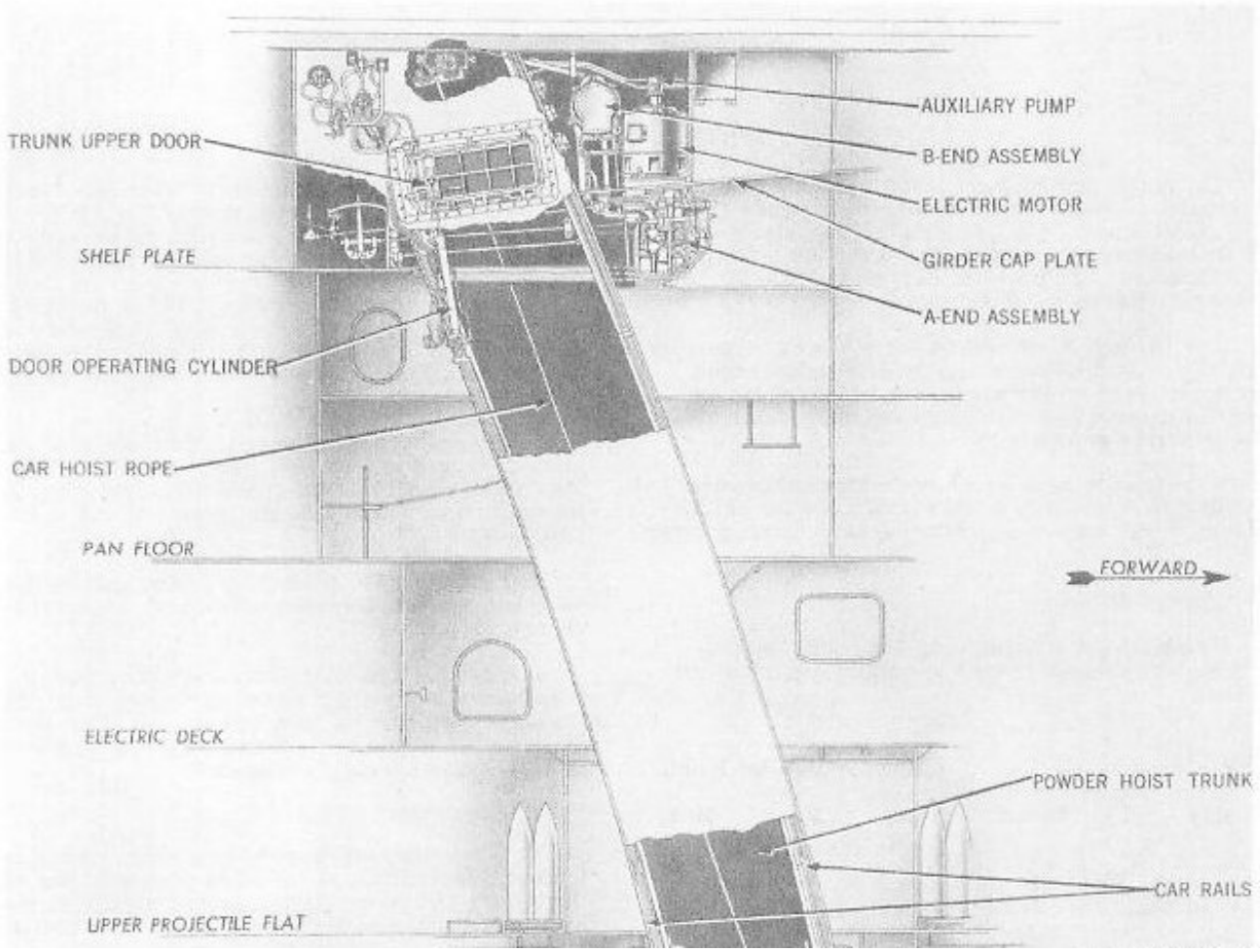
The arrangement of power drive operating controls is selective and provides for both servo and manual control of the hoist. Pressure for servo operation is derived from a control and supercharge pump mounted on the A-end assembly.

Design features

The turret powder hoist assemblies, independently

Component locations, shown in figure 11-1, are similar for the three turret assemblies. Power drive

controlled by separate hoist operators, have no interconnection. The assemblies have the same speeds and degrees of selective control.



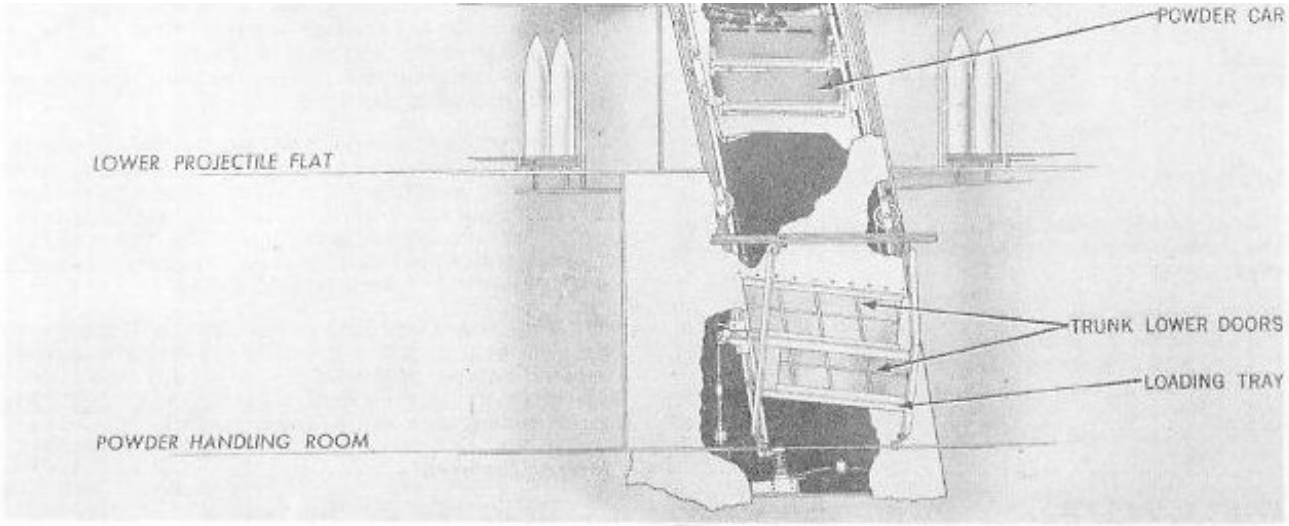


Figure 11-1. 16-Inch Powder Hoist Mk 9 Mod 0 - General Arrangement within Turret

The powder car, trunk lower and upper door assemblies, and the starting lever are interlocked. This arrangement prevents simultaneous opening of both doors, locks the starting lever at neutral (except when both doors are closed or when unloading the car at the upper station), and blocks opening of either door until the car arrives at that station.

Selective hoist controls provide for either servo or manual operation of the hoist.

The trunk upper door is operated by the rammer operator in the gun room.

Design differences

Turret powder hoist assemblies are of virtually identical design. The hoist vertical lift, tabulated below, varies according to its location. Power drive assemblies for right and center hoists are identical. They differ from the left hoist power drive assembly in that the B-end rotation is opposite due to its left hand installation. Powder cars for right and center installations are loaded and unloaded from the right side. The powder car for the left installations are loaded and unloaded from the right side. The powder car for the left installation is loaded and unloaded from the left side. Lower and

A-end assembly
B-end assembly
Auxiliary pump
Latch and vent valve
Safety car stop operating device
Safety car stop release valve
Control linkage
Dashpot

Component locations and arrangements. Located forward of the hoist trunks, the power drive units (fig. 11-1) are mounted above and within spaces formed by the gun girder box weldments. Left and center hoist units are mounted within the left box weldment, and the right hoist units are mounted within the right box weldment. At the top of the box weldments, girder cap plates subdivide the spaces and provide flooring and foundations for the electric motor and B-end assemblies. The A-end assembly, located below the cap plate and beneath the electric motor, is connected to the B-end by the main system hydraulic transmission pipes. The auxiliary pump is mounted on the electric motor upper end. Power drive control linkage extends rearward from the A-end assembly through the hoist trunk to the operator's control station.

loaded and unloaded from the left side. Lower and upper door assemblies and loading trays are mounted on the trunk to align with respective powder cars.

Data

All hoists have the same capacities and rates of delivery. The vertical lift varies for outboard and center gun turret installations and for the different turrets. These and other data are:

Hoist capacity	
Powder car (powder bags)	6
Vertical lift, feet	
Powder hoist designation	
Mk 9 Mod 0	45.48
Mk 9 Mod 1	45.64
Mk 9 Mod 2	45.48
Mk 9 Mod 3	54.08
Mk 9 Mod 4	54.14
Mk 9 Mod 5	54.08
Mk 9 Mod 6	43.08
Mk 9 Mod 7	43.14
Mk 9 Mod 8	43.08
Adjustable limits, feet	35 to 57.50
Hoist speed (longest vertical lift)	
Cycle time, seconds maximum	
Servo electrical	12.50
Manual mechanical (hoisting)	15.00
Manual mechanical (lowering)	12.00
Weights (pounds)	
Electric motor	2550
Electric controller	235
A-end assembly	1679
B-end assembly	2642
Powder car (empty)	2050

DETAIL DESCRIPTION

Power drive

The powder hoists are driven by identical electric-hydraulic power drive assemblies that consist of:

Electric motor
Electric controller
Motor to A-end couplings (two)

Electric motor. A squirrel-cage induction type, the electric motor is flange-mounted on the top of the gun girder cap plate. Vertically arranged, the motor has its output shaft at the lower end and is coupled to the A-end main shaft through two flexible couplings and a connecting shaft.

Motor data.

Type	squirrel cage, induction
Design features	waterproof, fan cooling, vertically mounted, direct drive
Horsepower	100
Revolutions per minute, synchronous	1800
Revolutions per minute, full load	1770
Rotation (looking down)	counterclockwise
Speed class	constant
Voltage	440
Amperes, full load	90
Amperes, locked rotor	950
Phases	3
Cycles	60
Ambient temperature, C	40
Torque class	normal
Weight, lb	2550
Manufacturer	Westinghouse Electric & Manufacturing Co.
Manufacturer's designation	CS-753
Drawing	274358

Electric controller. Each electric motor is powered and controlled through an across-the-line magnetic-type controller. Each controller contains a main contactor, overload relays, reset relays, and a hand-operated circuit breaker. Mounted in the machinery space of the upper projectile flat, the controller is controlled from a master pushbutton switch at the hoist operator's station. Normally open, the switch is closed to start the electric motor by pressing the START-EMERG button. The motor is stopped by pressing the master STOP button or an emergency stop pushbutton at the lower door operator's station.

Controller data.

Type	waterproof, semiautomatic, across-the-line starter, automatic circuit breaker, controlled by remote pushbutton

of rotation as it is tilted or offset from neutral by its yoke, which is connected to the servo and manual control devices.

The A-end hydraulic pump is a housing-enclosed multi-piston unit. It is a type K, reciprocating, vari-

Ampere rating, full load	126
Protection	
Overload, thermal type	
Adjustable range, amp.	125.8 to 170.2
Normal setting, amp	128.5
Short circuit, automatic circuit breaker, amp	1800
Undervoltage	
Drop-out voltage	50
Sealing voltage	370
Shock rating	150
Weight, lb	235
Manufacturer	Westinghouse Electric & Manufacturing Co.
Drawing	274360

Motor to A-end couplings (two). The electric motor shaft is coupled to the A-end shaft through a connecting shaft and two identical flexible couplings. Splined at each end, the connecting shafts for right and center power drive assemblies are 11.16 inches long, the connecting shaft for the left assembly is 13.75 inches long. The couplings, spline fitted at each end of a connecting shaft, are floating, self-aligning, extended, commercial units with design details as shown in figure 8-7 of chapter 8. Each coupling comprises a rigid hub which connects to a flexible sleeve and flexible hub. The flexible hub has external teeth at the shaft end which mesh with the internal teeth of the flexible sleeve. A slight clearance between the meshing teeth permits drive with small misalignment between the motor and A-end shaft. Each coupling is provided with a grease fitting for lubrication.

A-end assembly. The A-end assembly (fig. 11-2) consists of the components listed below. Type, arrangement, and functional purpose of the components are described in following paragraphs:

Hydraulic pump
Gear train
Control and supercharge pump
Control case
Oil filter
Oil supply tank

Hydraulic pump. Consisting of rotating and non-rotating groups, the pump is mounted in a housing and yoke. The rotating group comprises a cylinder block, seven pistons and connecting rods, a universal link and pin assembly, and the drive shaft. A yoke, valve plate, and valve block comprise the non-rotating group. The cylinder block and piston assembly are ball-bearing-mounted and are spring-held against the valve plate. The drive shaft, also ball-bearing-mounted, provides sockets for the connecting rods which attach to pistons within the cylinder block. Mounted within the cylinder block and main shaft, the universal link and pin assembly provides flexible drive between the two components. The valve plate and valve block are mounted in the valve

multiple piston unit. It is a type II, reciprocating, variable-stroke, rotating pump of modified commercial design.

The hydraulic pump unit, mounted vertically within the pump housing, is attached to the housing upper end with the splined drive shaft extending upward. Connected to the electric motor by the coupling arrangement described previously, the pump is continuously driven at approximately constant speed.

There are two centering spring assemblies, one for hoisting and one for lowering, which exert pressure on the pump yoke through spring-loaded plungers. Mounted vertically within the pump housing, the assemblies are so arranged that the plungers bear on arm mounted rollers of the pump yoke. The plungers are retracted by main system high pressure. After completion of a hoisting or lowering stroke, the assemblies return the pump yoke to a neutral position slightly offset toward hoisting.

The limit switch, used in the electric motor starting circuit, is mounted on top of the pump housing between the centering spring assemblies. It opens the starting circuit whenever the pump yoke is offset from a near-neutral position. This prevents a starting overload on the electric motor. It is a plunger-operated, two-pole normally closed switch. The switch plunger is operated by a limit switch cam mounted on the pump yoke midway between the arm-mounted rollers described above.

Gear train. A case-enclosed gear train assembly, comprising input, idler, and drive spur gears, is mounted on top of the A-end case. Driven at constant speed by electric motor input to the A-end pump, the assembly reduces electric motor speed to drive the control and supercharge pump at 1200 revolutions per minute.

Control and supercharge pump. The control and supercharge (servo) pump is a multiple vane, constant displacement, radial type. It is mounted on top of the gear train case by a flange attached to the pump housing. The pump is driven by a shaft spline fitted to the gear train drive gear. With its intake line connected to the A-end pump reservoir, the pump discharges through a duplex filter and control (servo) pump bypass valve into the A-end control case. The pump has a rated capacity of 11.0 gallons per minute at a pressure of 160 pounds per square inch, regulated by the circuit relief valve.

Control case. The control case, mounted on the side of the pump housing, is a valve block assembly with control levers. The valve block comprises a servo stroking piston, control pump relief valve, power failure valve, venting valve, control pump bypass valve, check valve, and servo valve. The control levers connect valve block components to the selector control lever and the control lever, in addition to operating the control pump bypass valve

valve plate and valve block are mounted in the yoke which is pintle-mounted on the pump housing. This arrangement provides a flexible drive connection between the drive shaft and cylinder block. The pump regulates hydraulic motor speed and direction

tion to operating the control pump bypass valve.

A-end mounting and access arrangements. The A-end pump housing is mounted on top of a zinc coated,

welded steel supply tank. Access to the tank is through inspection openings, normally closed by removable covers which are mounted on the tank ends.

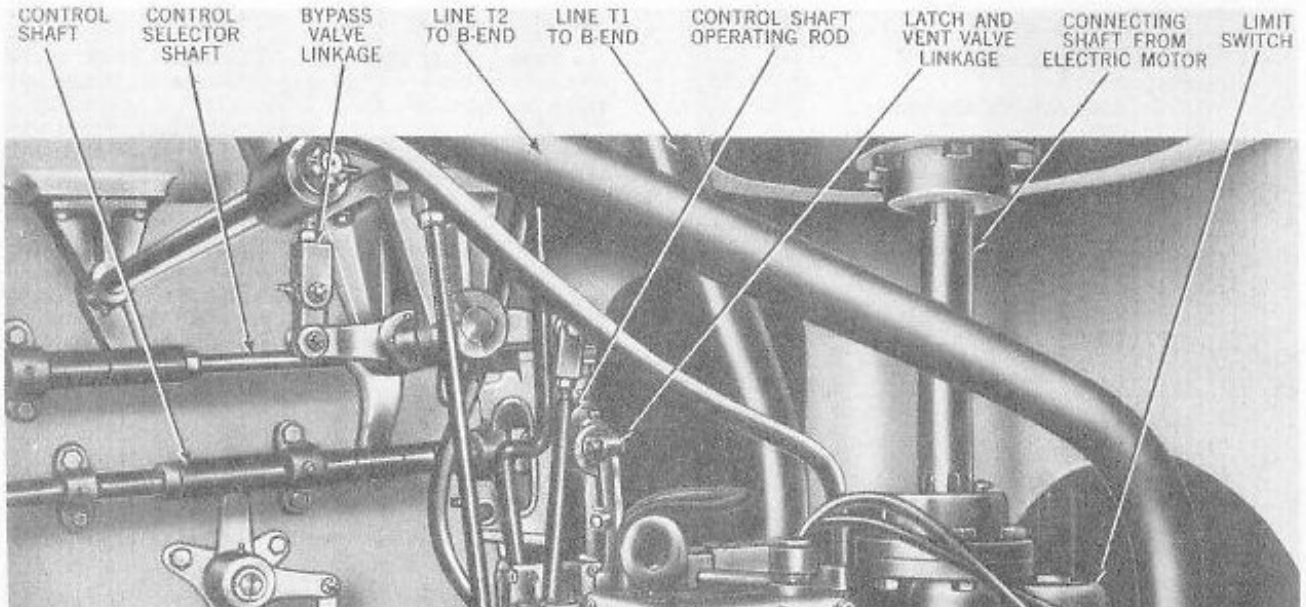
Oil filter. A screen-type filter in the control pump circuit removes foreign material from the hydraulic fluid before it enters the control case. The filter assembly, mounted on the side of the supply tank, comprises two elements which are used simultaneously in normal operation. However, a control valve permits individual use of either filter element, making it possible to clean a fouled element without stopping the power drive.

Oil supply tank. Providing a mounting base for the A-end pump housing, the supply tank is secured to its gun girder foundation by bolts and integral tank mounting feet. The tank and A-end assembly may be drained through a normally closed plug in the tank end. Filled through a removable cap in the side of the pump housing, the tank fluid level is verified by high and low level trycocks in the side of the tank.

B-end assembly. The B-end assembly (fig. 11-3) consists of the components listed below:

Hydraulic motor
Hoisting drum
Brake drum assembly
Foot valve
Acceleration and deceleration cams

Hydraulic motor. The hydraulic motor, consisting of rotating and non-rotating groups, is similar to the A-end hydraulic pump except that its cylinder block and valve plate have fixed offset position. A cylinder block, nine piston and piston rods, a drive shaft, and a universal link and pin assembly comprise



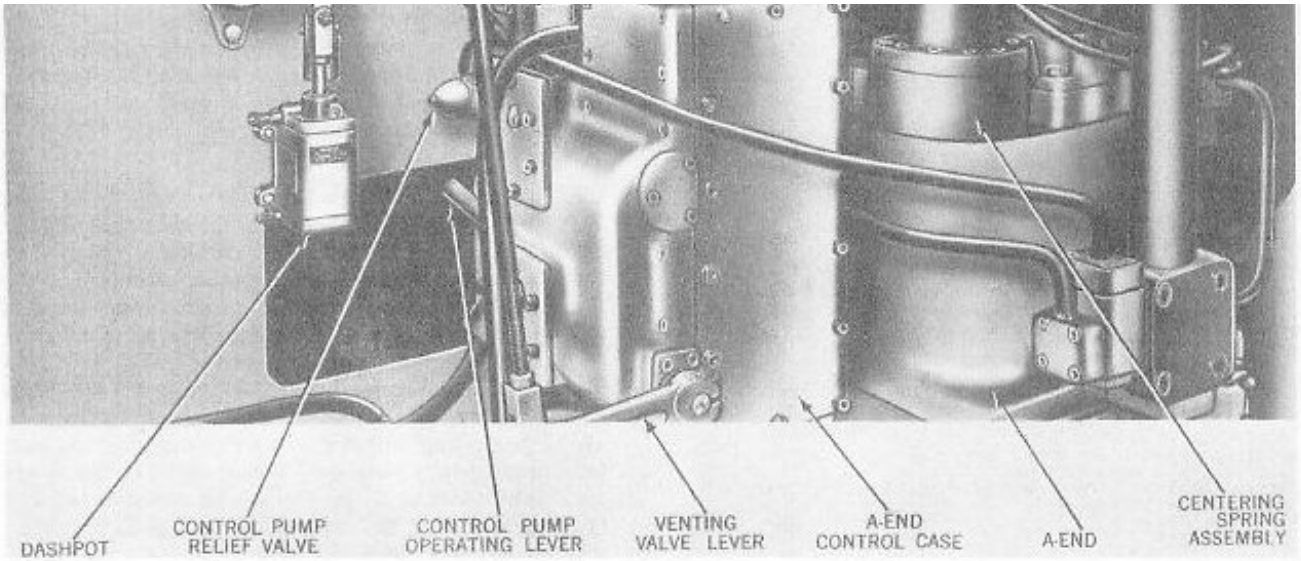


Figure 11-2. Powder Hoist A-end Assembly - General Arrangement

the rotating group. The non-rotating group comprises the motor housing, valve block, and valve plate. The rotating assembly is driven through a closed hydraulic circuit from the A-end pump which is connected to the B-end valve block by hydraulic transmission lines. Motor rotation is transmitted through the drive shaft, which is spline-fitted to the hoist drum. Hydraulic motor speed and direction of rotation are determined by the direction and degree of pump yoke offset.

The B-end hydraulic motor, a multi-piston unit, is a type K, reciprocating fixed stroke, rotating pump of modified commercial design. The hydraulic motor unit is horizontally mounted on a welded steel base plate which forms the foundation for the complete B-end assembly.

Components. The hydraulic motor consists of the following components:

Motor housing
Valve block
Valve plate
Cylinder block
Pistons and piston rods
Drive shaft

Relief valves. The hydraulic motor relief valves (two) are located in the B-end valve block. Identical valve assemblies, they are spring-loaded, plunger-type valves arranged in opposed positions, with separate oil passages. These extend to the main transmission pipe ports of the B-end valve plate. The valves are adjusted to relieve main system high pressure in excess of 2100 pounds per square inch.

Check valve. The check valve is located in the B-end valve block. It is a spring-loaded plunger-type valve that prevents excessive high pressure build-up at the start of a lowering cycle.

Hoist drum. The hoisting drum (fig. 11-3), a machined cylindrical steel weldment, is spline fitted on the hydraulic motor drive shaft. Thread-grooved to insure even winding of the powder car hoist rope, the drum has flanges at its outer ends to retain the rope on the drum.

Brake drum assembly. The brake drum assembly comprises the brake drum, brake band, brake oper-

Universal link and pin assembly
Relief valves
Check valve

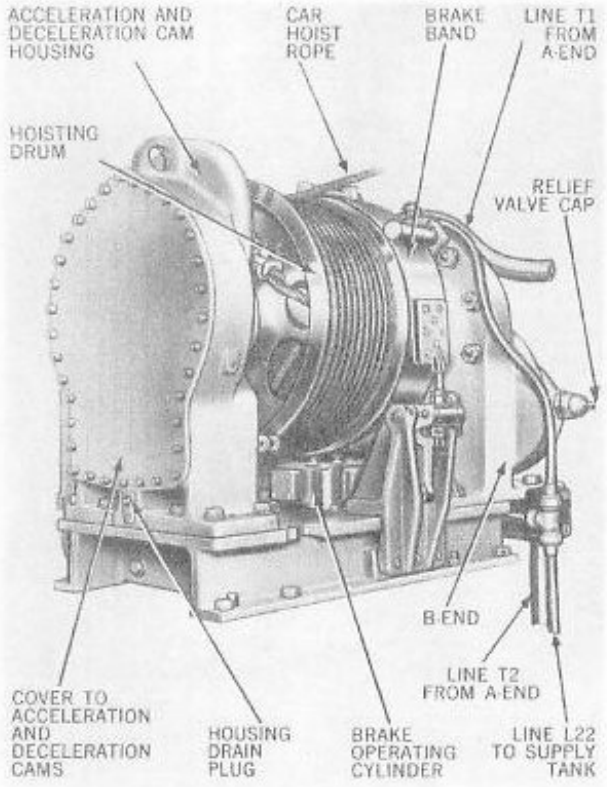


Figure 11-3. Powder Hoist B-end Assembly - General Arrangement

ating mechanism, and a brake ratchet assembly. The brake drum, a machined cylindrical steel weldment, is fitted with free bearing on the hydraulic motor drive shaft. It is connected to and driven by the hoisting drum through the brake ratchet assembly. The brake band is a steel band with attached brake lining material. Slightly narrower than the brake drum around which it is mounted, the band has riveted-on end pieces for attachment and adjustment. The brake operating mechanism is connected by a short link to the end of a brake operating lever which is attached to both ends of the brake band.

Brake operating mechanism. Secured to the welded steel base plate, the brake operating mechanism comprises a pressure-operated cylinder, links, and levers which operate to release or apply the brake. Pressure-operated to release, the brake is applied by venting the brake cylinder; this allows the spring in the cylinder to move the piston and linkage to contract the brake band. When the brake is released by main system high pressure, the band is forced out to rest against five adjustable stops, which hold the band away from the brake drum.

Foot valve. Mounted on the bottom of the B-end valve plate, the foot valve assembly is controlled by linkage mounted on the motor unit base plate. The foot valve prevents the powder car from lowering at the start of a cycle, while the brake is released and the main circuit pressure is building up to support the load. When stopping, after the main circuit is vented, the foot valve holds the load until the brake has had time to apply. The foot valve functions only at the beginning and end of a cycle because its control linkage is mechanically connected to the operating control linkage. As the A-end pump is offset from center, the foot valve linkage opens a valve which bypasses the foot valve. During a hoisting cycle, the foot valve is bypassed through a check valve in addition to the bypass valve.

Acceleration and deceleration cams. Four cams control the hoisting and lowering acceleration and deceleration rates. The cams are adjustable for positioning the flight and also for controlling its length.

is at SERVO ELECTRICAL. The valve, pressure-operated to withdraw the latch, is spring- and pressure-operated to return the latch to the cam notch. In mechanical control, the latch prevents movement

Cam housing. Located on the end of the B-end output shaft, the steel cam housing provides a mounting for the outboard bearing of the drive shaft. The housing includes a reduction gear which drives a cam support assembly. Geared to the output shaft, the cam support turns less than one revolution for a hoist flight of 53 feet. The acceleration and deceleration cams are secured to the cam support.

Cam controlled linkage. A rocker arm and shaft assembly, located at the lower end of the cam housing, transmits motion controlled by the cams to the A-end control rod. This motion is transmitted to the A-end through the control linkage and limits the degree the A-end pump may be offset. This determines the maximum speed of the hoist at each position of the powder car.

Differences between the B-end assemblies. B-end assemblies consist of exactly the same components for right and left installations, but the components are assembled differently. The method of changing power equipment from right-hand to left-hand is described on page 11-48.

Hydraulic system data.

Type . . . variable displacement speed gear	
Driven speed of pump, rpm	1800
Speed of hoisting drum	
Hoisting, rpm	168
Lowering, rpm	178
Torque load	
Normal, rated, ft-lb	2400
Maximum, rated, ft-lb	3750
Oil temperatures	
Normal operating range, F . . .	120 to 175
Maximum permitted, F	185
Displacements	
Pump, cubic inches per rev	11.84
Motor, cubic inches per rev. . . .	158.62
Manufacturer	Vickers, Incorporated
Manufacturer's designation	N-323
Drawings	325000, 325001

Auxiliary pump. The auxiliary pump is a multiple vane, constant displacement, radial type. It is mounted on the upper end of the hoist electric motor by an integral flange of the pump housing. Connected to the rotor shaft, the pump is directly driven at 1800 revolutions per minute by the electric motor. With its intake line connected to the supply tank, the pump discharges through a duplex filter into the hoist upper door hydraulic system, described on page 11-9. The pump has a rated capacity of 30.0 gallons per minute at a pressure of approximately 75 pounds per square inch, which is regulated by the system relief valve.

Latch and vent valve. The latch and vent valve, flange mounted on the forward end of the A-end case, of the hoist operator's control lever until the safety car stop release valve is moved to its start position. This prevents inadvertent lowering of the powder car on to the safety car stop device.

Safety car-stop operating device. The safety car-stop operating device (fig. 11-12) is a flange mounted on the forward side of the mounting plate that supports the safety car-stop release valve. Hydraulically connected to the valve, the device consists of a housing enclosed plunger which is attached to a lever mounted on the safety latch operating shaft. The device operates a pair of safety latches (described on page 11-12). These are withdrawn hydraulically from the path of the powder car when the starting lever is positioned at START. After a few inches car movement, the starting lever is released and the latches are spring-operated to return into the path of the car.

Safety car-stop release valve. The safety car-stop release valve, flange mounted at the hoist operator's station (fig. 11-4), is a two position, spool-type valve. It opens or blocks main system pressure flow to the safety car-stop operating device. Connected by linkage to the starting lever, the valve is manually operated. In the start position, it functions to start a cycle and to withdraw the safety latches from the path of the powder car. Spring-loaded, the valve returns to the stop position when the starting lever is released.

Control linkage. Control linkage elements (fig. 11-2) are located forward of the hoist trunk and interconnect the A-end control case and the control lever. The linkage consists of a steel bracket and shaft, to which are secured levers and adjustable control rods. Needle bearings are used to eliminate friction. The linkage connects the cam rocker arms in the B-end to the control pump operating lever at the A-end. The motion of the B-end cams is transmitted by the control linkage to the A-end pump yoke to limit hoist acceleration and deceleration rates.

Dashpot. The dashpot (fig. 11-2), flange mounted on the gun girder adjacent to the A-end, is a valve block arrangement of a dashpot piston, two ball check valves, and two plunger-type feed control valves. The piston is attached by a clevis and lever to the hoist control shaft. During mid-cycle (that is, when the rocker arms are clear of the acceleration and deceleration cams), the assembly prevents rapid shifting of the control lever. The assembly is adjustable by restrictions placed in passages to the feed control valves to slow down movement of the control lever. This sets the hoist acceleration and deceleration rates to not greater than 16 feet per second, nor less than the rates which are determined by the cams in the B-end.

is a two-position, spool-type valve. Connected to the control selector linkage, it acts during a mechanically controlled cycle to vent main system pressure and also to apply the hoist drum brake. The valve latch is mechanically held out of the hoist control linkage cam notch when the control selector lever

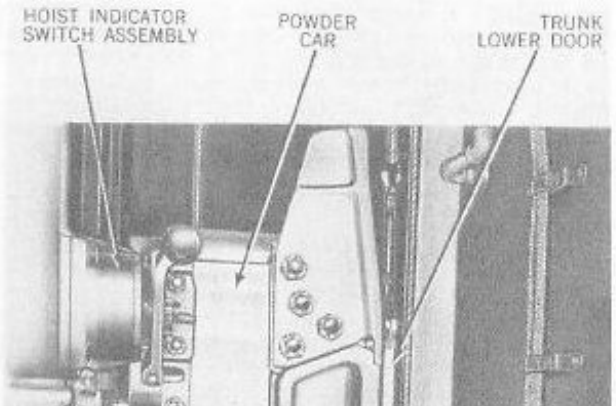
Powder hoist trunk

The powder hoist trunks comprise the powder car hoistways and accessory components within them. The three powder hoist trunks are similar enclosed

vertical hoistways (fig. 11-1) of rectangular plan section. They extend from the powder handling room and curve upward and rearward to the gun house roof. Left and center trunks rise within the left gun girder box weldment; the right trunk is similarly located within the right gun girder box weldment.

Components. The powder hoist trunk consists of the components listed below:

Car rails
Loading trays
Car buffer, lower
Car buffer, upper
Hoisting sheave
Car movement controls and interlocks



Car rails. The car rails provide curving double tracks for the powder car and are in vertical planes parallel to each other and to vertical planes of their respective gun axes. Each rail is made in five cast bronze segments. These are riveted to the side of the hoist trunk opposite the lower and upper door apertures with a width of 64.03 inches between rails. The lower segment of the forward rail is portable for powder car installation or removal.

Loading trays. The loading aperture at the lower end of the hoist trunk is provided with a loading tray assembly. This assembly comprises two fixed trough-like brass trays which are horizontally spaced 22.5 inches apart. The lower tray is 25.2 inches above the powder handling room platform. The trays tilt down at the forward end to align with the powder car trays when the car is at the loading station.

Lower car buffer. The lower car buffer assembly comprises two identical spring and hydraulic buffer units and an expansion tank. All are mounted at the bottom of the hoist trunk with the buffer units aligned to contact the forward and rear ends of the powder car. The buffer cylinder has throttling grooves of variable depth in its wall. A coil spring on the buffer piston rod beneath the piston rod head augments the buffing action and returns the piston to full stroke after it has been compressed. Located midway between the buffer units, the expansion tank provides a common buffer fluid reservoir for both hydraulic cylinders and is connected to them by copper piping. The buffer assembly is placed so that the powder car is 0.5-inch above the buffers when at the loading station. The maximum buffing stroke is 5.75 inches.

Upper car buffer. The upper car buffer comprises four rubber buffer pads. These are located immediately below the hoisting sheave and are attached to the same side of the hoist trunk as the car rails. Clearance between the pads and the powder car stop is 1.25 inches, when the car is at the upper unload-

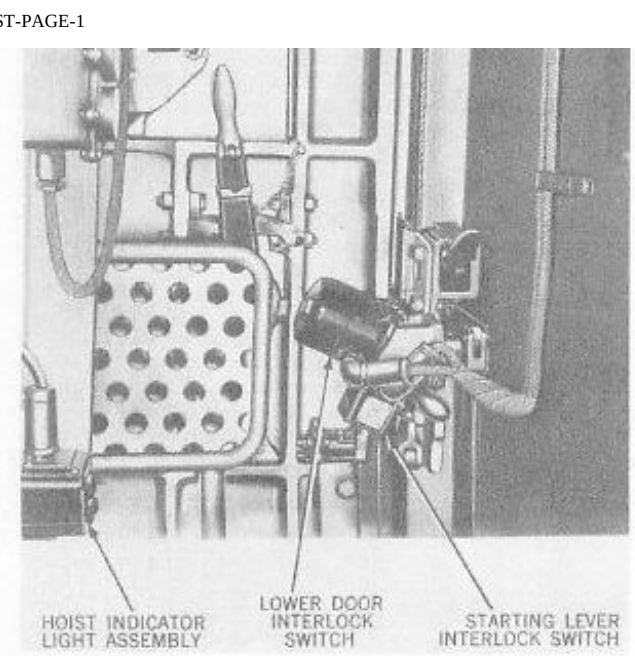


Figure 11-4. Powder Hoist Lower Door Operator's Station - General Arrangement

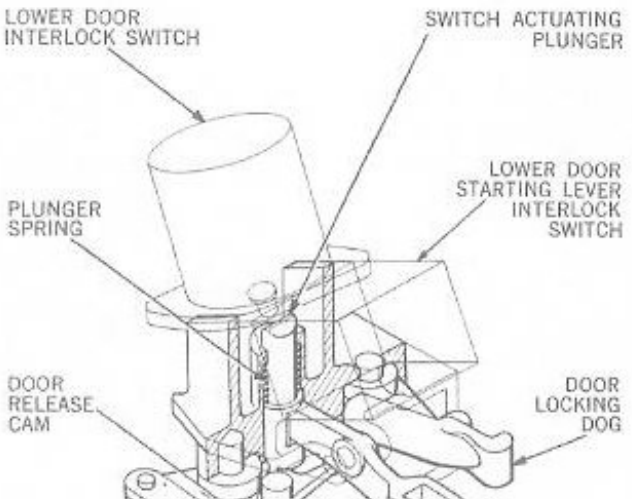
ing station.

Hoisting sheave. The hoisting sheave, mounted on brackets bolted to the sides of the hoist trunk, is suspended beneath the gun house roof. A 16-inch diameter single-grooved wheel, the sheave guides the car hoist rope and has free rotation on its mounting pin.

Car movement controls and interlocks. Car movement, car stopping at loading and unloading stations, and trunk door opening and closing are coordinated by controls and interlocks described on page 11-13.

Trunk lower door assembly

The loading aperture for each powder hoist trunk is fitted with a vertically sliding, manually operated, two section door. The upper section rises and the lower section drops when the door is opened. Both sections come together, when closed, at the level of the upper loading tray (as described above). The lower door is arranged with latches to prevent door opening movement except when the powder car is at the bottom of the hoist trunk.



Foot-operated latch. Operated by a foot pedal at the lower door operator's station, the foot-operated latch is a spring actuated device. It latches the door sections together until released by the operator when the car is at the loading station. The latch operates in conjunction with the lower door interlock switch and the starting lever solenoid switch so that the hoist cannot be operated when the lower door is open.

Trunk upper door assembly

The unloading aperature for each powder hoist trunk, located in the respective gun room, is fitted with a door hinged at the lower door sill. The door opens downward into the gun room to form a transfer tray between the powder car and the open projectile hoist cradle. The door is shown in its closed position in figure 11-6.

Components. The trunk upper door assembly consists of:

Door
Door locking dog mechanism

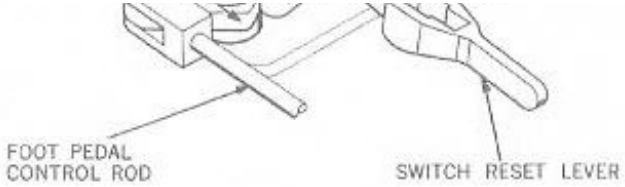


Figure 11-5. Powder Hoist Lower Door Latch - Cutaway View

Components. The trunk lower door assembly consists of:

Door
Door stops
Door latch
Foot-operated latch

Door. Made in sections, the lower door comprises two similar light weight, fabricated steel panels with stiffeners of the same material. Weighing approximately 57 pounds the door panels are identically rhomboid shaped. Arranged to slide in vertical channels of the supporting frame, the two panels are connected by a wire rope that passes around grooved sheaves. In this arrangement, each door section acts as a counterweight for the other in door opening or closing movements.

Door stops. Wedge-shaped door stops are mounted on the upper and lower edges, respectively, of the upper and lower door sections. These stops contact bracket mounted rubber bumpers which are arranged on the inner sides of the trunk both above and below the door aperture to limit door opening movement.

Door latch. A mechanical latch located on the inside of the door, the door locking dog (fig. 11-5) is spring actuated to latch when the door is closed and the powder car begins to ascend. The dog is arranged with a car actuated unlatching lever, located inside the hoist trunk, which projects into the path of a latch operating cam mounted on the car (page 11-12). Cam and lever function to unlatch the door during the final 2.75 inches of car descent.

Dog locking latch
Door operating mechanism

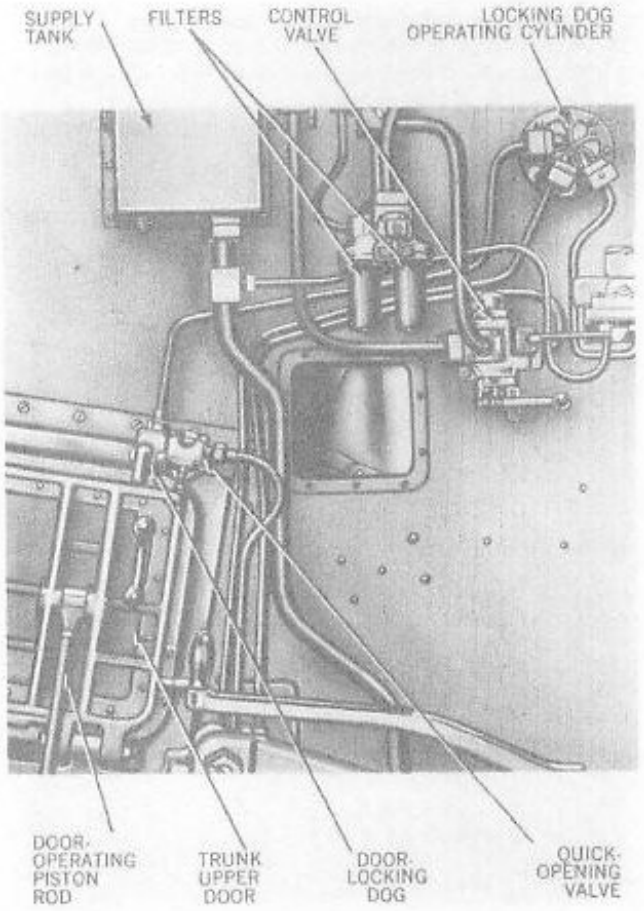


Figure 11-6. Powder Hoist Upper Door Control Station - General Arrangement

Door. The door is a rectangular aluminum alloy casting with integral hinge lugs on its lower edge.

moving to unlatch the dog linkage, the interlock hook and arm lever operates a normally closed interlock

The inner edge of the door is fitted with a rubber-cored asbestos-metal-cloth gasket which is secured by an aluminum retaining strip. The outer face, fitted with seven bronze dog wedges, has two integral lugs for mounting the door operating piston rod bearings. A cast bronze door frame, riveted in the trunk door aperture provides integral mating hinge lugs and a contact flange for the door hinge lugs and gasket respectively.

Door locking dog mechanism. The door locking dog mechanism comprises seven door locking dogs which are simultaneously operated by a linkage system to lock or to unlock. This system is actuated by a toggle and yoke linkage which is normally operated hydraulically, but which may also be operated by an emergency hand crank mechanism (fig. 11-7). Each dog locking operating mechanism is attachable to the toggle linkage by a removable coupling pin. Each is secured in a stowed position when it is uncoupled from the linkage.

Dog locking latch. The main toggle link of the locking dog linkage has a latch lug which engages a spring-loaded hook of an interlock hook and arm lever (when the dogs are in a closed position). The arm of the lever projects into the path of the powder car and is pushed back by the car to release the hook (and the toggle linkage) when the ascending car is 2.5 inches from its upper unloading position. When

switch.

Door operating mechanism. A hydraulic assembly, the upper door operating mechanism consists of a door operating cylinder, a locking dog operating cylinder, an auxiliary pump, a control valve, and a powder door solenoid valve. These units are shown schematically in figures 11-8, 11-9, and 11-10.

The door opening circuit is a low pressure hydraulic system independent of the car hoisting hydraulic system. The door operating piston is spring counterbalanced. Operating pressure is derived from the auxiliary pump described on page 11-7. The door control station is in the respective gun room.

The powder door solenoid valve, added by Ordalt, is an interlock that prevents door opening upon operation of the control valve until the gun is in battery, the breech is open, the bore clear condition has been verified, and the bore clear switch has been depressed, and the rammer has returned to the fully retracted position after ramming a projectile. After the above conditions are satisfied, the solenoid valve permits door opening, as shown in figures 11-8, 11-9, and 11-10, until the gun captain's ready switch is positioned to READY after loading. The powder door valve solenoid is controlled by the interlock portion of the IR circuit as explained in chapter 15.

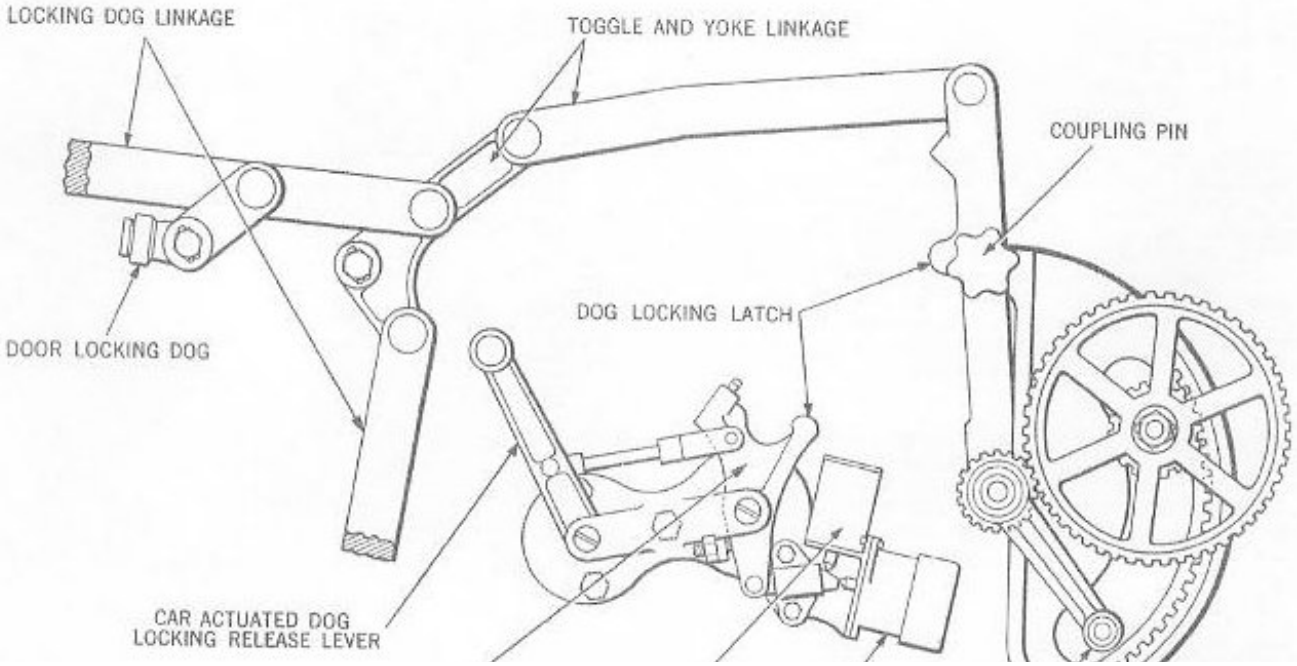




Figure 11-7. Upper Door Dog Operating Mechanism (Hand)

With the operating control at NEUTRAL (fig. 11-8), auxiliary pump pressure is vented to the supply tank through the relief valve. When the operating control is at OPEN (fig. 11-9), pressure is ported to the locking dog operating cylinder. This continues until final movement of the cylinder piston uncovers a port which ports the pressure to the top of the door operating piston. When the operating control is at CLOSED (fig. 11-10), pressure is ported to the locking dog operating cylinder automatically as the door closes by tripping of a quick-opening valve by the final closing movement of the door.

Powder car

The powder car (fig. 11-11) is arranged with guide wheels which bear on the car rails described on page 11-8. It is equipped with dumping trays and has attached control and operating cams and devices. The car conveys a full service powder load to the gun in each hoist cycle. Connected to the car hoist rope, the car has vertical movement through the hoist trunk (fig. 11-1).

11-10A/B

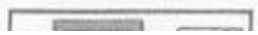
Components. The powder car consists of the components listed below:

Car
Car guide wheels
Safety latch stops
Safety latches
Safety latch cams
Lower door latch operating cam
Upper door dog unlocking cam
Car hoist rope
Rope guide
Car switch operating bar

Car. The car body (fig. 11-11) is a box-like aluminum casting, open at the tray side. Two cast aluminum powder bag (dumping) trays, horizontally pivoted in ball bearings, are mounted one above the other in the car body front and rear. Both trays have limited tilt and are separately tilted from their normal position by handles. These are located at the rear of the car toward the hoist operator and have detent arrangements to latch the trays in normal position. Steel bar balance weights are attached to the undersides of the trays. Approximately 16 pounds for each tray, the weights prevent tray oscillation when the car is traveling from one station to another.

Car guide wheels. The car guide wheels are pin-mounted in fixed cast steel brackets which are mounted at the four corners of the car body. The wheels are machined steel with bronze bushing inserts for bearings.

Safety latch stops. The safety latch stops comprise four steel blocks bolted two at the front and two at the rear of the powder car at the tray side. Arranged the same at front and rear, one block is located at the bottom of the car and the other is 22.5 inches above the bottom. Contacted by the safety latches, the safety latch stops provide emergency support for the car.



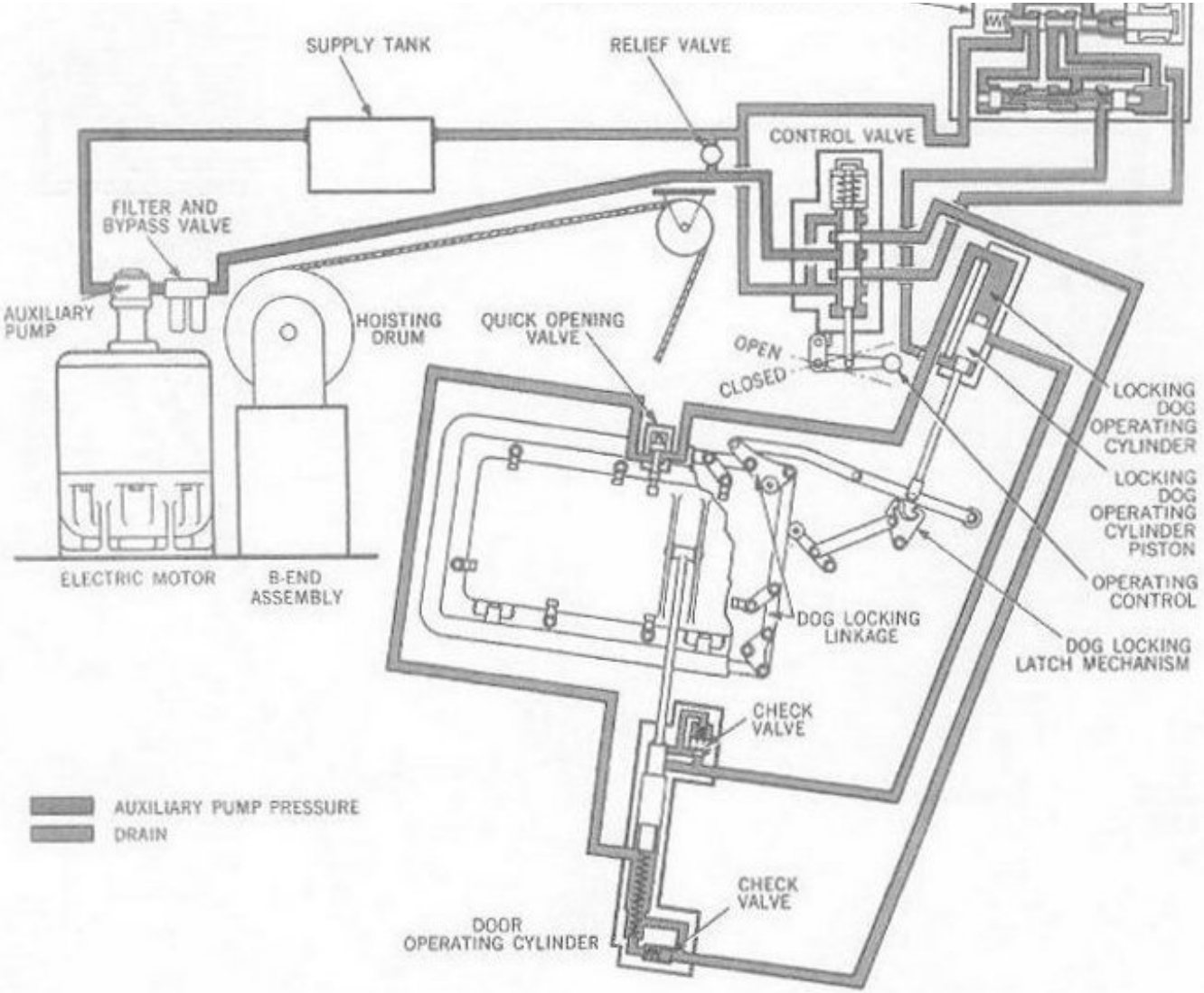


Figure 11-8. Trunk Upper Door Closed, Control Neutral - Schematic Diagram.

Safety latches. The safety latches (fig. 11-12) project into the path of the powder car, to engage the safety latch stops, when the car is at either the upper or lower unloading station. Operated by the

Upper door dog unlocking cam. The upper door dog unlocking cam is located on the rear side of the car at the top. The cam contacts the arm of the interlock hook and arm lever (page 11-10) to unlatch

safety car stop operating device (described on page 11-7), the two safety latches prevent the car from dropping in the event of hoist rope failure. The safety latches are spring loaded pawls installed with free bearing on the speed gear control shaft. They are located in the hoist trunk below the upper door.

Safety latch cam plates. The two vertical front edges of the powder car are cam surfaces which are extended upward, above the top of the car by two cam plates. These cams displace the safety latches as the ascending car approaches the unloading stations.

Lower door latch operating cam. One of the safety latch stops (page 11-11) is provided with a cam surface. This is the operating element which unlocks the lower door as the descending powder car approaches the loading station. The lower door latch is described on page 11-9.

the hook and actuate an interlock switch.

Car hoist rope. The powder car hoist rope is a 5/8 inch diameter wire rope. Secured to the hoisting drum, the rope passes over the hoisting sheave (page 11-8) and has adjustable attachment to the car. Looped around the wrist pin of the rope adjusting socket bolt after it is passed under the rope guide, the rope end is secured to the standing part by U bolts.

Rope guide. The rope guide, a cast bronze block, is mounted in the center of the powder car top. Grooved for retaining the car hoist rope, the rope guide is mounted with free bearing on a wrist pin which is installed in integral lugs of the car body.

Car switch operating bar. A vertically positioned subassembly, the car switch operating bar includes two adjustable trip brackets located on the forward

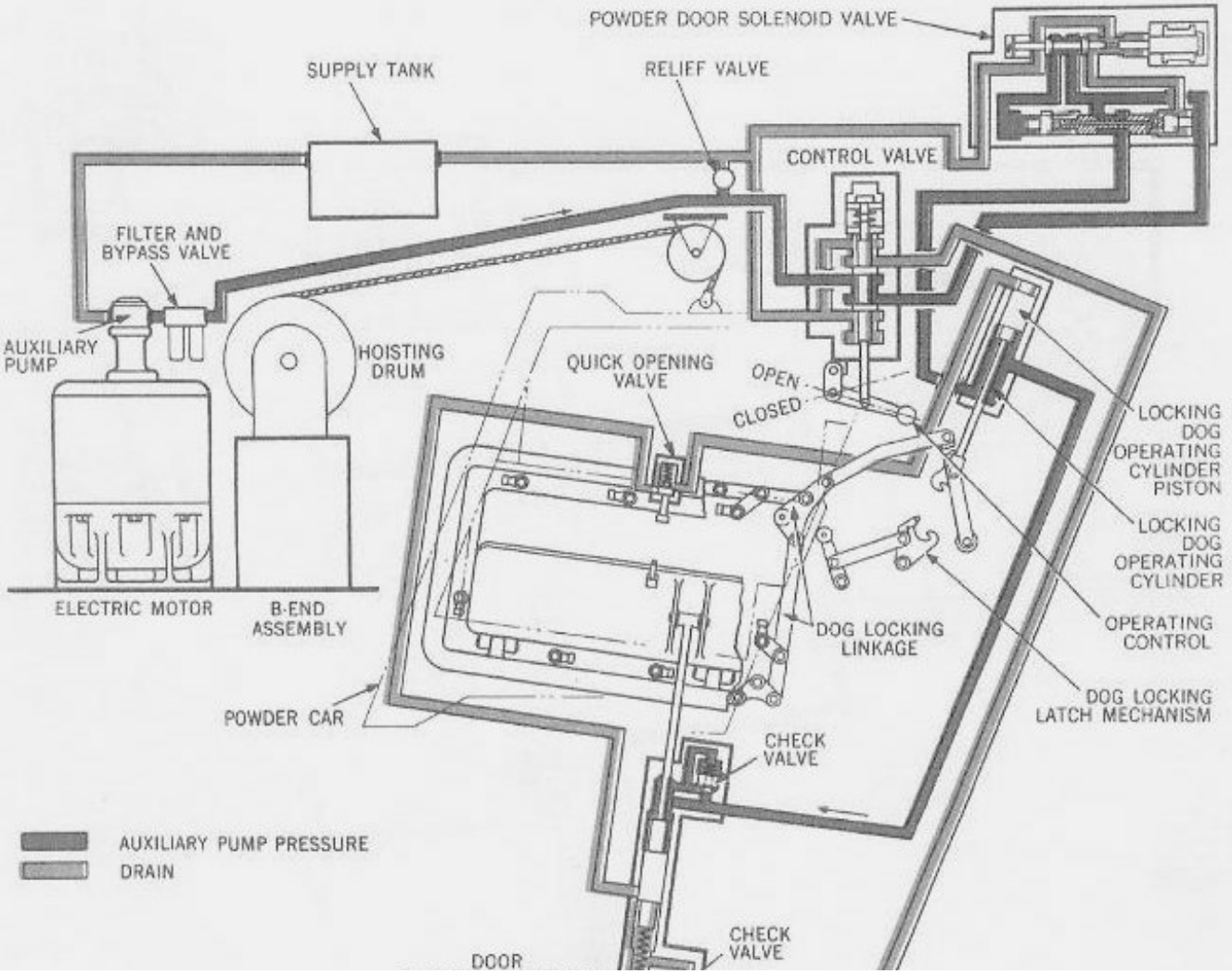




Figure 11-9. Trunk Upper Door Opening, Control at OPEN - Schematic Diagram.

side of the powder car. The bar actuates the levers of limit switches located at the top and bottom of the hoist trunk.

Controls and interlocks

The powder hoist operating controls and interlocks include starting and stopping controls, selection of servo or manual electrical and mechanical controls, powder hoist controls, an interlock and indicator system, power drive controls and interlocks, a power-on circuit, and door and dog latch interlocks. These control devices and their functions are described in following paragraphs:

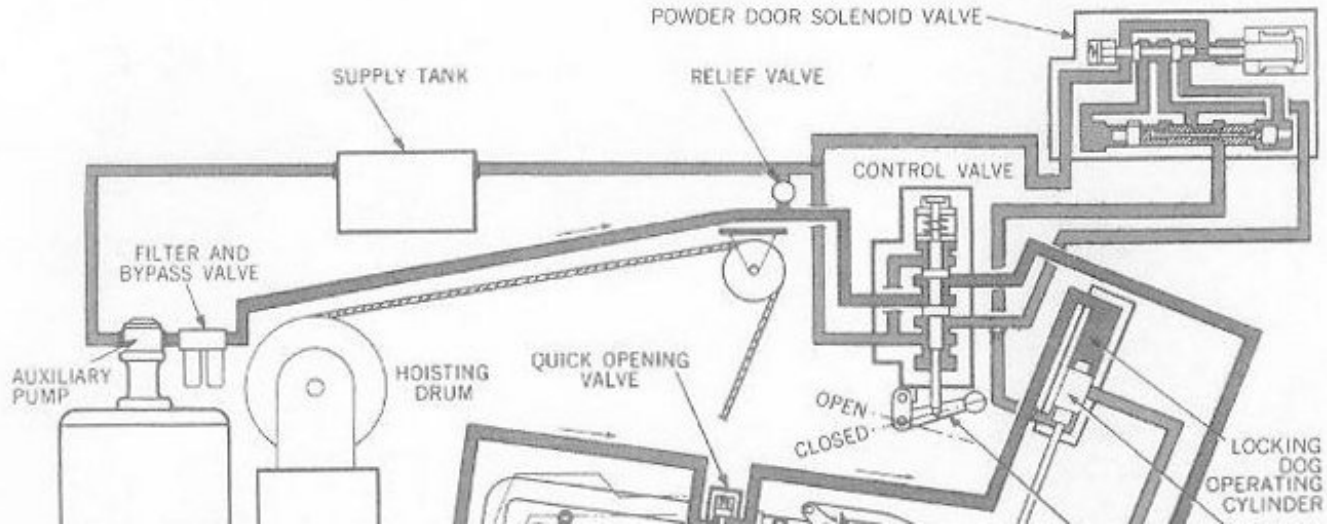
Start-stop control.

Push-button station. The master start-stop switch for each powder hoist controller is a push-button type located at the hoist operator's station. The switch is of enclosed watertight design with two buttons designated START-EMERG and STOP. Normally open, the switch is closed by pressing the START-EMERG button and opened by pressing the STOP button. The switch is arranged in the controller starting circuit with another switch contact that must be closed to complete the circuit when the START-EMERG button is pressed. This switch contact, the limit switch, is closed when the A-end is at neutral stroke.

Stop switch station. An emergency stop switch is provided for each powder hoist controller. Of enclosed watertight design, a switch is similarly located at each lower door operator's station. The switch is normally closed and is opened by pressing its STOP button.

Powder hoist control. Powder hoist control arrangements at the hoist operator's station include an installation of three levers. These are:

Starting lever
Control lever
Control selector lever



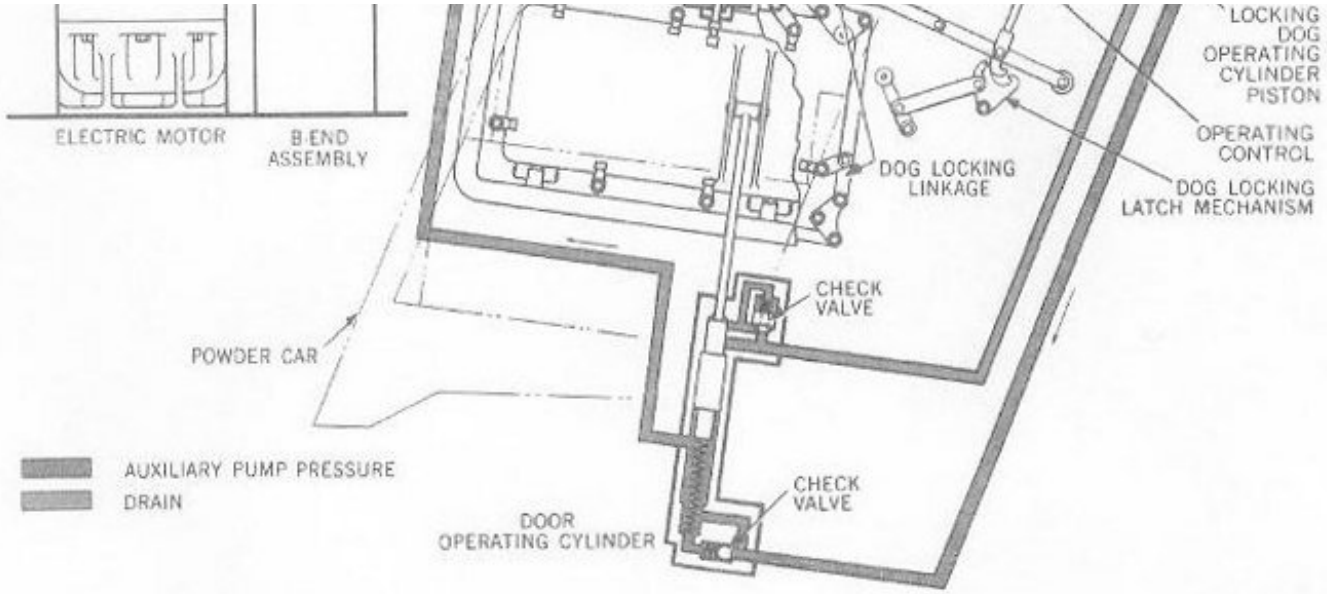
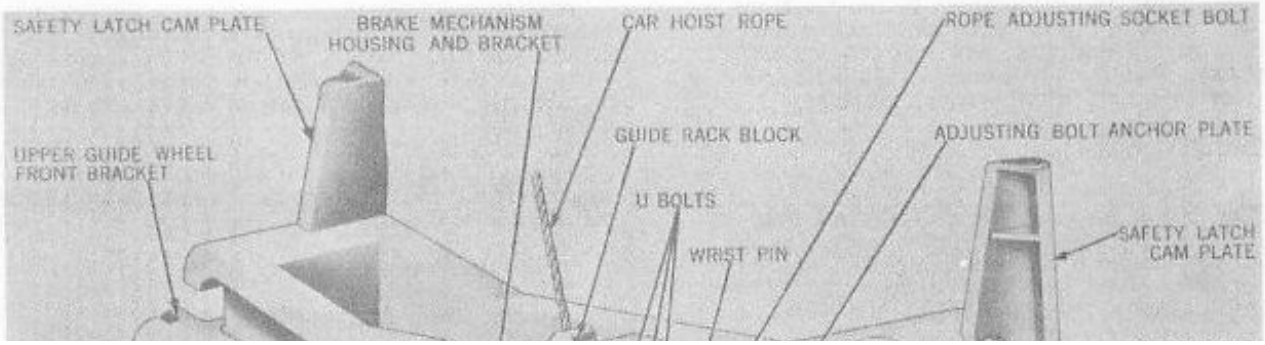


Figure 11-10. Trunk Upper Door Closing, Control at CLOSED - Schematic Diagram.



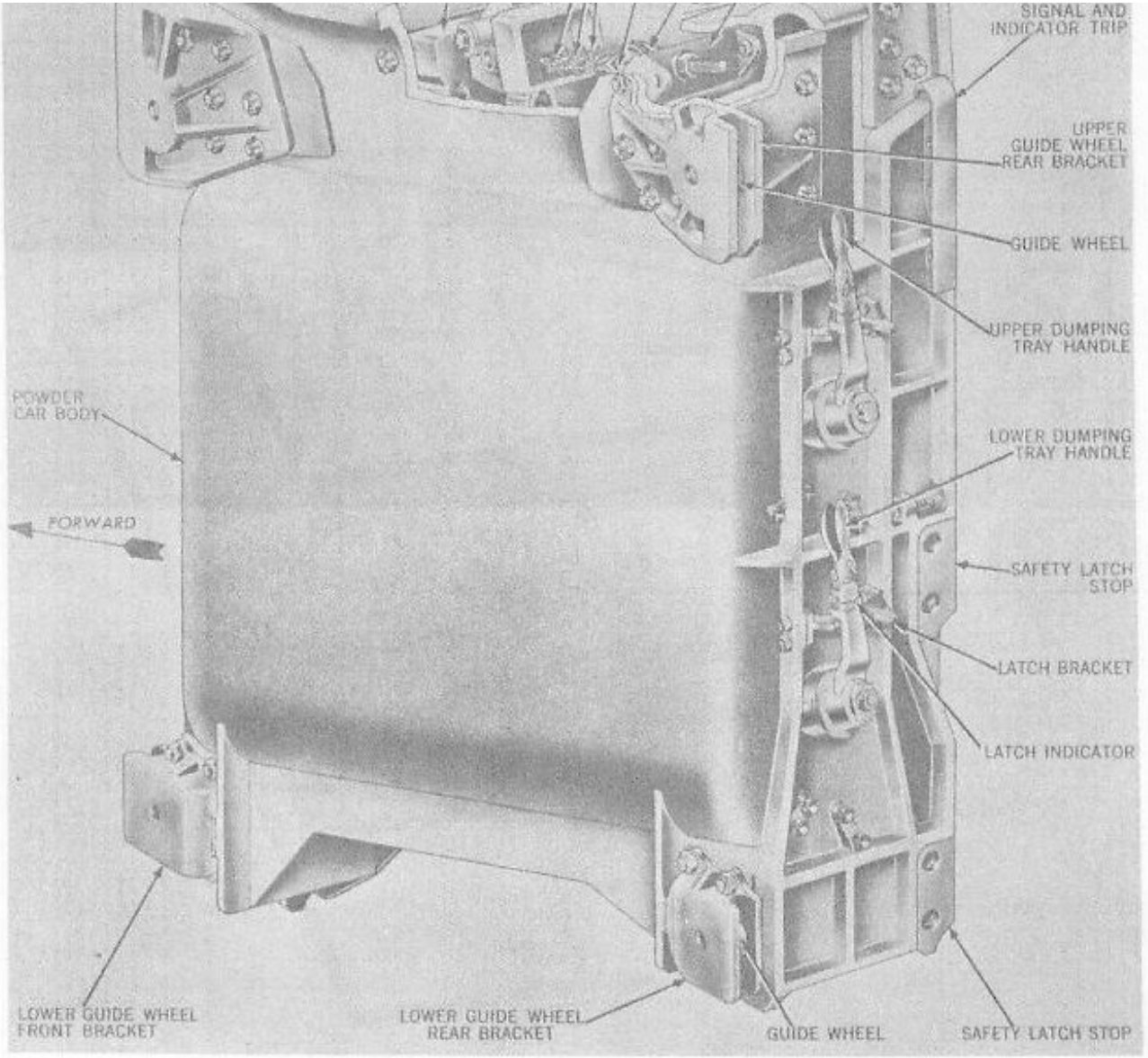


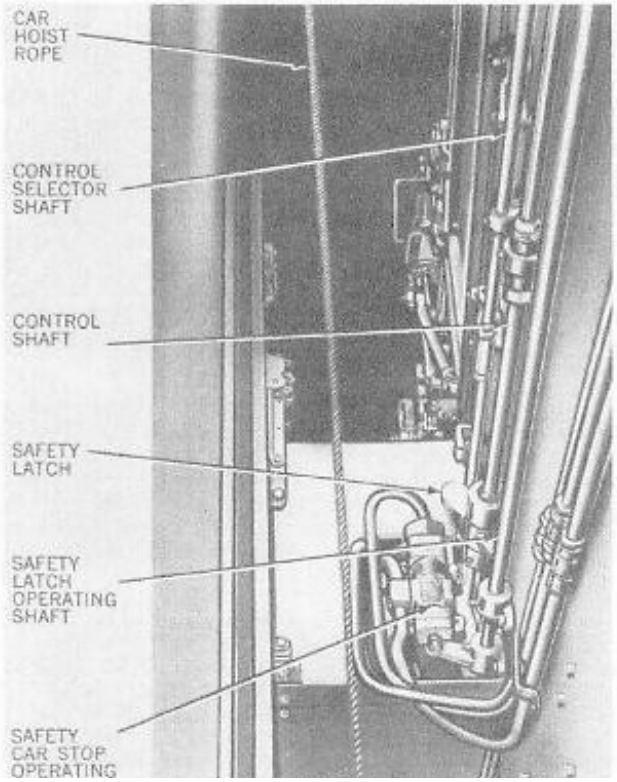
Figure 11-11. Powder Car, Rear View - General Arrangement

Starting lever. The starting lever is bracket

Starting lever. The starting lever is bracket mounted on the rear of the hoist trunk rear plate (fig. 11-14). It is connected to operate the safety car stop release valve and one of a series of starting circuit switches. The starting lever is interlocked with the lower door and with the upper door dog-locking latch through a solenoid-operated detent. It has two positions designated START and STOP.

Control lever. The control lever is bracket mounted on the hoist trunk division plate at the hoist operator's station. It is arranged with a guide quadrant which has two positions, designated HOIST and LOWER, in addition to a neutral notch. The lever is keyed to shafts and levers extending forward to the dashpot, A-end pump yoke controls, and the B-end. In SERVO operation, moving the control lever offsets the A-end yoke by displacing the servo valve which controls pressure to the servo piston. In MANUAL operation, moving the control lever moves the pump yoke through a mechanical linkage.

Control selector lever. The control selector lever is bracket mounted adjacent to the control lever. Arranged with a guide, the lever is positively



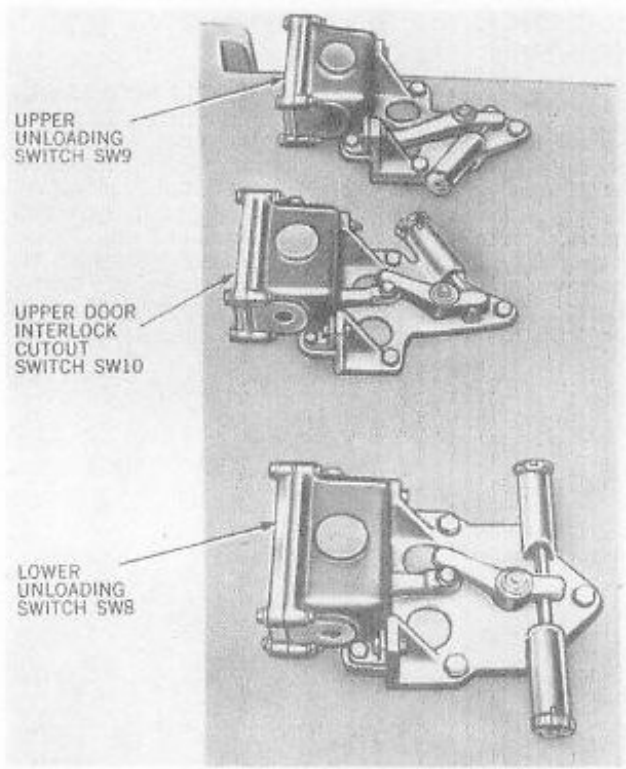


Figure 11-13. Limit Stop and Interlock Switches Trunk Upper End

held in either of two positions, designated SERVO ELECTRICAL and SERVO MECHANICAL AND MANUAL. The lever, keyed to a shaft which extends forward to the A-end pump controls, is provided with linkage connected to a venting valve and a control lever shaft latch.

Starting lever interlock and car indicator system.

Starting lever interlock. The starting lever interlock, comprising a bracket mounted solenoid and starting lever detent assembly, locks the starting lever at STOP when the solenoid (S3) is de-energized. The interlock insures that both hoist doors are closed before starting to hoist, and before starting to lower from the lower unloading station. When both the upper and lower hoist doors are closed, the upper and lower door starting lever interlock switches (SW12 and SW11) are closed. This energizes the starting lever interlock solenoid (S3) which retracts and unlocks the starting lever, and permits its movement to start. When lowering from the upper unload-

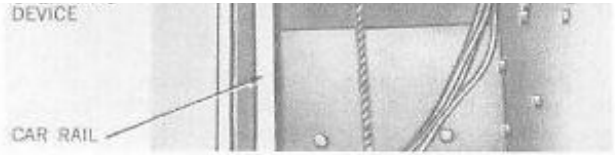


Figure 11-12. Powder Hoist Car Stop Assembly - General Arrangement

ing station (upper door open) the interlock is bypassed by the interlock cutout switch (SW10), which permits starting lever movement to lower the car to the lower unloading station.

The starting lever detent assembly is provided with a manually operated keeper. Located below the solenoid, the keeper locks out the interlock circuit (in the event of interlock circuit or solenoid (failure) by keeping the solenoid retracted.

The circuit is completely independent of the electrical hoist control circuit and is normally in use whether the control selector lever is at SERVO ELECTRICAL or at SERVO MECHANICAL AND MANUAL.

Hoist signal indicator system. The hoist signal indicator system operates in conjunction with powder car movement and informs the hoist operator when the car is loaded and ready to hoist. An electrical system, it comprises two identical indicator light assemblies (fig. 11-15), one located at each of the lower door and hoist operator's stations. These assemblies are arranged with a switch assembly at the lower end, a car mounted cam, and necessary wiring. The system is energized only when the hoist motor is in operation.

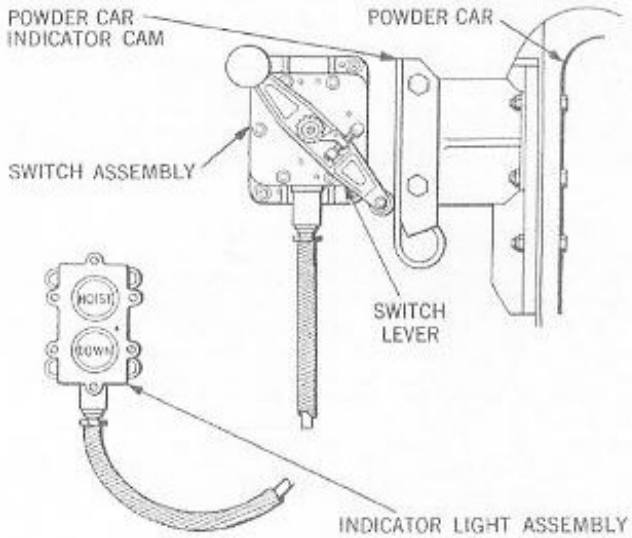
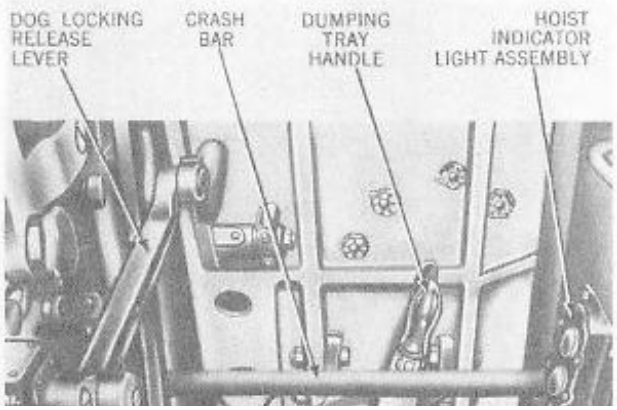


Figure 11-15. Powder Hoist Indicator and Switch Assembly - Trunk Lower End



The indicator light assemblies each have two dials, one marked HOIST and the other DOWN. The switch assembly contains a two plate selector switch, each plate having eight connection points. One plate is connected to the HOIST dials, energizing them four times in each rotation of the moving contracts. The other plate is similarly connected to the DOWN dials, but with connections offset 45 degrees from the first to alternate the dial indications. The required 45 degrees switch contact movements are obtained by a pawl on the switch lever and an eight-toothed ratchet on the switch spindle. The switch is held in the correct position by detents on a star wheel in

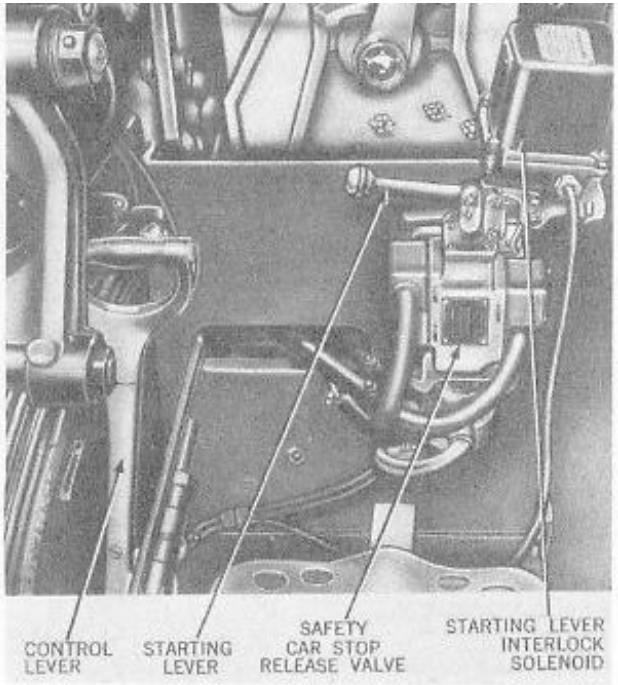


Figure 11-14. Powder Hoist Control Station - General Arrangement

the switch. The switch handle is limited by stop pins to 90 degrees movement between horizontal and vertical. A spring returns the switch handle to horizontal after it is released by the car car or the lower door operator.

Upper end. The indicator is bracket mounted in full view of the hoist operator (fig. 11-14). When the car is at the loading station, DOWN dials are illuminated in both indicators. When the car is ready for hoisting, the lower door operator moves the switch lever to a vertical position. DOWN lights go out and HOIST dials are illuminated in both indicators.

Lower end. The indicator is mounted on the trunk wall below the switch assembly. When the car is at either unloading station the HOIST dials are illuminated in both indicators. When the car is lowered to the loading station, the cam on the car trips the switch lever as the car reaches the hoist bottom. HOIST lights go out and DOWN dials are illuminated in both indicators.

Power drive controls and interlocks. The installed arrangement of the powder hoist hydraulic equipment provides power for hoisting and lowering the car. Car movement is controlled by the operator and hoist interlock switches. The controls include devices to limit acceleration and deceleration rates, and to prevent dropping of the car in event of power failure.

Control arrangement. The powder hoist power drive is designed for normal control through a servo stroking system. This system positions the A-end pump yoke by a servo stroking piston that is operated by pressure from the control and supercharge pump (described on page 11-4). There are two control selections, designated SERVO ELECTRICAL and SERVO MECHANICAL, that use servo stroking control. In MANUAL MECHANICAL control, the pump yoke is manually offset to a stroke position.

Servo electrical control. This control selection utilizes powder car position switches, door interlock switches, and a starting lever switch. These open and close the hoist control circuit to energize a solenoid which shifts the venting valve to build up control pressure. The amount of stroke of the A-end yoke is controlled by manual movement of the control lever toward HOIST or LOWER. Car acceleration, deceleration, and speed are limited by cams in the

switch; these switches are in different circuits. The upper door interlock switch opens the hoist control circuit and de-energizes the venting valve solenoid when the upper door is open, except when the powder car is at the upper unloading station. The upper door interlock switch, series connected with the lower door interlock switch, de-energizes the starting lever interlock solenoid to lock the starting lever when the upper door is open. The starting lever is not locked when the car is at the upper unloading station. This is prevented by the closing of the upper door interlock cutout switch by the car; this keeps the starting lever interlock solenoid energized and the starting lever free to move the car from the upper to the lower unloading station.

OPERATION

General

Powder car hoisting and lowering are power

deceleration, and speed are limited by cams in the B-end housing (described on page 11-7). Stopping is controlled by car-operated switches that act to vent the main hydraulic system and apply the brake.

Servo mechanical control. This is a control selection in which the hoist control circuit and the venting valve solenoid are inoperative and the venting valve is manually shifted by the control selector lever and linkage. Movement of the control lever initiates SERVO piston stroke. Powder car acceleration, deceleration, and speed are limited by cams in the B-end housing (described on page 11-7). Stopping is controlled by the latch and vent valve.

Servo control actions, limits, and speeds. The powder car may be stopped and started again at any time during a hoisting or lowering cycle with the control lever. In mid-cycle, acceleration and deceleration rates are limited to less than 16 feet per second per second by the dashpot attached to the control shaft (fig. 11-2). At the beginning and end of cycles, these rates are limited to the same valve by the B-end cams.

Manual control. This is a control selection in which the yoke is offset by mechanical linkage from the control lever. Car acceleration, deceleration and speed are limited by the cams in the B-end housing (described on page 11-7). The hoist control circuit and venting valve solenoid are inoperative as in servo mechanical control. The car may be stopped and started again at any time during a hoisting or lowering cycle by moving the control lever.

Power failure. A power failure valve, solenoid-operated, applies the B-end brake and stops the hoist in the event of electric power failure. This action occurs regardless of the position of the control levers.

Power on circuit. The controller is arranged with a power on circuit connected to a solenoid of the power drive controls. When the controller main contactors are closed the power on circuit is closed and the power failure valve operating solenoid is energized to position the valve as outlined in the previous paragraph.

Door and dog latch interlocks. The upper door assembly is arranged with an upper door interlock switch, and a starting lever detent-operating solenoid

drive operations, servo or manually controlled. The selection of control and the control of starting, stopping, and speed of hoisting and lowering is determined by the position and movement of levers. The powder car cannot be hoisted or lowered manually. Circuit flow conditions and resultant movement of components, shown schematically in figures 11-16 to 11-23 inclusive, are described in the following paragraphs:

Starting

Perform the following operations when starting the electric motor:

1. Place the controller circuit-breaker lever at ON.
2. Place the control lever at neutral.
3. Press the START-EMERG button.

Stopping

Perform the following operations when stopping the electric motor:

1. Move the powder car to the loading station.
2. Place the control lever at neutral.
3. Press the STOP button.

Servo electrical control

The normal control selection is SERVO ELECTRICAL. Hoist operations in this method of control, described below, are shown schematically in figures 11-16 to 11-19 inclusive.

Stop position. The control selector is at SERVO ELECTRICAL, the starting lever is at STOP, and the control lever is at neutral.

1. Main system pressure, vented and bypassed, is insufficient to retract the plungers of centering spring assemblies CS1 and CS2 which hold the pump yoke at neutral (slightly offset toward hoisting). The brake operating cylinder is open to drain which allows its spring to apply the brake. The control circuit is vented because solenoid S1 (de-energized) has positioned venting valve V1 in its vent position.

2. Transmission line T2 is bypassed through check valve V18, lines L15, L24 and L25, venting valve V1, PFV, and line L23 to return line T1.

3. The control circuit is vented through venting valve V1, around bypass valve V4, and servo valve V2 to the supply tank.

4. Restriction R1 maintains low supercharging pressure in lines T1 and T2 when the control (supercharge) circuit is vented.

Controls set ready to hoist. The control selector lever is at SERVO ELECTRICAL, the starting lever is at START, and the control lever is at neutral. With the power drive motor running and a hoisting stroke ready to be initiated, the following conditions exist (fig. 11-17):

1. Starting lever interlock solenoid S3 is energized when interlock switches SW11 and SW12 are closed (upper and lower trunk doors closed). This unlocks the starting lever which, when moved to START, closes starting lever switch SW6 and positions car stop release valve V3 to port main system pressure to the safety car stop operating device. With door interlock switches SW4 and SW5 closed and unloading switches SW3 and SW9 closed, the closing of SW6 by the starting lever completes the circuit to energize venting valve solenoid S1.

2. Energized, solenoid S1 moves venting valve V1 to close the main system and control circuit vents thereby permitting main system and control pressure build-up.

3. Control pressure shifts bypass valve V4, porting control pressure to chamber A of servo stroking piston P1. With servo valve V2 held in neutral position, fluid trapped in chamber B of P1 prevents movement of P1.

4. With the pump yoke held at neutral (slightly offset toward hoisting) by the control lever, main system pressure build up in line T2, ported through check valve V18 and lines L10, L15 and L11 retracts the plungers of centering spring assemblies CS1 and CS2. When the plungers are retracted, the control lever may be moved to offset the pump yoke.

5. Main system pressure build-up in line T2 ported through V18, L15, L24, L25, V1, PFV, L26 line L17, and V6, through line L16 to the brake operating cylinder releases the brake.

6. With the brake released, foot valve V5 maintains back pressure in line L12 to prevent the car from dropping. Check valve V13 and bypass valve V14 block line L12 to prevent B-end rotation.

Hoisting. The control selector lever is at

2. Hoisting acceleration and deceleration is mechanically controlled by the B-end cams through control linkage L5 which is connected to servo linkage L2. At its lower end, L2 is connected to V2 which is held with restricted movement by locking cam C5. Connected to V2 by L2, P1 will offset the pump yoke whenever V2 is positioned by the control lever. When control lever movement toward hoist is stopped, P1 will continue to move until V2 is closed by L2.

3. When the car rises slightly it permits switch SW7 to close; this bypasses SW6 in the solenoid S1 circuit to keep the solenoid energized. When the starting lever is returned to STOP, it opens switch SW6 and shifts the car stop release valve V3 to vent the safety car stop cylinder and return latch L1 into the path of the car.

4. Hoisting acceleration is controlled by cam follower CR2 riding on cam C1. The car rises at constant speed until CR2 rides on cam C3, which moves V2 enough in the opposite direction to port control pressure to chamber B of P1. This moves the pump yoke toward center and decelerates the hoist. Line T1 is the main system return line; the system is replenished through supercharge check valve V16.

5. As the car reaches the upper unloading station it opens switch SW9. This de-energizes S1 which shifts V1 so that it vents and bypasses the main system and vents the control circuit. When the main system is vented, the brake is applied and the plungers of centering spring assemblies CS1 and CS2 extend to position the pump yoke at neutral.

6. With the car at the upper unloading station, the interlock cutout switch SW10 is closed energizing solenoid S3 and unlocking the starting lever while the upper door is open.

7. The starting lever is moved to START, closing switch SW6. Switch SW9 is spring-operated to close when the car is lowered to the lower unloading station.

8. Moved toward LOWER, the control lever shifts V2 (through L2) to port control pressure to chamber B of P1 which moves the pump yoke to lower.

9. As lowering movement starts, pressure in line T1 is bypassed through check valve V9, to prevent valves RV relieving before the brake releases.

10. After the brake releases, back pressure ported into line L12 closes V9. This closes the main system bypass. Fluid ported through line T1 is at greater pressure than the adjustment of V5 and the B-end rotates to lower.

SERVO ELECTRICAL, the starting lever is at STOP, and the control lever is at HOIST. The following conditions exist (fig. 11-20):

1. Moved toward HOIST to initiate a hoisting cycle, the control lever moves linkage L2 which shifts servo valve V2 enough to vent chamber B of piston P1 to the tank. Control pressure in chamber A moves P1 toward the left offsetting the pump yoke to hoisting position, to cause B-end rotation. Movement of the control lever also actuates linkage to move cam follower CR2 to contact and ride on hoisting acceleration cam C1.

11. After the car lowers approximately 3 inches from the upper unloading station, switch SW9 closes. The starting lever should be returned to STOP to move latch L1 into the path of the car. If the starting lever is not returned to STOP (upper door open) the car will lower, controlled by cam C2, until switch SW8 is opened. This vents the system and applies the brake at the lower unloading station.

12. As the car lowers, switch SW10 opens, de-energizing solenoid S3 and locking the starting lever.

13. Unlocked when switch SW5 is closed by closing the upper door, the starting lever is moved to START to close SW6.

14. Moved toward lower, the control lever shifts V2, porting control pressure to chamber B of P1 which moves the pump yoke to lower.

15. As lowering movement starts, pressure in line T1 is bypassed through check valve V9, preventing valves RV relieving before the brake releases.

16. After the brake releases, back pressure ported into line L12 closes V9 and closes the main system bypass. Fluid ported through line T1 is at greater pressure than the adjustment of V5 and the B-end rotates to lower.

17. Controlled by cam C2, the pump yoke moves to lower and linkage L3 opens bypass valve V14.

18. As the pump yoke is returned to neutral by cam C4 (at the end of the cycle), V14 is closed by L3. Fluid is ported through line T1 at greater pressure than the adjustment of V5.

19. Switch SW7, opened by the car, de-energizes S1 which shifts V1 to vent the main system and apply the brake.

Power failure.

Hoisting cycle. The control selector lever is at SERVO ELECTRICAL, the starting lever is at STOP, and the control lever is at HOIST. When the motor electric power circuit fails during a hoisting cycle, the following conditions exist (fig. 11-19):

Servo mechanical control

Servo mechanical control operations, described below, are shown schematically in figures 11-20 to 11-23 inclusive.

Stop position. The control selector lever is at SERVO MECHANICAL, the starting lever is at STOP, and the control lever is at neutral. The following conditions exist (fig. 11-20):

1. Movement of the control selector lever to SERVO MECHANICAL actuates linkage which shifts venting V1 and latch and vent valve V6 to vent the main system and control circuit, and in addition drops latch L4 into the notch on cam C6.

2. Vented main system pressure is insufficient to retract the plungers of centering spring assemblies CS1 and CS2 which hold the pump yoke at neutral (slightly offset toward hoisting). In addition the vented main system allows the brake to apply.

3. The main system and control circuit is vented via transmission lines T1 and T2 through check valves V17 and V18, through lines L15, L24, and L25 V1, PFV to line L26, through line L17 to V6, through line L1i to V3 and through lines L19 and L20 to the tank.

4. The main system bypass is closed by V1 which is held in closed position by the control selector lever.

Controls set ready to hoist. The control selector lever is at SERVO MECHANICAL, the starting lever is at START, and the control lever is neutral. The

1. When power fails, solenoids S1 and S2 are de-energized causing the main system to be vented and bypassed thereby appling the brake and permitting the plungers QS1 and CS2 to extend and move the pump yoke to neutral.

2. When the brake applies, pump rotation is continued by motor inertia. Brake ratchet assembly BR permits overrun of the drum and B-end. The car decelerates to a gradual stop and is held from dropping by the applied brake.

3. While the pump yoke is offset to hoisting, line L24 opens to line L25 through restriction R2 until the pump yoke is near neutral.

Lowering cycle. The control selector lever is at SERVO ELECTRICAL, the starting lever is at STOP, and the control lever is at LOWER. When the motor power circuit fails during a lowering cycle, the following conditions exist (fig. 11-19).

1. Venting valve solenoid S1 and power failure solenoid S2 are de-energized, bypassing and venting the main system, venting the control circuit, and applying the brake.

2. Simultaneously, pressure drops in line T1, centering spring assemblies CS1 and CS2 are vented to the tank and the plunger of CS1 moves the pump yoke to neutral.

following conditions exist (see fig. 11-21):

1. Movement of the starting lever to START shifts car stop release valve V3 to close the main system thereby permitting main system pressure to build-up. Linkage actuated by the starting lever moves valve V6 up (to port main system pressure to the brake operating cylinder, releasing the brake) and also unlocks cam C6 (by moving latch L4 out of the C6 notch thereby permitting control lever movement).

2. Main system pressure build-up is sufficient to hold the loaded car from falling because the pump yoke is slightly offset toward hoisting when it is held at neutral by the control lever. Pressure ported to CS1 and CS2 retracts the plungers and permits offset movement of the pump yoke.

3. Control pressure shifts bypass valve V4, porting control pressure to chamber A of piston P1. With servo valve V2 held in neutral position fluid trapped in chamber B of P1 prevents movement of P1.

4. With the brake released, foot valve V5 maintains back pressure in line L12 to prevent the car from dropping. Check valve V13 and bypass valve V14 block line L12 to prevent B-end rotation.

Hoisting. The control lever is at SERVO MECHANICAL, the starting lever is at STOP, and the control lever is at HOIST. The following conditions exist (fig. 11-22):

1. Moved toward HOIST to initiate a hoisting cycle, the control lever moves linkage L2 which

shifts servo valve V2 enough to vent chamber B of piston P1 to the tank. Control pressure in chamber A moves P1 toward the left, offsetting the pump yoke toward hoisting, causing B-end rotation. Movement of the control lever also actuates linkage to move cam follower CR2 to contact and ride on hoisting acceleration cam C1.

2. The starting lever, moved to START to begin the hoisting cycle, must be released as soon as car movement begins so that latch L1 is returned into the path of the car.

3. Latch L4 is operated by main system pressure (in the top of valve V6) to ride on cam C6 until the control lever is moved to neutral by either the

2. When the brake applies, pump rotation is continued by motor inertia. Brake ratchet assembly BR permits overrun of the drum and B end. The car decelerates to a gradual stop and is held from dropping by the brake.

3. While the pump yoke is offset to hoisting, line L24 opens to line L25 through restriction R2 until the pump yoke is near neutral.

Lowering cycle. The control selector lever is at SERVO MECHANICAL, the starting lever is at STOP, and the control lever is at LOWER. When the motor power circuit fails during a lowering cycle, the following conditions exist (fig. 11-23):

operator of cam C3. Latch L4 is spring-operated to complete the latching operation after the main system and control circuit are vented by V6 moving L4 into the notch of C6.

4. When the main system is vented, the brake-operating cylinder vents through line L22 to the tank. Centering spring assemblies CS1 and CS2 are vented to the tank through lines L11 and L10 respectively and the plungers extend to position the pump yoke at neutral. The car is at the upper unloading station.

The control lever can not be moved until the starting lever is moved to START.

5. Moved toward LOWER, the control lever shifts V2 porting control pressure to chamber B of P1 which moves the pump yoke to lower.

6. As lowering movement starts, pressure in line T1 is bypassed through check valve V9, to prevent valves RV relieving before the brake releases.

7. After the brake releases, back pressure ported into line L12 closes V9 to close the main system bypass. Fluid ported through line T1 is at greater pressure than the adjustment of V5 and the B-end rotates to lower. The starting lever must be released as soon as car movement begins so that latch L1 is returned into the path of the car.

8. The main system and control circuit are vented by V6. The brake is applied and CS1 and CS2 position the pump yoke at neutral.

9. The starting lever is moved to START and the lowering cycle is continued as in operations 16, 17, 18, 19, 20, and 21 under servo electrical control.

10. The main system and control circuit are vented by V6. The brake is applied and CS1 and CS2 position the pump yoke at neutral.

Power failure.

Hoisting cycle. The control selector lever is at SERVO MECHANICAL, the starting lever is at STOP, and the control lever is at HOIST. When the motor electric power circuit fails during a hoisting cycle, the following conditions exist (fig. 11-23):

1. When power fails, solenoid S2 is de-energized causing the main system and control circuit to be vented thereby applying the brake and permitting the plunger of CS2 to extend and move the pump yoke to neutral.

1. Power failure solenoid S2 is de-energized shifting valve PFV to vent the main system and control circuit, and apply the brake.

2. Simultaneously pressure drops in line T1, centering spring assemblies CS1 and CS2 are vented to the tank and the plunger of CS1 moves the pump yoke to neutral.

Interlock system operation

Hoist interlock system arrangements and operation are described in the following paragraphs and are shown schematically in figures 11-24 to 11-26 inclusive. Designated circuit QC, the interlock circuit is described in chapters 12 and 15.

Powder car at loading level; trunk lower door open. With the electric motor running and the starting lever at STOP, the following conditions exist (fig. 11-24):

1. Because the lower door is open and unlocked, the lower door interlock switch SW4 and the lower door starting lever interlock switch SW11 are open. The loading position switch SW7 is held open by contact with the powder car.

2. The starting lever interlock solenoid S3, also de-energized, locks the starting lever at STOP and prevents closure of the starting lever switch SW6.

3. With the starting lever switch SW6 open, the venting valve solenoid S1 is de-energized and positions the venting valve to vent the hydraulic system.

Lower and upper trunk doors closed; car rising. The starting lever is shown after it has been returned to STOP from the START position. As the car is rising, the following conditions exist (fig. 11-25):

1. With the lower door closed and locked, the lower door interlock switch SW4 and the lower door starting lever interlock switch SW11 close Starting lever interlock solenoid S3, energized, unlocks the starting lever. The upper interlock switch SW5 and the lower and upper unloading switches SW8 and SW9 are closed. When the starting lever is positioned at START it closes switch SW6 and completes the circuit to energize venting valve solenoid S1. This closes the hydraulic system and the car rises.

POWDER HOIST PAGE 2

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OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

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CHAPTER 12 FIRE CONTROL

Chapter 12

FIRE CONTROL

The general arrangement of turret fire control equipment, shown in figure 12-1, is the same in all turrets, with the exception of turret I, from which the rangefinder has been removed, together with the projecting hoods.

Each installation governs turret operation under three basic methods of control: primary, secondary, and local. Each method of control does not employ all of the equipment.

For a detailed description of the main battery fire control system, see OP 856.

Ship fire control system

The ship fire control system enables turret operation in each of the three basic methods of control, as described below.

Primary control. 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 the follow-the-pointer operation. The firing station in both types of control is normally the stable vertical in either plotting room.

Secondary control. 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. Local control is independent turret control deriving target bearing and range locally by visual estimate. It is control in which the sight control stations, rangefinder, and auxiliary computer control the turret and gun positions.

GENERAL DESCRIPTION

Turret fire control circuits

The turret fire control circuits consist of electrical circuits through which fire control orders are transmitted for loading, positioning, and firing the guns, and for turret communications. The circuits are listed below and described in the following paragraphs.

Gun-laying control
Gun-firing control
Interlocks and indicators
Interior communications systems

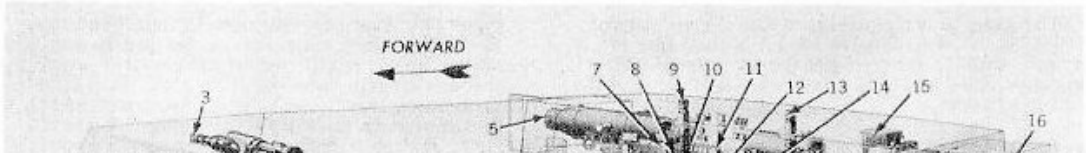
Gun-laying control. Gun-laying and turret train are controlled through circuits designated GE and GEP.

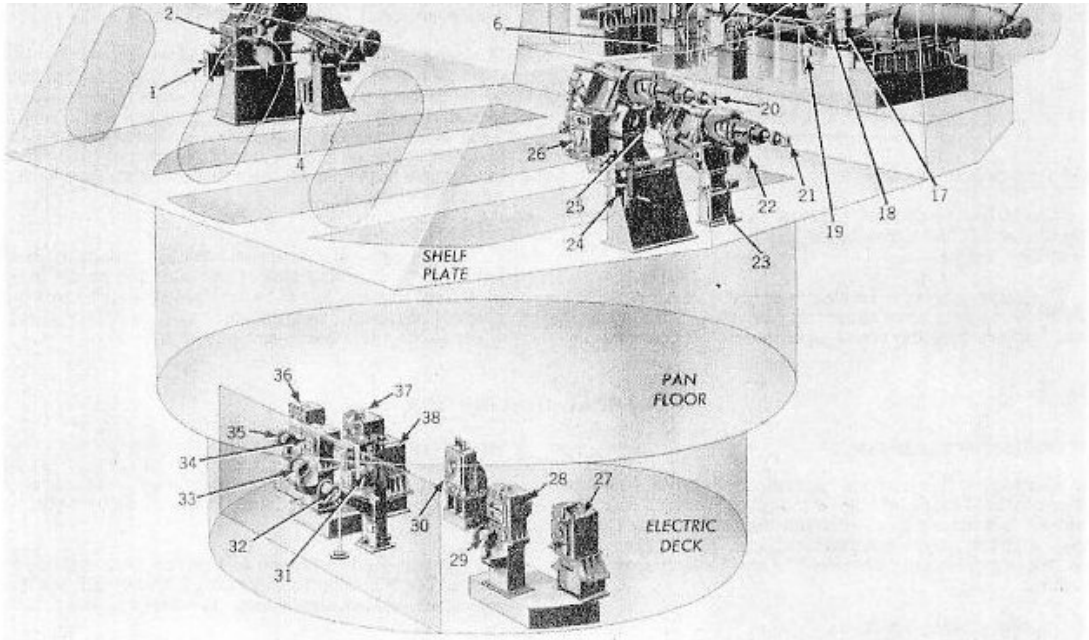
Circuit GE. Shown in figures 12-2 and 12-4, [illegible] local control through signals provided by the directors, the other turrets, or the local turret. In addition, range and train angle data may be transmitted to either plotting room and to the other turrets.

Circuit GEP. Shown in figures 12-3 and 12-5, circuit GEP connects the same fire control instruments identified above and, in addition, the following:

Elevation receiver-regulator
Train receiver-regulator

The general arrangement and function of these instruments are described in chapters 5 and 6. They automatically control gun-laying and turret train in primary, secondary, or local control through signals provided by the directors, the other turrets, or the local turret.





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 12-1. Turret Fire Control Installation, General Arrangement

Circuit 1R. Circuit 1R, the main battery ready light circuit, includes an arrangement of indicator dials located at turret control stations. It also includes foot-operated switches and manually operated switches, as well as a system of relays, solenoids, Q, QB, and QC.

Circuit CS. Circuit CS, the sight setter's clutch indicator and interlock circuit, supplies power to interlock solenoids and two-dial indicators located at the sight setters' stations. Alternate legs of the cir-

and limit switches at various locations. The 1R circuit is interconnected with the turret officer's transfer switchboard and selective switch, and with ready switches at the gun captain's, gun layer's, trainer's, and sight setter's stations. This circuit serves to coordinate loading and gun-laying operations by indicating the readiness of each station with indicator lights. In addition, the 1R circuit includes a safety interlocking arrangement which prevents lowering the cradle and opening the powder unloading door at any but the proper time during the gun-loading sequence. The general arrangement and function of the elements of this circuit are described in detail in chapter 15.

Circuit 1VB. Circuit 1VB, the salvo signal circuit, is an arrangement of appropriately located buzzer-type horns. The circuit is interconnected with local contact makers at the turret officer's station and at the right and left sight pointer's stations. Salvo signals, which indicate to turret personnel when guns are to be fired, originate at remote principal fire control stations or the local stations.

Circuit 1U. Circuit 1U, the cease firing signal circuit, powers a bell mounted in the left rear corner of the turret officer's compartment. The bell is operated to indicate "cease firing" by closing a contact maker at any of the remote principal fire control stations. It cannot be operated by turret personnel.

Interlocks and indicators. The interlock and indicator circuits are designated: CS, CP, RP, QE, cuit are energized by clutch-operated microswitches so that the relative positions of the sight setters' clutches are indicated by dial lights. The clutches are interlocked, so that only one can be engaged at a time, by solenoids energized through the microswitches.

Circuit CP. Circuit CP, the sight pointer's clutch indicator circuit illuminates one-dial indicators located at the sight pointer's stations. The circuit is interconnected with a clutch-actuated switch so that when either sight pointer is clutched in, the indicator is illuminated to warn the other sight pointer not to engage his clutch.

Circuit RP. Circuit RP, the projectile ring ready light circuit, includes three-dial indicators located on the projectile flats at the right operators' stations. Identical circuits on each flat are interconnected with three contact makers, one located at each projectile hoist operator's station. Illumination of the indicators notifies the ring operator when the ring may be rotated. The projectile hoist loading crews may also order ring rotation.

Circuit QE. Circuit QE, the projectile hoist interlock circuit, includes an arrangement of three interlock solenoids, two located at each hoist control handle and one at the function control and shut-off valve handle. An identical circuit for each projectile hoist is interconnected with two neutral start interlock and eight door and shutter interlock switches.

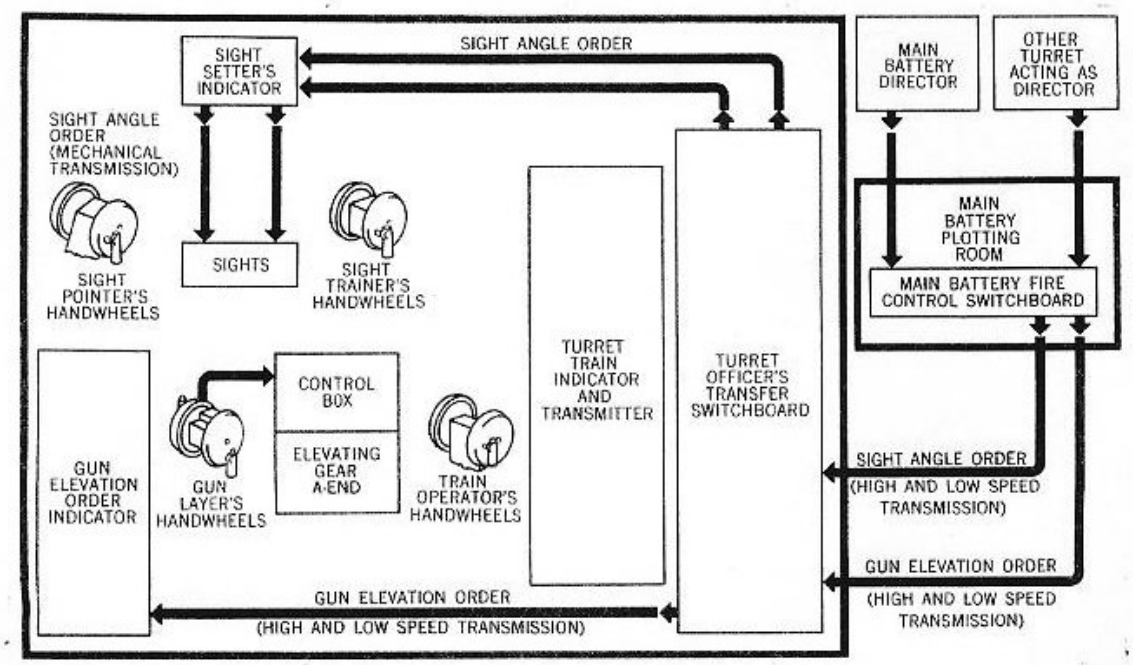


Figure 12-2. Gun Elevation Control - Circuit GE - Functional Diagram

Through circuit QE, movement of the function control and shut-off valve is blocked and the power drive motor cannot be started unless the hoist control handles are both at neutral. The hoist control handles cannot be moved from neutral unless all door and shutter switches are closed.

Circuit Q. Circuit Q, the projectile hoist control handle interlock circuit, is an arrangement of a five-dial indicator, a gong, and two solenoids located at each projectile hoist operator's station. The circuit is interconnected with a gong relay and with switches at the function control and shut-off valve, the projectile indicator lever, and the projectile latch. Circuit Q prevents hoisting or limits control handle movement under certain conditions. In addition, it provides the hoist control operator with visual and audible signals of the hoist cycles.

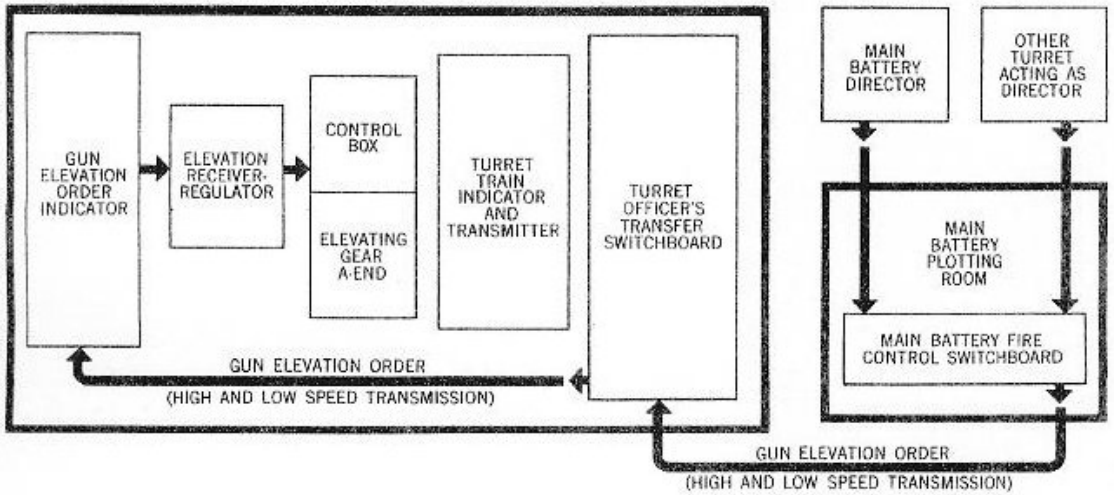


Figure 12-3. Gun Elevation Control - Circuit GEP - Functional Diagram

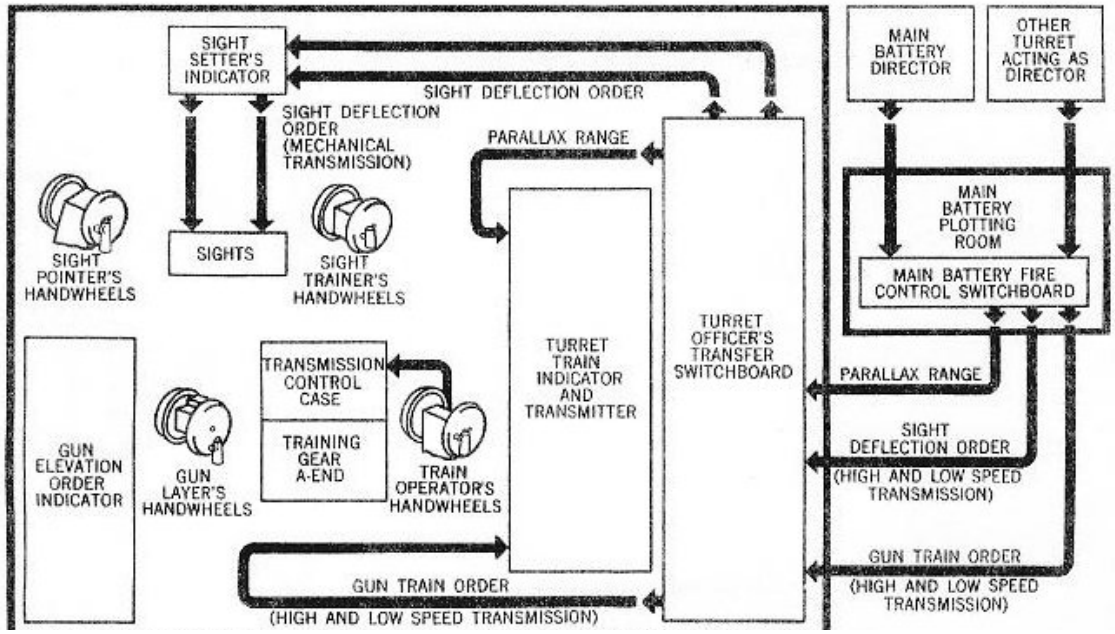


Figure 12-4. Turret Train Control - Circuit GE - Functional Diagram

Circuit QB. Circuit QB, the projectile latch indicator circuit, is an arrangement of a one-dial indicator located at each projectile hoist operator's station and shared with circuit Q. The circuit is interconnected with a switch mounted on the top of the hoist operating cylinder. Circuit QB provides the hoist control operator with a visual signal when the hoist has completed a hoisting stroke.

Circuit QC. Circuit QC, the powder hoist interlock circuit, energizes two solenoids located at the hoist starting lever and the venting valve. The circuit is interconnected with nine switches which energize or de-energize the solenoids to coordinate powder hoist operations. Circuit QC vents the hydraulic drive and sets a brake to hold the powder car at a loading or unloading level. In addition it prevents powder car movement when either door of the hoist trunk is open or undogged.

Interior communications systems. The interior communications systems are the circuits designated DS, RA, TW, MC, JA, XJ, J, and E.

Circuit DS. Circuit DS, the depression and train stop signal circuit, includes an arrangement of a three-dial and three one-dial indicators located at the train operator's and gun-layer's 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 indicator lights) when a gun's line of fire approaches the ship's superstructure.

Circuit RA. Circuit RA, the emergency alarm circuit within the turret, energizes nine sirens located as follows: one in the turret officer's compartment, one in each gun room compartment, one on the electric deck, one on each projectile flat, and one each in the powder handling room and the powder passing space. The circuit is interconnected with identical locking type contact makers at each siren and additional contact makers (all normally open) in the powder handling room and powder passing space. An additional non-locking contact maker, in the turret officer's compartment is normally closed. Circuit RA sounds the alarm sirens when any one of the locking contact makers is closed. The circuit can be opened by holding the non-locking contact maker open.

Circuit TW. Circuit TW, the train warning signal circuit, operates a bell mounted under the turret overhang. The circuit is interconnected with a normally open push button located at the turret officer's station. Circuit TW provides an audible warning to personnel outside the turret when it is about to train.

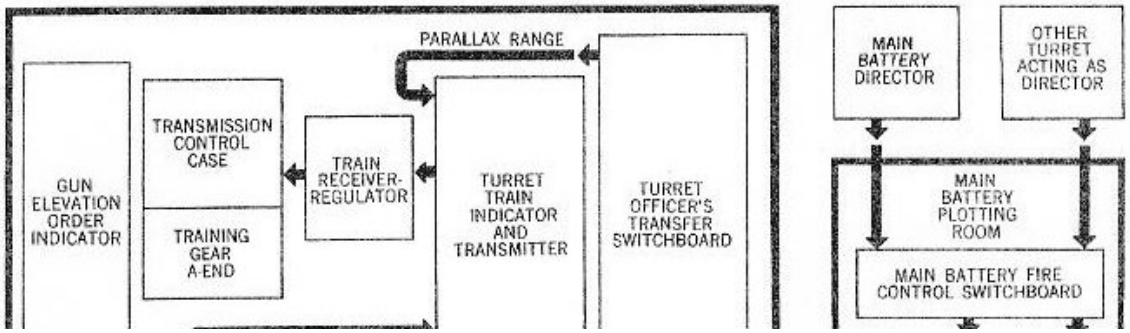
Circuit MC. Circuit MC, the turret announcing circuit, connects 16 reproducers at various locations in the turret. The circuit is interconnected with an amplifier, a transmitter control box, and a turret officer's microphone. Circuit MC allows the turret officer and turret captain to communicate with any or all turret stations. The circuit also provides transmission for general alarm and chemical attack signals.

Circuit JA. Circuit JA, the battle telephone circuit, is an arrangement of five branch circuits each of which connect with the forward and after main battery plotting rooms. These circuits are designated as follows:

Control circuit JD - Turret officer to plotting room and associated director and control station.

Sight setter's circuit JE - Local computer, left and right sight setters, and train operator to associated computer, director, and control station.

Fuze setter's circuit JK - Fuze setter to secondary battery computer fuze follow-up operator.



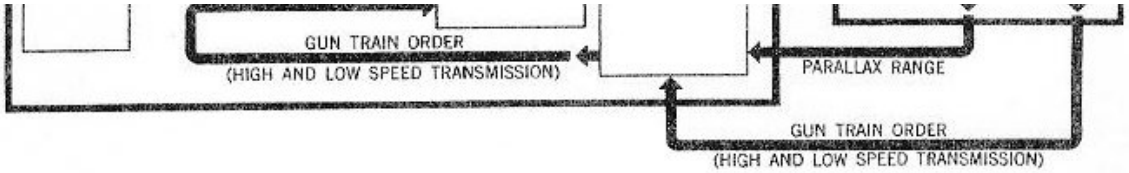


Figure 12-5. Turret Train Control - Circuit GEP - Functional Diagram

Rangefinder operator's circuit JW - Local rangefinder and local computer to graphic plot operator and range receiver operator in associated plotting room and director.

Spotter's circuit JB - Local computer to associated plotting room, control station, director and combat information center (CIC).

The circuit tie switches are in a telephone switch box adjacent to the turret officer's transfer switchboard. In event of casualty to either the forward or after section, the damaged section may be isolated by opening switches designated TIE in the switch box.

Circuit XJ. Circuit XJ, the turret officer's telephone circuit (fig. 12-14), is an arrangement of six supplementary local turret circuits designated as follows: Pointer's circuit X101J, ammunition circuit X102J, subcaliber circuit X103J, right powder hoist circuit X104J, center powder hoist circuit X105J, and left powder hoist circuit X106J.

The above designations are for turret I, the designations for turret II are X201J to X206J inclusive. The designations for turret III are X301J to X306J inclusive.

Circuit XJ provides communication within the turret between stations of the above circuits and the turret officer.

Circuit J. Circuit J, the ship's service telephone circuit, is an arrangement of dial-type telephones installed in the turret officer's compartment and the electric deck. These connect through a central automatic switchboard to any similar dial telephone in the ship.

Circuit E. Circuit E, the sound-powered telephone and call bell circuit is an audible call system which parallels the supplementary local XJ circuits and most voice tubes. It is an arrangement of bells and buzzers at various turret locations which parallel the voice tubes and telephones respectively, except for a call bell for circuit X102J from the electric deck to the turret officer's compartment. The circuit is interconnected with single or multiple push buttons. Circuit E provides an audible signal system to call personnel to circuit XJ telephones or to

Mount Mk 5 Mod 10 and is located in turret I. Periscope Mk 28 is supported by Periscope Mount Mk 5 Mod 11 and is located in turrets II and III. Periscopes Mk 28 and 29 are "quick tilt" periscopes of the prismatic fixed-power (12x) type. Their major apparent difference lies in the length, Periscope Mk 28 being the longer of the two. Other differences are described in detail in OP 1338, the instruction book for these periscopes. The main supporting member of the periscope mount is a base ring secured to the underside of the roof plate. The base ring is provided with an azimuth index, roller bearing supports for the periscope holder, and a fixed internal ring gear which meshes with the train handwheel gearing supported by the periscope holder. The periscope holder, a tubular casting with an integral external rimmed spider, supports the periscope through pressure blocks and an azimuth locking pin. The periscope holder also supports the deflection offset knob and dial, training handwheel assembly and azimuth index. The periscope collar, a tubular steel casting, is mounted on top of the roof plate to provide both a rigid vertical alignment and a watertight seal for the periscope. The only differences between these periscope mounts, and Periscope Mount Mk 5 Mod 9, described in detail in OP 810 for Gun Director Mk 38, lie in the differing heights of the various periscope collars and the mounting spacers for the base ring as required by the different lengths of the periscopes and thicknesses of the roof plates of director and turrets.

Turret transfer switchboard. The turret transfer switchboard (fig. 12-9) is mounted in the turret officer's compartment as shown in figure 12-8. With 16 rectangular panels arranged across its front, the switchboard has 21 rotary disc-type switches mounted in 14 panels. The remaining two panels, horizontally aligned in the lower right corner, serve miscellaneous purposes. The transfer switchboard provides ON - OFF and transfer switching facilities for most of the turret fire control circuits.

Multiple turret train indicator. The multiple turret train indicator (fig. 12-10) is mounted in the turret officer's compartment as shown in figure 12-7. An electrical receiver, the instrument has one-speed and 36-speed synchros operating calibrated dials. One dial indicates modified turret train response, the other (a zero reader) indicates the difference between train order and modified turret train re-

tem to call personnel to circuit XJ telephones or to voice tubes.

Turret fire control station equipment

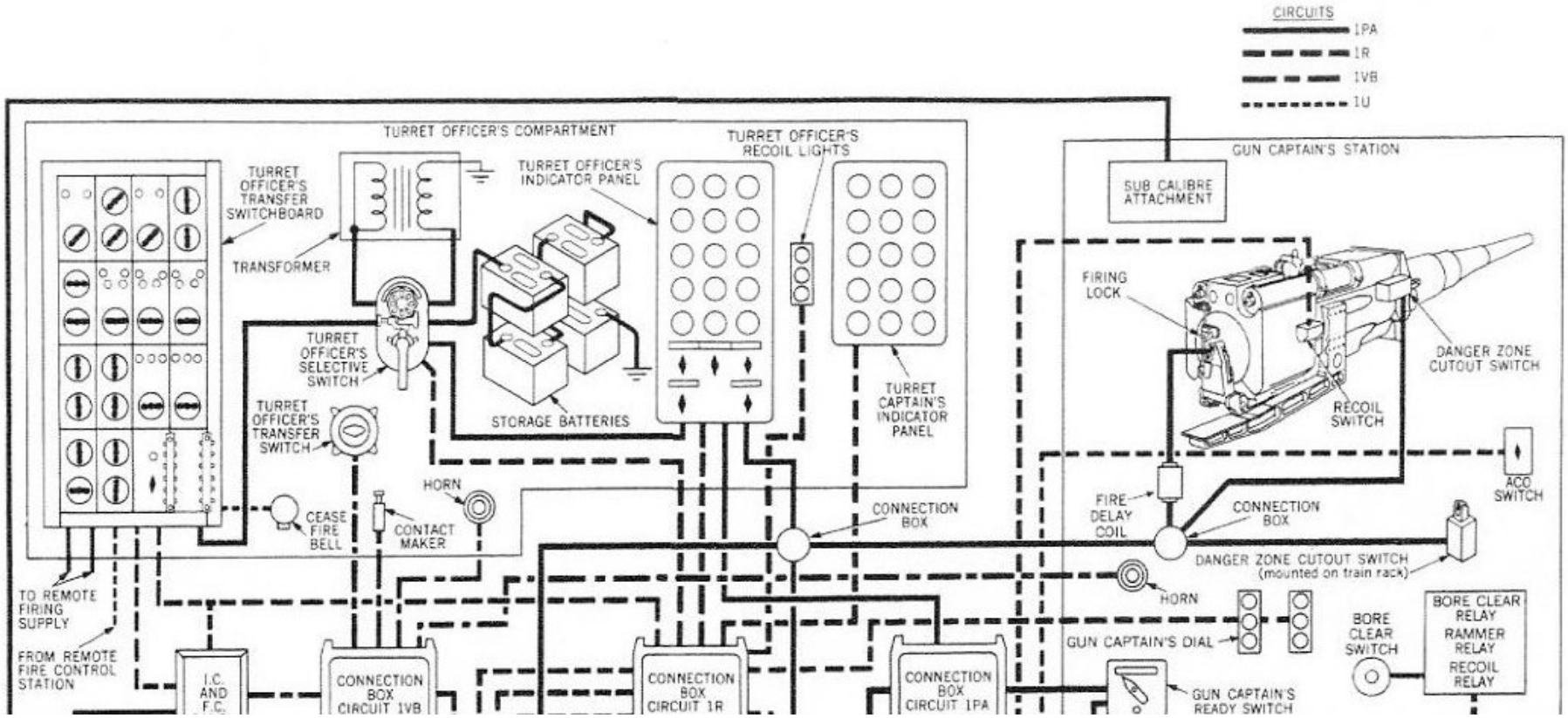
The turret fire control stations, interconnected by the circuits described previously, are equipped with the units described in following paragraphs.

Turret officer's station. The turret officer's station is at the right side of the turret officer's compartment shown in figures 12-7 and 12-8. His position at the turret transfer switchboard provides ready access to the nearby equipment described below.

Turret officer's periscope and mount. The turret officer's periscope is mounted in the roof plate above the turret officer's station as shown in figure 12-7. Periscope Mk 29 is supported by Periscope

sponse. The instrument indicates whether the turrets are following gun train orders in addition to indicating modified turret train response (turret train response from which correction for horizontal parallax has been removed). A complete description of these instruments is provided in OP 1309.

Turret officer's selective switch. The turret officer's selective switch (fig. 12-11) is mounted in the turret officer's compartment as shown in figure 12-7. It comprises a pair of rotary switches housed in a watertight case. Controlled by a pointer-type knob, the upper switch has three positions, labeled DIRECTOR - OFF - LOCAL. The lower, operated by a pointer-handle, also has three positions, labeled AC SUPPLY - OFF - BATTERY. Through the selective switch the turret officer selects the character of fire, either director or local, and the source of power, either alternating current supply or battery, to energize the firing circuit. Battery power can be used only for local turret firing (see fig. 15-37).



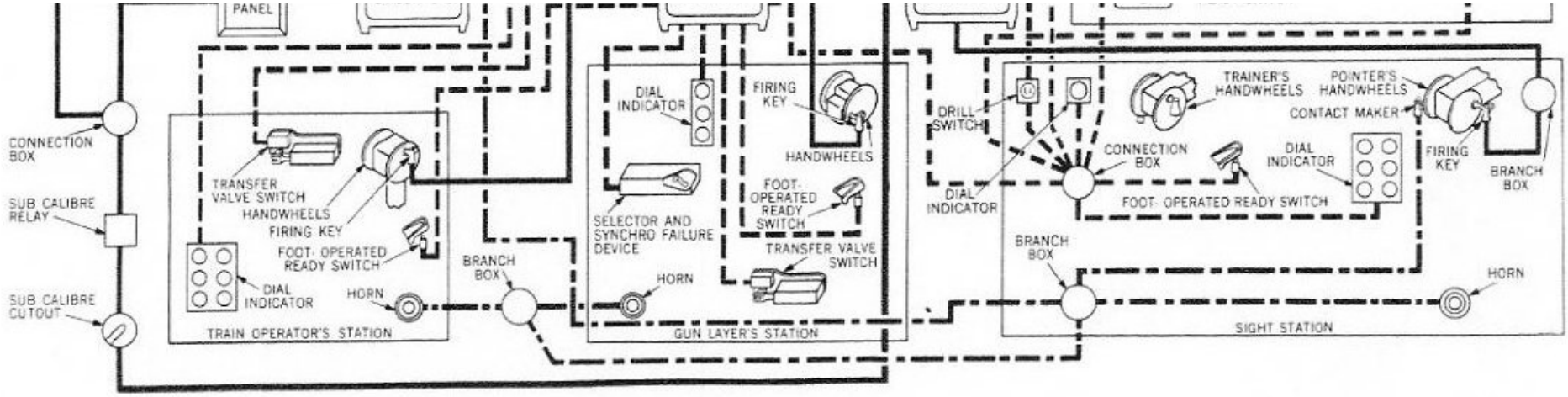


Figure 12-6. Gun Firing Control System Arrangement For Circuits 1PA, 1R, 1VB, and 1U

12-6A/B

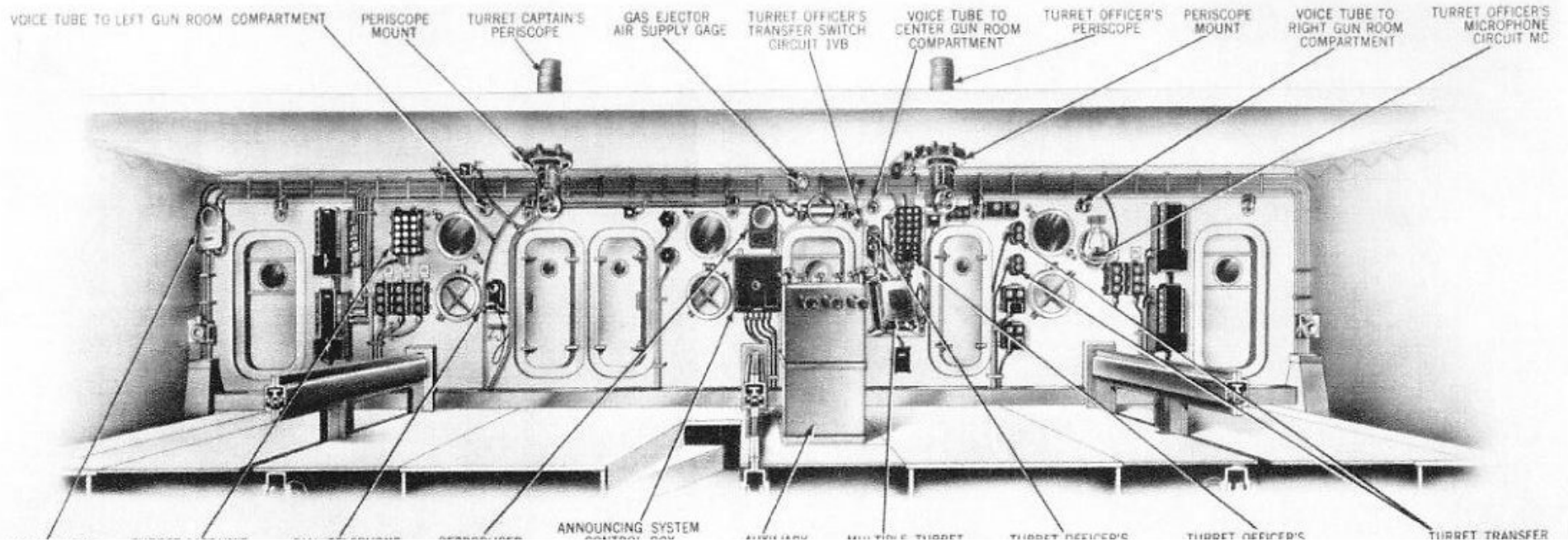




Figure 12-7. Turret Officer's Booth Fire Control Arrangement, Looking Forward

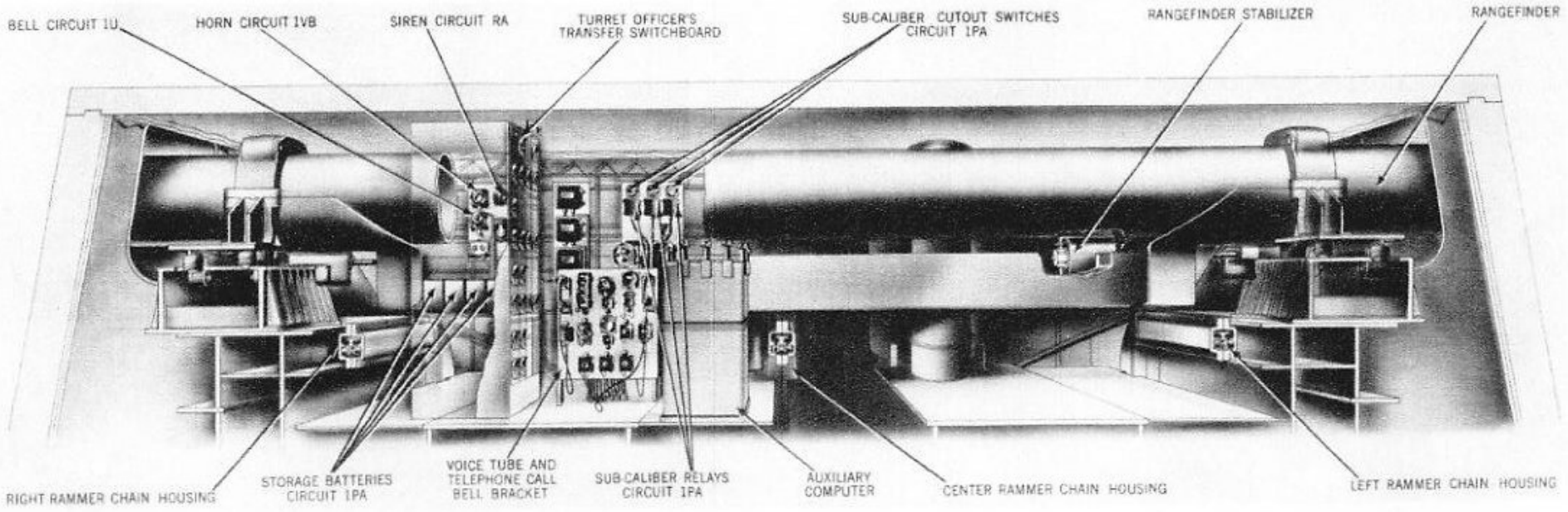
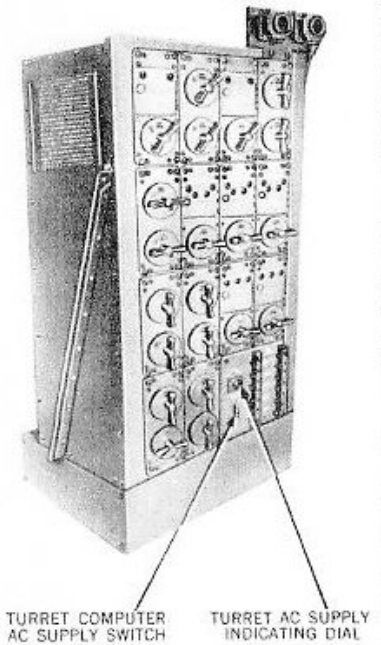


Figure 12-8. Turret Officer's Booth Fire Control Arrangement, Looking Aft

12-6C/D

SWITCH NUMBER AND NAME

	1 TRAIN INDICATOR		2 TURRET I MULTIPLE TURRET TRAIN INDICATOR
3 TRAIN	4 GUN TRAIN	5 TURRET COMPUTER	6 TURRET II MULTIPLE

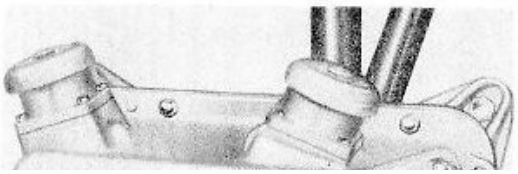


TRANSMITTER	RECEIVER–REGULATOR	TRAIN RECEIVER	TURRET TRAIN INDICATOR
7 ELEVATION INDICATOR SELECTOR			
8 ELEVATION RECEIVER–REGULATOR SELECTOR	9 LEFT GUN INDICATOR AND RECEIVER–REGULATOR	10 CENTER GUN INDICATOR AND RECEIVER–REGULATOR	11 RIGHT GUN INDICATOR AND RECEIVER–REGULATOR
12 ELEVATION TRANSMITTER 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 12-9. Turret Officer's Transfer Switchboard - Turret II - General Arrangement

12-7

Salvo signal control. When the turret is in local control operation of the salvo signal horns (circuit 1VB) is controlled by the portable contact maker located adjacent to the multiple turret train indicator shown in figure 12-7. The device is a normally-open, button-actuated switch mounted in a cylindrical grip-type handle.



Cease firing contact maker. Cease firing contact makers (circuit 1V) are located at several remote fire control stations outside the turret. They indicate "cease firing" and cannot be operated by turret personnel.

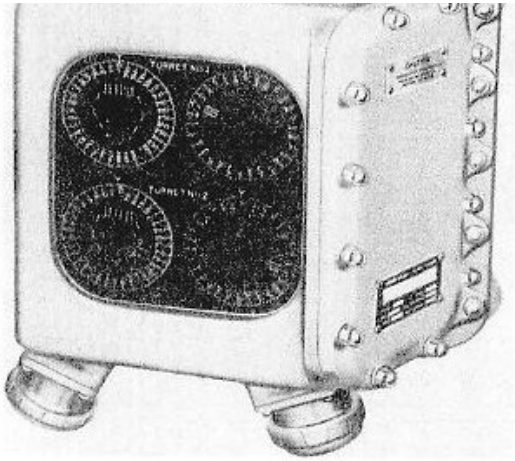


Figure 12-10. Multiple Turret Train Indicator Mk 12 Mod 7

Turret officer's indicator panel. The turret officer's indicator panel (circuit 1R) is mounted in the turret officer's compartment as shown in figure 12-7. Except for the addition of five rotary snap switches arranged in two horizontal rows at the bottom, and three amber recoil lights arranged in a horizontal row at the top, this indicator panel is identical with the turret captain's indicator panel (fig. 12-12) described on page 12-9. In addition to dial light indications, this panel provides the turret officer with individual firing key cutout and cut-in switch facilities.

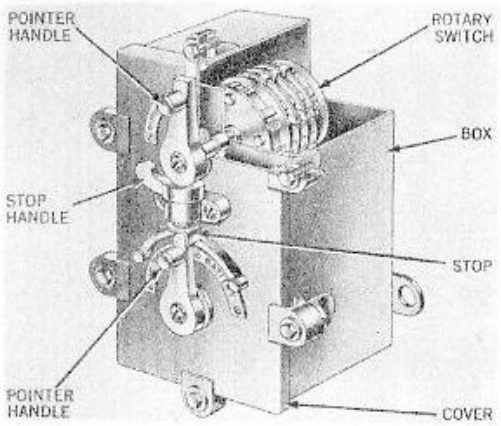


Figure 12-11. Turret Officer's Selective Switch

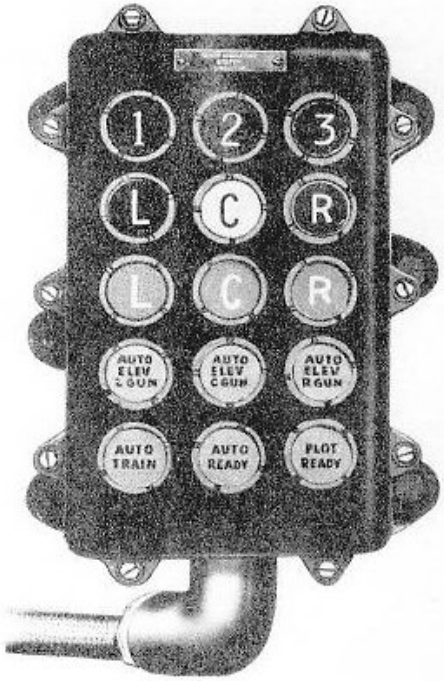


Figure 12-12. Turret Captain's Indicator Panel

Turret transfer signal indicator. The turret transfer signal indicator (circuit GE) is mounted in the turret officer's compartment as shown in figure 12-7. It is a two-dial indicator with the dials marked F and A for the forward or after plotting room respectively. It indicates the selected position for transfer

Turret captain's periscope and mount. The turret captain's periscope is mounted in the turret roof plate above the turret captain's station as shown in figure 12-7. The turret officer's and turret captain's periscope installations in any one turret are identical.

tively. It indicates the selected position for transfer switches through which control circuits are actuated from either plotting room.

Danger sector indicator. The danger sector indicator (circuit D8) is mounted in the turret officer's compartment as shown in figure 12-7. It is a three-dial indicator with the dials marked STOP LEFT GUN, STOP CENTER GUN, and STOP RIGHT GUN. The dials are illuminated to indicate an obstructed line of fire as the respective elevation and train danger zone switches (described on page 6-19, chapter 6) are closed.

Turret officer's microphone (MC). The turret officer's microphone (circuit MC) is attached by a 20-foot length of cord to the transmitter control box. The breast-plate mounted microphone is supported by a strap and has a press-to-talk button. It is a portable means of communicating over the reproducer circuit.

Transmitter control box (MC). The transmitter control box (circuit MC) is mounted in the turret officer's compartment as shown in figure 12-7. The control box switches control the circuit amplifier. In addition there is a group of key-type switches with which any combination of talk-back reproducers may be tied into the circuit. Cutout switches permit any combination of reproducers to be cut out of the circuit in event of trouble in an individual circuit.

Reproducer (MC). Reproducers (circuit MC) are mounted in the turret officer's compartment as shown in figure 12-7. These are permanent magnet, non-talk-back type.

Telephones (J, XJ, JA). Three turret telephone circuits (circuits J, XJ, and JA described on pages 12-5 and 12-6) are available to the turret officer at his station.

Circuit J comprises the dial-type telephone mounted on the transverse bulkhead as shown in figure 12-7.

Circuit XJ connections and circuit JA connections are at the instrument panel shown in figure 12-8.

Call bell buttons (circuit E). The turret officer's call bell circuit (circuit E described on page has push buttons with which the turret officer may call either sight control station, any of the gun-layers, or the train operator. These buttons are arranged on the instrument panel shown in figure 12-8.

Turret captain's station. The turret captain's station, shown in figure 12-7, is equipped with controls that partially duplicate those of the turret officers station. The turret captain's station is equipped with a periscope indicator panel, emergency alarm contact maker, train warning push button and communications as described in following paragraphs.

Turret captain's indicator panel. Mounted in the turret officer's compartment (fig. 12-7), the turret captain's indicator panel is a watertight indicator assembly comprising fifteen dials marked as shown in figure 12-12. Arranged in five horizontal rows of three in each row, the dials are colored as follows: Top row, yellow; second row (from left to right), red, clear, and green; third row, yellow; fourth row, clear; bottom row, clear. The panel dials indicate the loading or firing readiness of the local turret, the firing readiness of all turrets, and the readiness of the plotting room in control.

Emergency alarm contact maker. The emergency alarm contact maker is mounted in the turret captain's compartment as shown in figure 12-7. It is a non-locking type contact maker, normally closed, that can be held open by hand against a spring return. When held open, the alarm sirens are stilled and instructions and order may be transmitted to turret personnel through other communication circuits.

Train warning push button. The train warning push button is located at the turret captain's station. Of watertight design, the push button is normally open and must be held closed to sound the train warning bell.

Communications. Telephone and call bell units at the turret captain's station provide battle telephone communications to turret control and operating stations. This arrangement can be tied in to any other station through a telephone switch box at the turret officer's station. In addition, the dial-type telephone (circuit J) is located at the turret captain's station.

Computer's station. The computer's station, shown in figures 12-7 and 12-8, is equipped with fire control equipment consisting of an auxiliary computer and telephone communication units. This equipment provides the turret with local means for receiving and computing the various fire control data required for generating values of sight angle and sight deflection, and for transmitting these values orally to the sight setters.

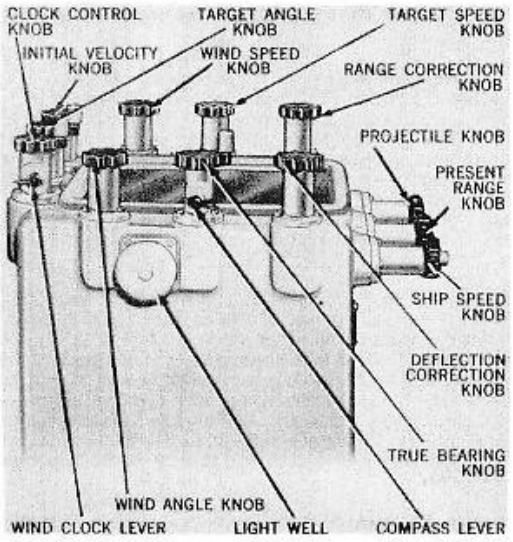
Auxiliary Computer Mark 3 Mod 2. The auxiliary computer (fig. 12-13) is mounted in the turret officer's compartment as shown in figure 12-7. Computer Mk 3 Mod 2 is a computing and indicating mechanism used by the computer operator and talker to solve fire control problems. It generates indicated values of sight angle and sight deflection based upon three electrical inputs and 13 manual inputs. Complete information on this instrument is contained in OP 1290.

Communications. Range information is received and sight angle and sight deflection orders are transmitted over the telephone facilities at the computer's station. These comprise battle telephone (circuit JA) and supplementary turret officer's telephone (circuit XJ) tie-in arrangements which connect the computer

talker with the sight pointers and trainers, sightsetters, gun-layers, train operator, range finder, plotting rooms, and directors.

Gun captain's station equipment. The gun captain's station, shown in figure 12-15, has fire control equipment consisting of two 3-dial indicators, synchro power on indicator, elevating motor STOP button, projectile hoist pushbutton, bore clear switch pushbutton, action cutout switch for 1R circuit, drill switch, turret alarm contact maker, and communications. Each gun captain's station is similarly equipped.

Gun captain's ready switch. Mounted on the post at each gun captain's station is a gun captain's ready switch (circuit 1R). This switch is a two-position, spring return lever-operated, rotary-type unit, and has an integral unlocking solenoid which prevents the lever from being shifted to the opposite position until this solenoid is energized. One position of the lever is SAFE (meaning "safe to load"), and the other position is READY (meaning "ready to fire"). This lever is spring-returned to the SAFE position when the unlocking solenoid is energized. A manual PULL TO RELEASE button is also located on the switch. This release button can be pulled out to release the lever if the unlocking solenoid should fail to function. When positioned at SAFE, the switch illuminates dials marked LOAD at the gun captain's and gun layer's indicators; in addition, with this switch at SAFE, a device at the elevation receiver-regulator causes the gun to move to its loading position (in automatic control). When positioned at READY the switch illuminates red dials at the gun captain's and gun layer's indicators; in addition, with the switch at READY, a device at the elevation receiver-regulator causes the gun to match the gun elevation order signal (in automatic control). The gun captain's ready switch also functions in a safety interlocking electrical circuit to prevent lowering the cradle and opening the powder unloading door until the switch lever is positioned to SAFE and other operations have taken place during the loading sequence. See chapter 15 for details.



Gun elevation ready, gun ready, and load indicators. Located at each gun captain's station, these three-dial indicator lights indicate, from top to bottom, respectively: gun captain ready, gun elevation ready, and load. The indicators for the left gun captain's station are marked, from top to bottom, L, L, and LOAD. Similarly, indicators for the center gun captain's station are marked C, C, and LOAD; and for the right gun captain's station, R, R, and LOAD. The lower (LOAD) dial is illuminated (with the gun captain's ready switch at SAFE, through interlocking relays) during the loading cycle, and goes OFF when the gun is ready to fire. It remains OFF during firing and recoil, until the gun is back in battery; then it goes on again. In other words, the LOAD light indicates to the gun captain that this portion of his ready light circuit is in operation and that the gun is to be moved to, or is at, the loading angle.

The upper (red) light is illuminated when the gun captain's ready switch is positioned to READY. These lights indicate to the gun captain that his signal circuit is functioning. The middle (blue) dial is illuminated by the gun layer, through his foot-operated ready switch (described on page 12-13). This indicates to the gun captain that the gun elevation is matched with the gun order.

Breech closed, recoil, and bore clear indicators. A second three-dial indicator is located at each gun captain's station, mounted directly above the gun elevation ready, gun ready, and load indicator lights. These dials are illuminated when the actions they identify occur during the loading and firing cycle.

Action cutout switch. Located at each gun captain's station, mounted on the post and below the gun captain's ready switch, is the action cutout switch. This is a snap switch with on-off-on-off action, and serves to turn off the power supply to the indicator lights, switches, and control relays of the ready light circuit. Before the gun can go through the loading sequence, this switch must be in an ON position.

Drill switch. Located at each gun captain's station, mounted on the post and below the action cutout switch, is the drill switch. This is a single receptacle which requires the insertion of a plug to close the circuit. This switch is only used during gun drill and serves to by-pass the recoil switch (ch. 15) so that, without firing the gun, the sequences of the loading and firing operations can be rehearsed while the gun is in battery. It permits the normal functioning of the safety interlocking arrangement in the ready light circuit (1R) without the need for having the gun go through recoil.

Figure 12-13. Auxiliary Computer - General Arrangement

Bore clear switch. Located forward and to one side of each gun captain's station, on the longitudinal bulkhead, is the bore clear switch (fig. 15-25A). This switch is a momentary contact unit with a spring-loaded pushbutton. The main body of the switch is mounted on the opposite side of the bulkhead, and only the mushroom head of the pushbutton extends through to the gun captain's station. With the gun captain's ready switch at SAFE, momentarily depressing the bore clear switch pushbutton (done after ascertaining the condition of the bore) will illuminate the bore clear indicator light and will initiate the relay circuit which releases the cradle for lowering.

Synchro power on indicator. A one-dial indicator marked SYNCHRO POWER ON is located at the gun captain's station. When illuminated, it indicates that synchro power is available for the related elevation receiver-regulator.

Elevating motor STOP button. The elevating motor STOP button is mounted adjacent to the gun ready switch. It is a normally closed, single pushbutton switch which, when pressed to open, stops the elevating motor and brings the gun to a quick stop.

Projectile hoist pushbutton. The projectile hoist pushbutton is mounted on the transverse bulkhead at the gun captain's station. It is a lever-operated switch with two pushbuttons labeled START EMERG and STOP. The projectile hoist motor is started or stopped from the gun captain's station by this switch.

Turret alarm contact maker. The turret alarm contact maker is mounted on the transerve bulkhead adjacent to the projectile hoist pushbutton. It is a normally open, double contact, lever-operated, locking type. When closed, the contact maker sounds all the sirens in the turret emergency alarm circuit (circuit RA).

Communications. The gun captain's communication facilities include a talk-back type reproducer (circuit MC), turret officer's telephone (circuit XJ), and call bell (circuit E) circuits. The circuit arrangements enable the gun captain to communicate with the turret officer, or with the powder hoist and projectile hoist control stations.

Right and left sight stations. The right and left sight stations have similar fire control equipment which includes a sight setter's indicator, gun elevation and train ready indicator, train ready indicator, foot operated ready switch, firing key, sight setter's clutch indicator, pointer's clutch indicator, gun elevation order transmitter, and communications.

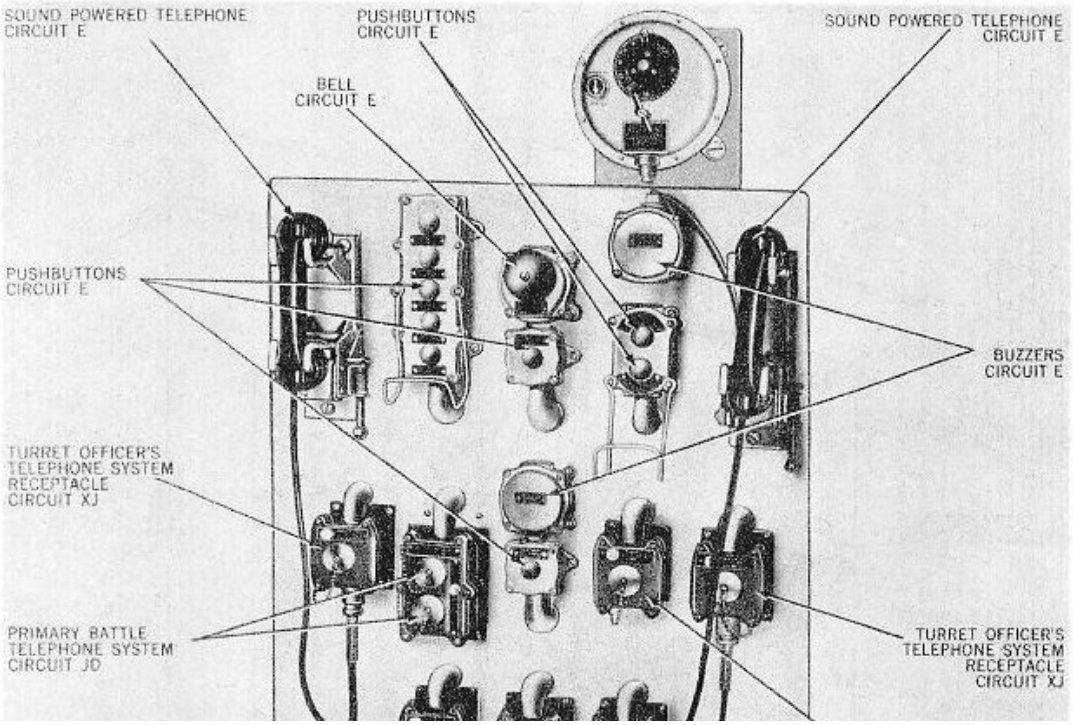
Sight setter's indicator. Mounted on the forward side of the sight trainer's handwheel pedestal, the sight setter's indicator (fig. 12-16) is enclosed in a square case. It has two hand cranks, three dials, and two output shafts. Sight angle and sight deflection received electrically by the indicator synchros from the plotting rooms operate the indicator dials. These are "follow-the-pointer" dials with calibrated ring dials (hand crank operated) which are matched with the calibrated inner dials (synchro operated). Hand crank rotation is transmitted to the trainer's and pointer's sights through output shafts to correct the sights for deflection and angle respectively. This instrument is described in detail in OP 880.

Gun elevation and train ready indicator. Located at the sight pointer's station, this is a four-dial indicator with the dials marked L, C, and R (for respective left, center, and right guns), and TRAIN READY. When illuminated the dials indicate to the sight pointer that the gun and turret positions are matched with gun and train order signals.

Train ready indicator. Located at the sight trainer's station, this is a one-dial indicator (circuit 1R) marked TRAIN READY. When illuminated (by closing the foot-operated ready switch) it indicates to the sight trainer that his signal circuit is functioning.

Foot-operated ready switch. Located at the sight trainer's station, this is a normally open, bridge-type switch (circuit 1R). When closed by foot pressure it illuminates TRAIN READY dials at the turret officer's, turret captain's, train operator's, and the sight station indicators.

Firing key. Firing Key Mk 16 Mod 8 is mounted on the sight pointer's handwheels. It is a pistol grip design with spring-loaded trigger-type contact maker. The design includes a latch to hold the trigger closed for director fire. Connected in



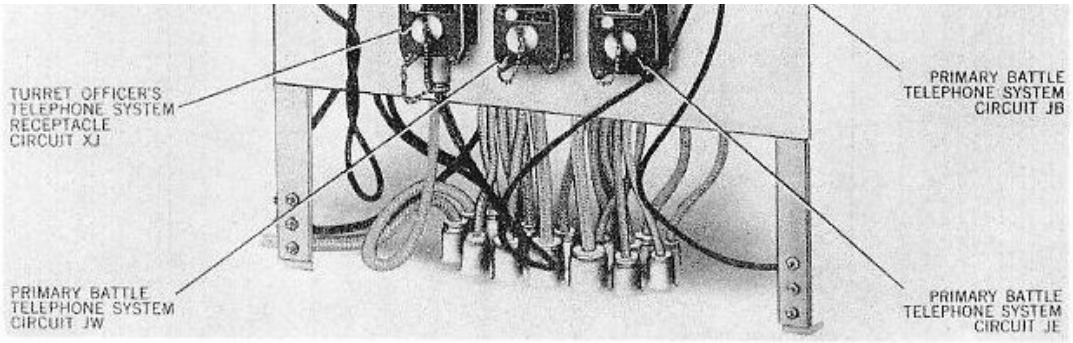


Figure 12-14. Voice and Telephone Call Bell Bracket

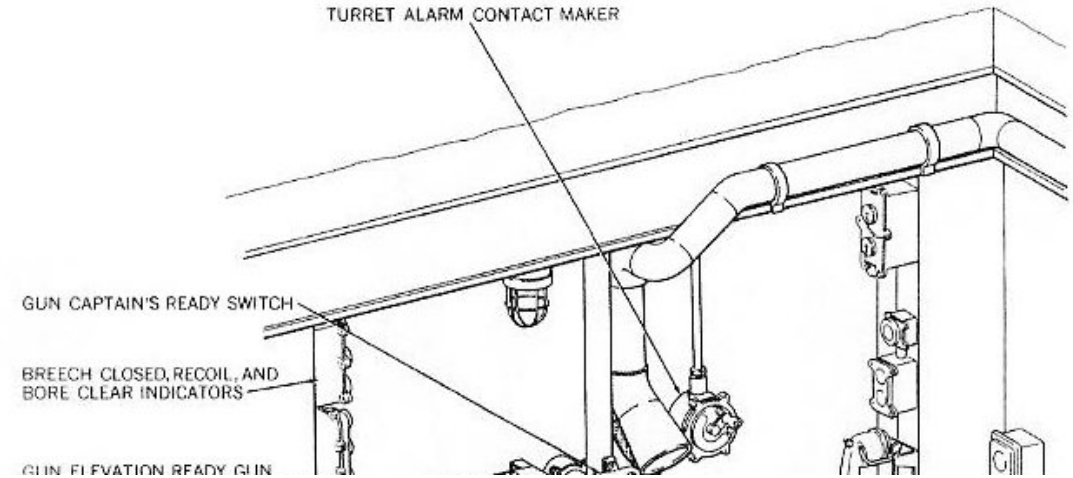
circuit 1PA, the firing keys can be individually closed to fire the guns (through switches on the turret officer's indicator panel) when in local control (as described on page 12-8.

Sight setter's clutch indicator. The sight setter's clutch indicator (circuit CS), is a two-dial type with red and green dials. Depending on which dial is illuminated, the relative positions of both sight setter's clutches are indicated. Red indicates that the opposite sight setter's clutch is engaged. Green indicates that neither clutch is engaged.

Pointer's clutch indicator. The pointer's clutch indicator (circuit CP) is a one-dial type with a red dial labeled CLUTCH WARNING LIGHT. Illuminated by either sight pointer as he engages his clutch, it warns the opposite sight pointer to remain disengaged.

Gun Elevation Order Transmitter Mk 2 Mods 0 and 1. Mounted on the sight pointer's handwheel pedestal, the case-enclosed transmitter (figs. 17 and 19) is designated Transmitter Mk 2 Mod 0 at the right station, and Transmitter Mk 2 Mod 1 at the left. It is an electrical transmitter with 2-speed and 36-speed synchros operating calibrated transmitter dials for adjustment purposes. With the pointer's sight acting as a local director, the instrument transmits gun elevation orders to related synchros in the elevation indicator. This instrument is described in detail in OP 1308.

Communications. Sight station communication facilities include battle telephone (circuit JE), turret officer's telephone (circuit XJ), and call bell (circuit E) circuits. These arrangements enable the turret officer to communicate with the sight stations and also connect the sight stations with the main battery directors.



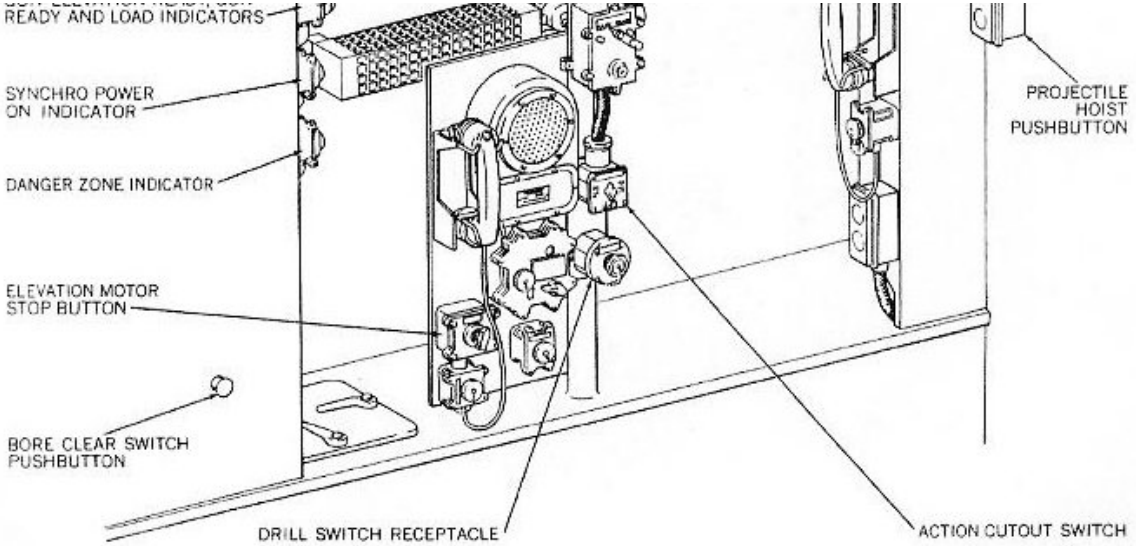


Figure 12-15. Gun Captain's Station - General Arrangement.

12-12

Gun-layers' stations. The gun-layers' stations (fig. 12-18) have similar fire control equipment which includes a gun elevation indicator, synchro power-on indicator, firing key, gun elevation ready and gun ready indicator, foot-operated ready switch, and communications.

Gun Elevation Indicator Mk 33 Mods 3 and 4. Mounted on the gun-layer's handwheel pedestal, the case-enclosed indicator (fig. 12-18) is designated Indicator Mk 33 Mod 3 at the right and center stations, and Indicator Mk 33 Mod 4 at the left station. There are six dials arranged in three horizontal rows on the indicator face. In the top row there are 2-speed and 36-speed synchro operated dials which are the zero reader and follow-the-pointer dials respectively. These provide gun elevation orders which are matched by the gun-layer in "indicating" control. In the middle row there are also zero reader and follow-the-pointer dials. These are mechanically operated at 2- and 36-speeds through shafting from the sight pointer's handwheels. They provide gun elevation orders which are matched by the gun-layer in "local" control. In the bottom row there are velocity loss and angle reader dials. The velocity loss dial mechanically indicates correction for difference in equivalent service rounds fired. This correction is based on the quantities "sight angle" and "difference in velocity loss" and is set manually through knobs. The angle reader dial is mechanically operated through shafting from the sight setters' indicators. This instrument is completely described in OP 854.

Synchro power-on indicator. Located at the gun-layer's station, this indicator is a one-dial type marked SYNCHRO POWER ON. When illuminated it indicates that synchro power is available for the related elevation receiver-regulator.

Firing key. Mounted on each of the gun-layer's handwheels, this key is identical in designation, arrangement, and function to the sight pointer's firing key described on page 12-11.

Gun elevation ready and gun ready indicator. Located at each gun-layer's station, this indicator is a three-dial type with the two upper dials marked L, C, or R (for respective left, center, or right stations) and the lower dial marked LOAD. The lower dial is illuminated when the gun captain's ready switch is positioned to SAFE and the middle dial is illuminated when the switch is positioned to READY: These lights indicate to the gun-layer when the gun is being loaded and when the gun position may be matched with the gun order signal. The upper dial is illuminated by the gun-layer through his foot-operated ready switch. This indicates to the gun-layer that his signal circuit is functioning.

Foot-operated ready switch. Located at each gun-layer's station, this switch is a normally open, bridge-type (circuit 1R). When closed by foot pressure it illuminates dials marked L, C, or R (for respective left, center, or right stations) at the turret officers, turret captain's, trainer's, gun captain's, and the sight station's indicators to indicate that the gun is ready.

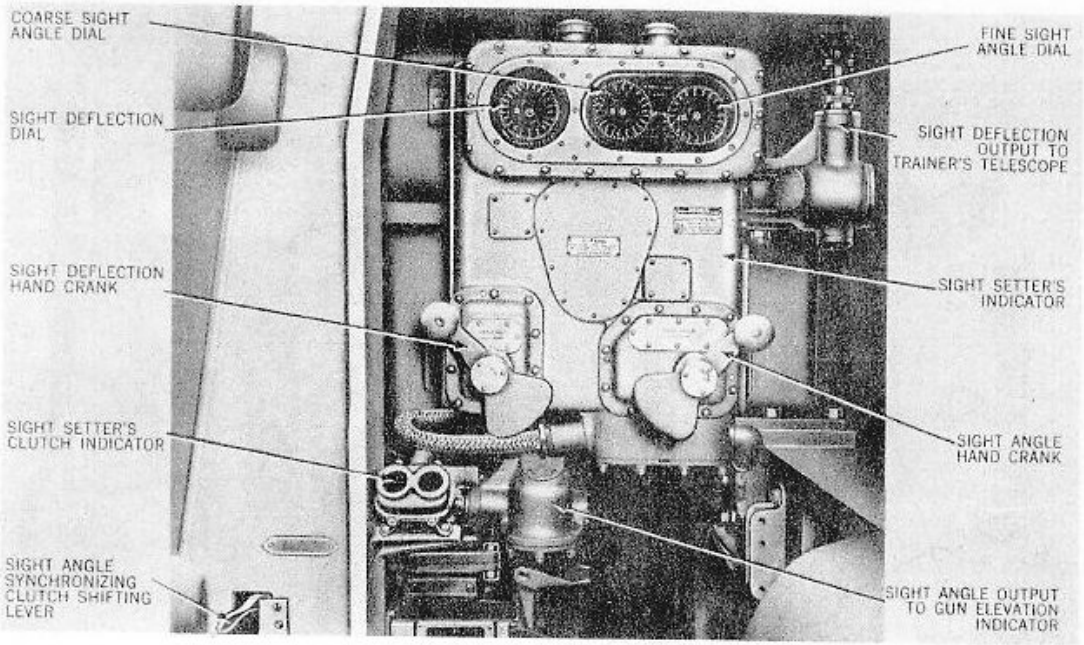


Figure 12-16. Sight Setter's Station - Fire Control Arrangement

Communications. Gun-layer communication facilities include a talk-back type reproducer (circuit MC), turret officer's telephone (circuit XJ), and call bell (circuit E) circuits. These arrangements provide communications between the gun-layer and the turret officer.

Trainer's station. The trainer's (train operator's), station has fire control equipment which includes a turret train indicator and transmitter, firing key, gun elevation and train ready indicator, foot-operated ready switch and communications.

Turret Train Indicator and Transmitter Mark 37 Mods 4, 5, and 6. Mounted on the trainer's handwheel pedestal, the case-enclosed Indicator and Transmitter is designated Mk 37 Mods 4, 5, and 6 for turrets I, II and III respectively. As an indicator, the instrument shows four quantities on dials: gun train order, modified turret train response, parallax-range order, and parallax range in terms of range in yards. As a transmitter, the instrument sends modified turret train response (electrically) to other stations throughout the ship, and parallax range (mechanically) to the train receiver-regulator. The instrument is used by the train operator who rotates

Gun elevation and train ready indicator. Located at the trainer's station, this is a four-dial indicator (circuit 1R) with the dials marked L, C, and R (for respective left, center, and right guns), and TRAIN READY. When illuminated, the dials marked L, C, and R indicate that the gun positions are matched with the gun order signals. TRAIN READY indicate to the trainer that his signal circuit is functioning.

Foot-operated ready switch. Located at the trainer's station, this is a normally open, bridge-type switch (circuit 1R). When closed by foot pressure it illuminates dials marked TRAIN READY at the turret officer's, turret captain's, trainer's, and the sight station indicators.

Communications. Trainer communication facilities include a talk-back type reproducer (circuit MC), battle telephone (circuit JE), turret officer's telephone (circuit XJ), and call bell (circuit E) circuits. These arrangements provide communications between the trainer and the turret officer and main battery directors.

his handwheels to match pointers on the dials. The train operator also turns the parallax-range hand-crank to match pointers on the range dials. This instrument is completely described in OP 851.

Firing key. Mounted on the trainer's handwheels, this key is identical in designation, arrangement, and function to the sight pointer's firing key described on page 12-11.

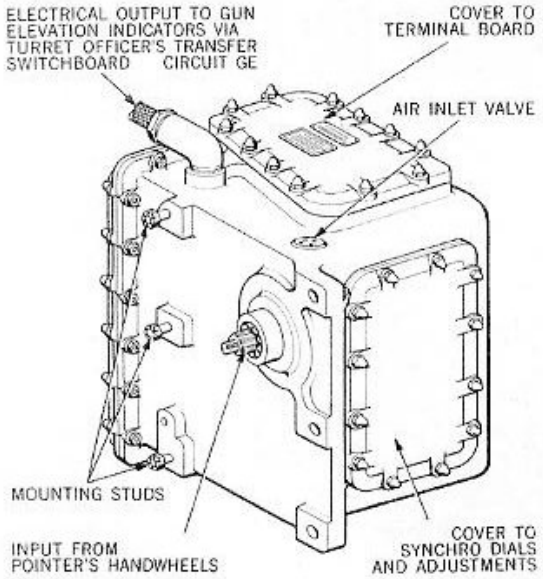


Figure 12-17. Gun Elevation Order Transmitter

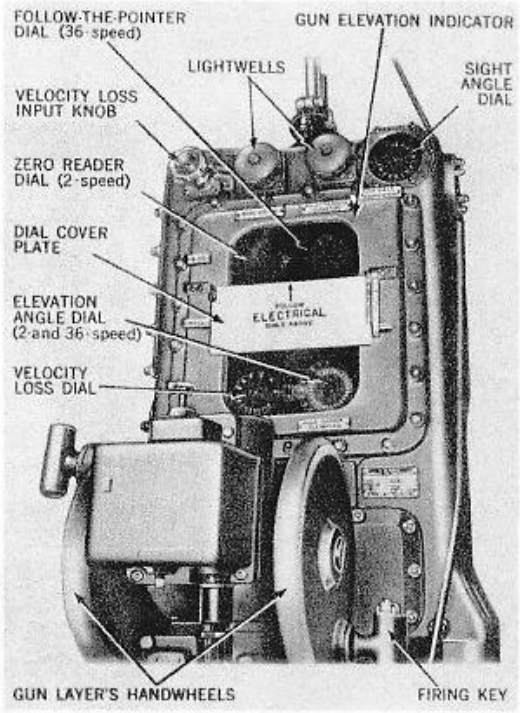


Figure 12-18. Gun Layer's Station - Fire Control Arrangement

Rangefinder operator's station. The rangefinder operator's station in turrets II and III has fire control equipment which includes the rangefinder, the rangefinder stabilizer, and communications.

Rangefinder. The rangefinder Mk 52, stereoscopic type, is mounted transversely at the rear of the turret as shown in figure 12-8. It provides target ranges during "secondary" or "local" control operation. This instrument is described in detail in OP 1573.

Rangefinder Stabilizer Mk 4 Mod 1. Mounted on the rear of the rangefinder stand, the stabilizer is an electric motor-driven assembly automatically controlled by a gyroscope. The stabilizer keeps the rangefinder line of sight horizontal, as described in chapter 14.

Communications. Rangefinder communication facilities include battle telephone (circuit JA), and the turret officer's compartment non-talk-back type reproducer. These arrangements provide communication between the rangefinder operator and local computer, graphic plot operator, and associated plotting room and director.

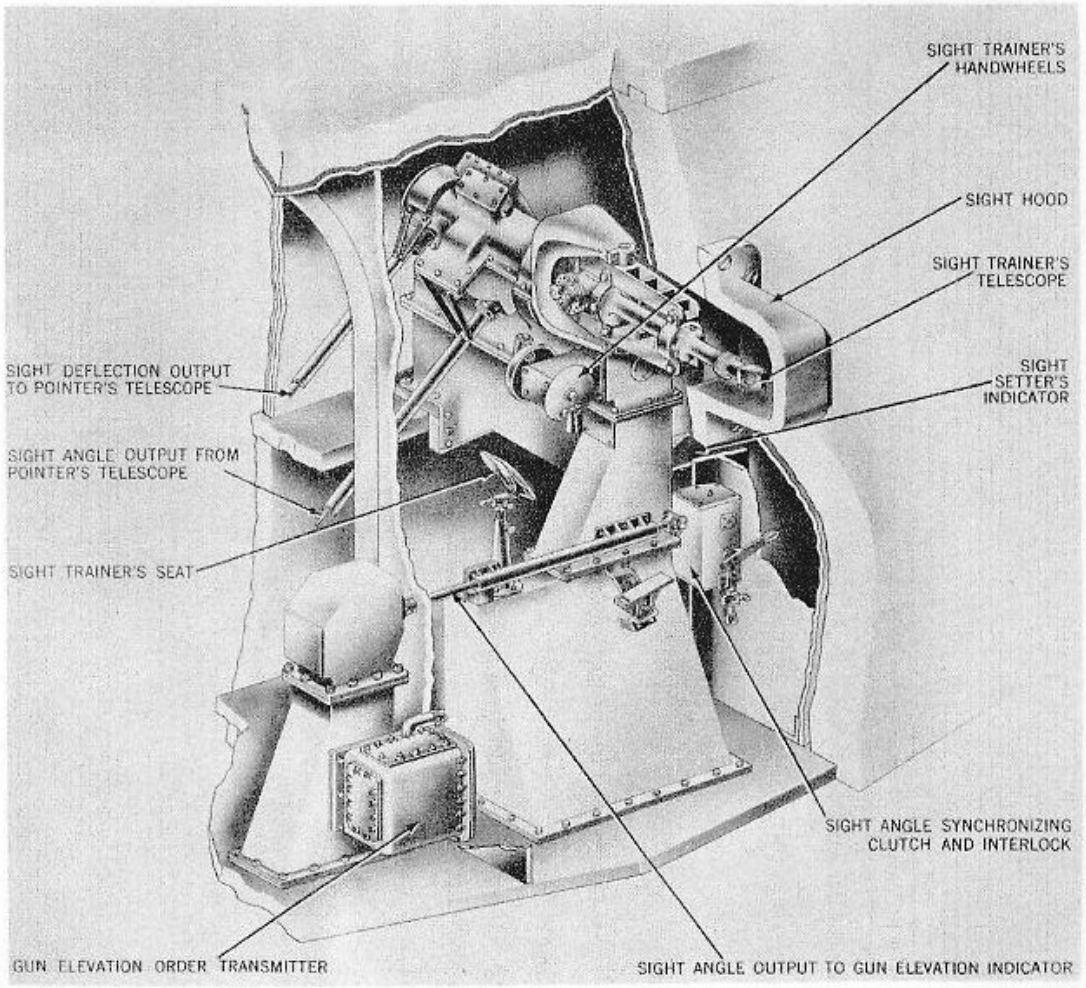


Figure 12-19. Sight Trainer's Station - Fire Control Arrangement

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OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

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CHAPTER 13 SIGHT ASSEMBLIES

Chapter 13

SIGHT ASSEMBLIES

16-inch Sight Mark 4 Mods 2 and 3

GENERAL DESCRIPTION

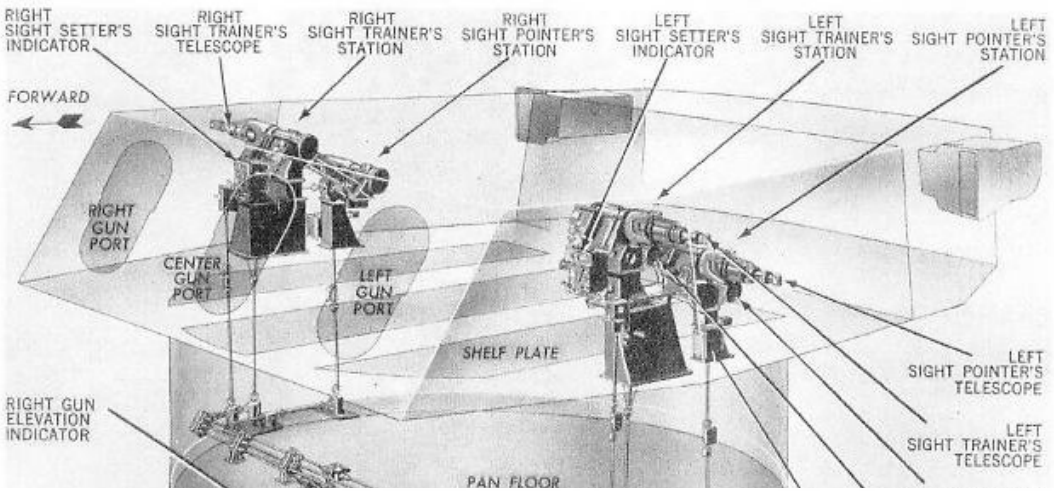
Turret local fire control arrangements comprise two interconnected sight assemblies and attached or associated instruments. The installations are identical in all turrets.

Type

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 of two stations. These stations are designated 16-inch Sight Mk 4 Mod 2, in the right side of the gun house, and 16-inch Sight Mk 4 Mod 3, in the left side.

General arrangements of sight stations and components

The arrangement of the sight stations and associated instruments is shown in figure 13-1. Each 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. However, the sight trainer's telescopes may be unlatched from the sight angle and sight pointer's inputs. Sight angle and sight pointer's movements are transmitted 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 handwheel may be clutched to the servo control of the training gear speed gear. The mechanical system of gun order transmission extends transversely between the two sight stations and connects line-of-sight and sight setter outputs of both stations to all indicating instruments. The interconnection is arranged with manually operated, interlocked, synchronized selectors. By this means either sight station can quickly assume control of gun direction in response to the turret officer's designation of the controlling sight. Turret train control selectors (for LOCAL) are manually positioned clutches located at the train operator's station. Either sight trainer may be given control from this station when the operator unclutches his speed gear control.

Functional arrangements

The fire control system utilizing the above described arrangements is supplementary to two other basic systems, designated PRIMARY and SECONDARY. They are director control systems which use a portion of the sight facilities described below.

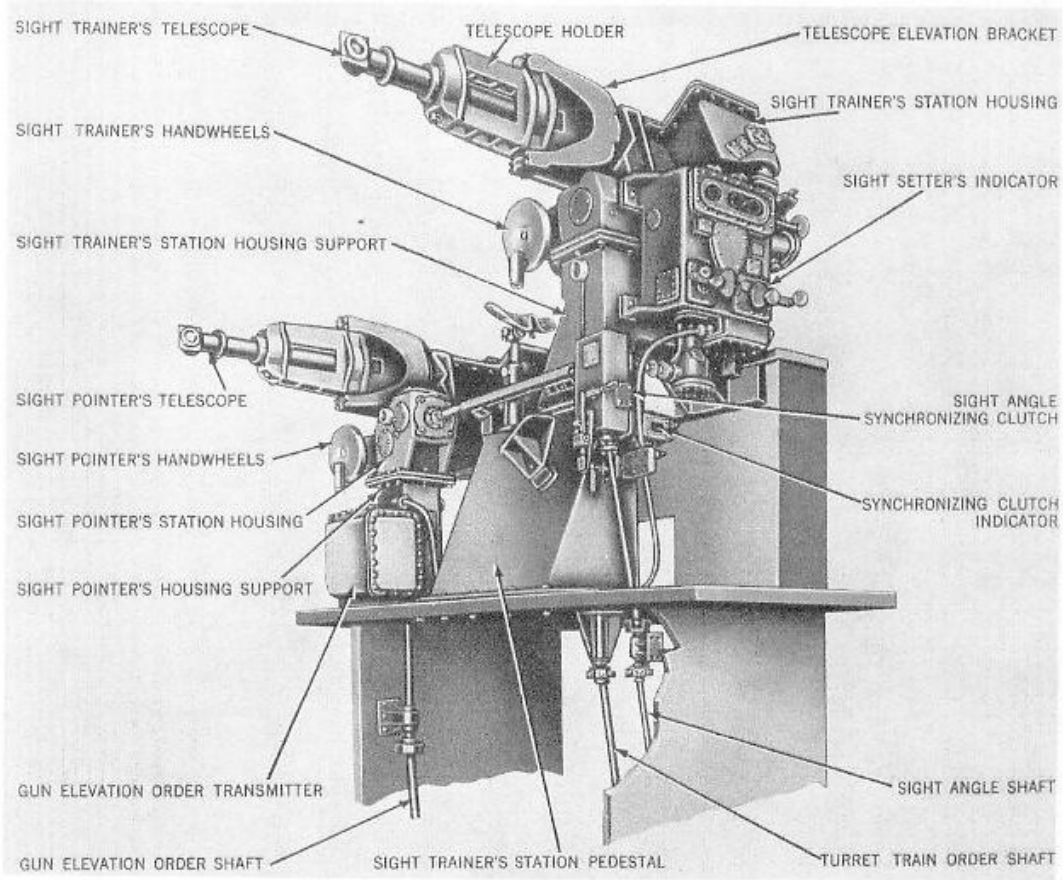
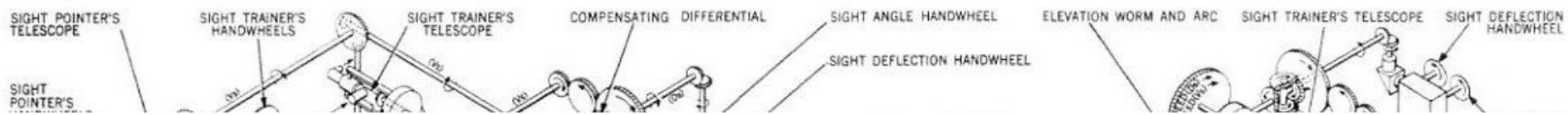


Figure 13-2. 16-Inch Sight Mk 4 Mod 2



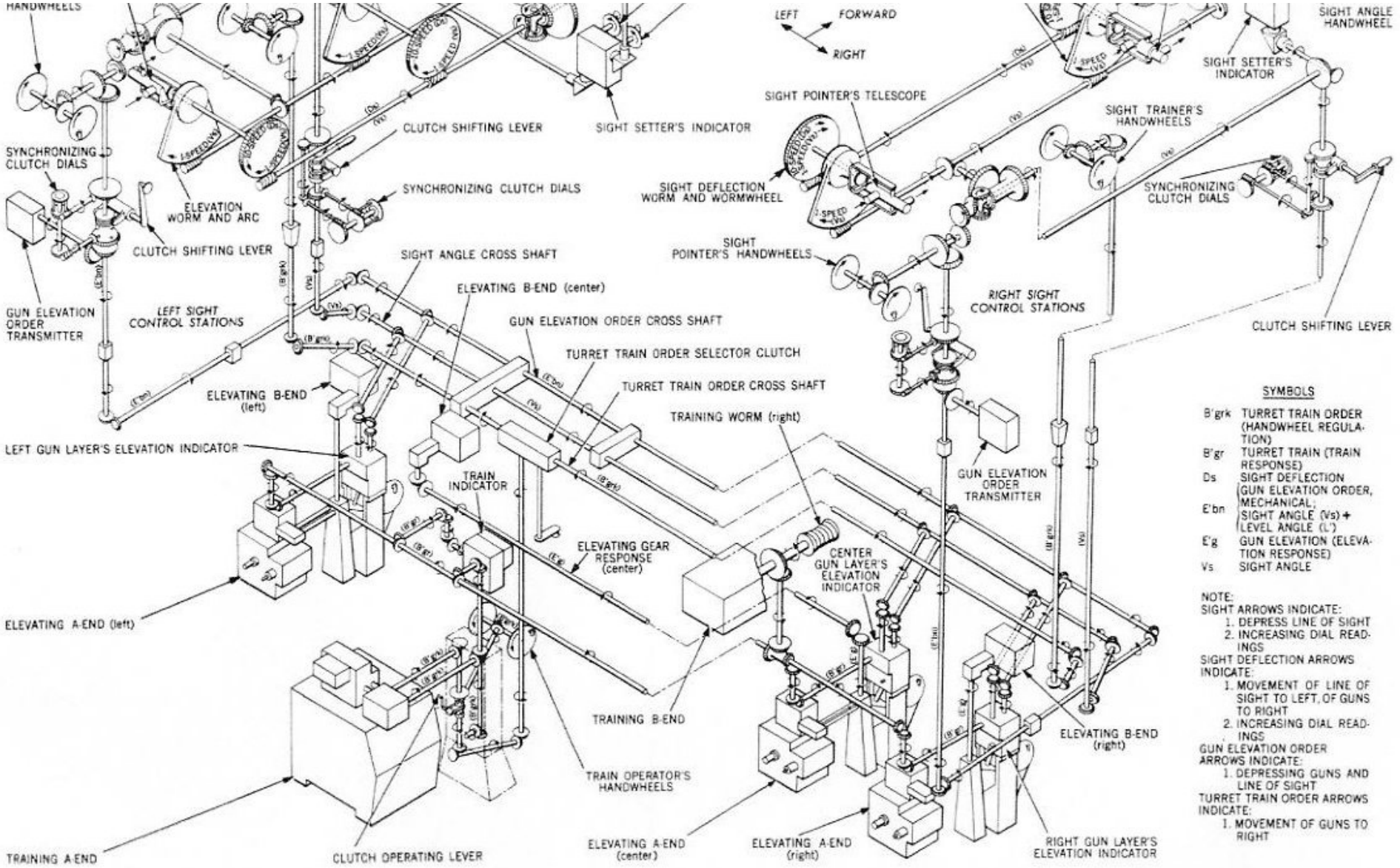


Figure 13-3. 16-Inch Sight Mk 4, Mods 2 and 3, Schematic Arrangement

13-2A/B

PRIMARY control. In PRIMARY control the main battery fire control director system operates to position the guns "automatically" or by "indicating." In either case, gun orders are generated by the rangekeeper in the forward or aft plotting room from signals received from either the forward or aft main director. In "automatic" PRIMARY control, the orders are transmitted to the gun and turret drive receiver-regulators, providing remote control of all gun positioning movements. PRIMARY "indicating" control transmits orders to dials of the indicators at the gun layer and turret train operator stations. Both methods require continuous operation of one sight setter's indicator in order that sight angle corrections for erosion may be entered in each gun elevation indicator.

SECONDARY control. SECONDARY control is an auxiliary method of director fire control in which gun orders originate in one turret (as a controlling director) and are transmitted to the other turrets. The system provides "automatic" and "indicating" control in the same manner as PRIMARY control, requiring similar operation of one sight setter's indicator.

Local control instruments

The instruments listed below are directly associated with the operation of the sights, but are not part of the sight assembly. Details of their arrangement with respect to the sight assemblies are given in the description of the sight. A more complete description occurs later in this chapter. The electrical circuit arrangements, illumination, and fire control system selector connections are described in chapter 15. The instruments are as follows:

Telescope Mk 66 Mod 0
Sight Setter's Indicator Mk 3 Mods 2 and 3 or 4 and 5
Gun Elevation Indicator Mk 33 Mods 3 and 4
Turret Train Indicator and Transmitter Mk 37 Mods 4, 5, or 6
Gun Elevation Order Transmitter Mk 2 Mods 0 and 1
Multiple Turret Train Indicator Mk 12 Mods 5 or 6
Battle Order Indicator Mk 28
Train Receiver-Regulator Mk 18 Mods 5, 6, or 7
Elevation Receiver-Regulator Mk 10 Mod 0

DETAILED DESCRIPTION

Sight

16-inch Sight Mk 4 Mod 2 comprises the right sight station assembly and the elements of the shaft system of brackets, gearing, shafts, clutches, and connected parts that extend across the turret to the left sight station and to the machinery floor. 16-inch Sight Mk 4 Mod 3 comprises the left sight station assembly. The two sight station assemblies are approximately symmetrical about the longitudinal center line of the turret.

Location and subassemblies. The elements and arrangement of the right sight station are illustrated in figure 13-2. This is typical of both stations except for the right and left positions of parts. Shafts from the two stations extend through the shelf plate to brackets on the circular girder above the pan floor, then obliquely forward to cross shafts running transversely through the turret to connect the two sight assemblies. From cross shaft brackets other shafts extend into the gun layer's and turret train operator's compartments to connect to elevation indicators and the turret train operator's handwheel bracket. See figure 13-3 for the schematic arrangement of the system.

Components. The components of the sights are as follows:

Left and right sight pointer's stations
Left and right sight trainer's stations
Shaft and gear box transmitting system
Sight hoods

Line-of-sight data.

Sight positions in plan:

Sight pointer's telescope objective, right and left of longitudinal centerline of turret, inches	239.50
Sight pointer's telescope objective, rear of transverse centerline of turret, inches	20.0
Sight trainer's telescope objective, right and left of longitudinal centerline of turret, inches	233.50
Sight trainer's telescope objective, forward of transverse centerline of turret, inches	36.0

Sight positions above plane of gun trunnion axis:

Sight pointer's telescope objective, inches	5.5
Sight trainer's telescope objective, inches	36.5

Sight positions above plane of shelf plate:

Sight pointer's telescope objective, inches	54.5
Sight trainer's telescope objective, inches	85.5

Line-of-sight movement limits:

Depression of line of sight (includes 20° of roll), deg.	50
Elevation of line of sight (for 20° of roll), deg.	20
Left deflection of line of sight, mils	100
Right deflection of line of sight, mils	175

Pointer's station. The principal components of each sight pointer's station (figs. 13-4 and 13-5) are described below.

Telescope holder. The telescope holder (fig. 13-5) holds the telescope, rotates with the elevation bracket for sight angle input, and provides vertical trunnions for deflection movement of the telescope. A sector gear, mounted on the inboard end of the casting, is driven by a pinion to move the telescope holder in deflection.

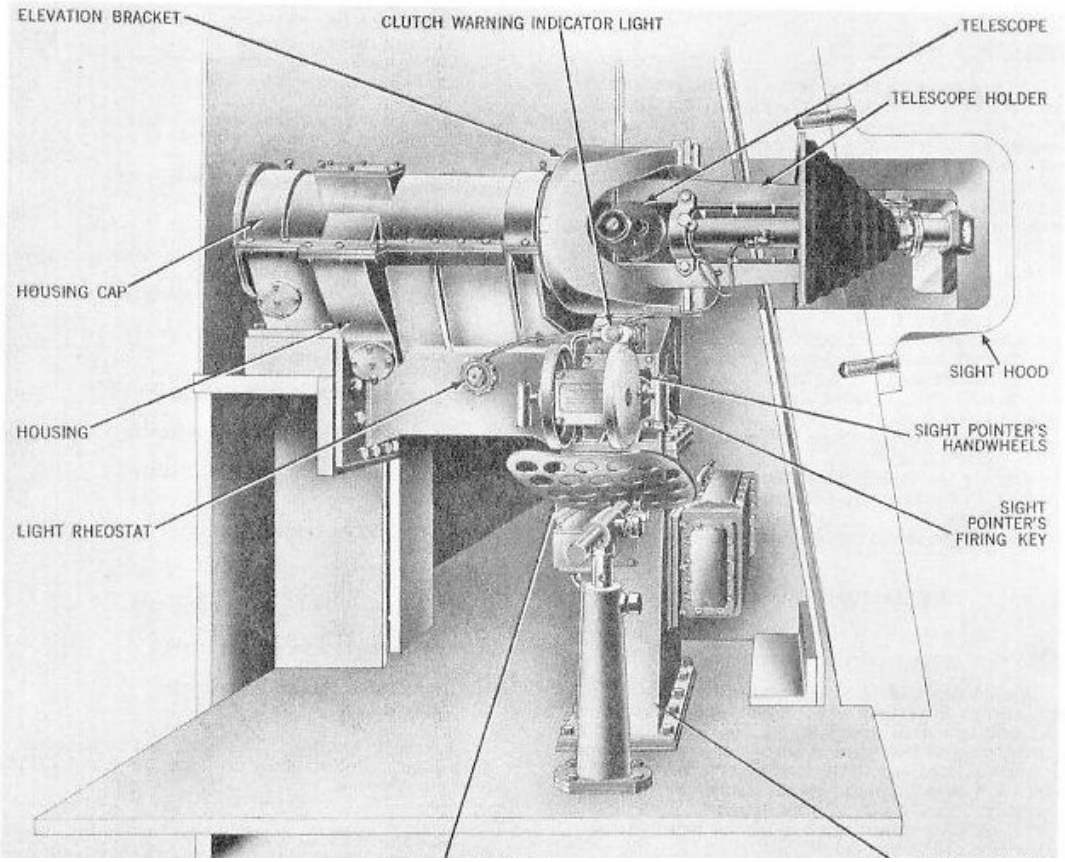
Deflection gear sector and pinion. Telescope deflection is accomplished through the deflection gear sector and pinion (fig. 13-5). Sight deflection input from the sight setter's handwheel turns the pinion to rotate the telescope holder about its vertical trunnions.

Deflection worm and worm wheel. The sight deflection worm and worm wheel (fig. 13-5) are part of the gear train between the sight deflection handwheel and the telescope holder. The worm is on a shaft extension from the sight trainer's station deflection input, so that both stations receive identical sight deflection input.

Elevation bracket. The elevation bracket supports the telescope holder and supplies elevation input. The hollow inboard shaft section of the bracket mounts the elevation worm arc which is driven by sight angle and elevation handwheel inputs. This portion of the bracket also encloses and supports the deflection pinion shaft.

Elevation worm and arc. The sight elevation worm and worm arc drive the elevation bracket in elevation. The worm is driven by the sight angle bevel gears which transmit combined sight angle and pointer's handwheel input from the pointer's station differential. A shaft from the worm also connects through an adjustable coupling to the sight trainer's station elevation worm.

Sight pointer's station differential. The sight pointer's station differential consists of a planetary arrangement of a spider, two idler bevel gears, a combination bevel gear, and a combination spur and bevel gear. These elements combine sight setter's sight angle and sight pointer's handwheel elevation to position the telescopes in elevation.



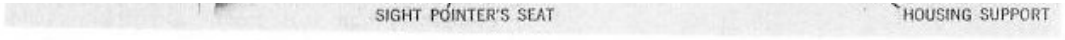


Figure 13-4. Sight Pointer's Station, 16-inch Sight Mk 4, Mod 2 or 3, General Arrangement

Handwheel and order shaft gearing. The handwheel and order shaft gearing is composed of two bevel gears at the handwheel shaft, a pair of bevel gears that connect the handwheel shaft to the elevation order shaft, and a spur gear that connects the handwheel shaft to the spur bevel gear of the differential. These gears and shafts, as well as all others in the sight, are ball bearing mounted. The elevation order shaft is connected from the handwheels to the lower bearing sleeve by the synchronizing clutch and its related indicator gearing.

Synchronizing clutch assembly. The sight pointer's station synchronizing clutch, clutch dials, and clutch gearing comprise a device for synchronizing the sight station (sight pointer's handwheels) with the gun elevation indicators at the gun layer's stations. When the dials are matched, the clutch may be engaged. The clutch upper jaw is located on the splined section of the elevation order shaft just below the upper synchronizing dial bevel gear. The clutch lower jaw is a combination jaw, containing holes to receive and match the different diameter pins of the upper jaw and a double bevel gear. One side of the double bevel gear is for the synchronizing dial mechanism and the other side is for the gun elevation order transmitter. The matching dial bevel gears are shaft-connected to worms and wormwheels which rotate their respective matching dials of the synchronizing clutch matching dials. These dials are enclosed by the synchronizing dial housing. Each clutch is arranged with an indicator light and a switch in an electrical warning light circuit (see chapter 15). The indicator light and switch are mounted on the handwheel bracket.

Synchronizing dial housing. The synchronizing dial housing is attached to the station housing support. It contains elements for the support and enclosure of the synchronizing dial mechanism.

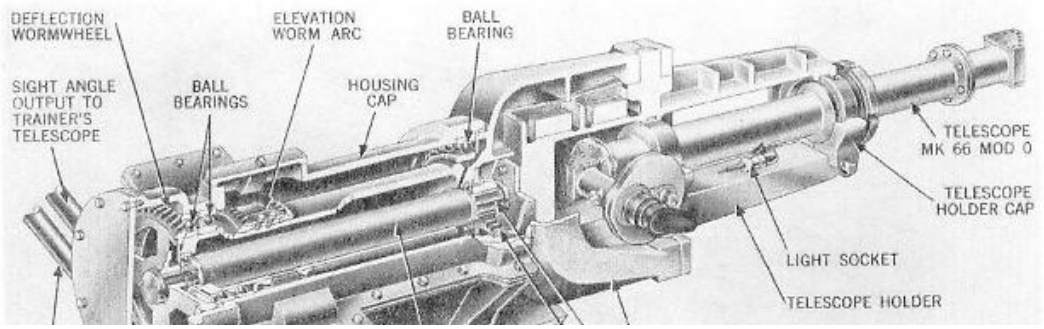
Handwheel bracket. The handwheel bracket (fig. 13-4) supports the handwheel shaft and the handwheel bevel and spur gear shaft. The bracket is attached to the station housing; it has a cover to enable inspection and assembly of the enclosed mechanisms.

Housing cap. The housing cap (fig. 13-4) encloses the telescope elevation bracket, sight deflection gearing, and sight elevation gearing. The cap is bolted to the top of the cap.

Housing. The housing contains elements for the support and enclosure of the handwheel, deflection, elevation, and sight angle shafts and gearing. Attached to the housing are the housing cap, housing support, and various covers used in connection with the support, inspection, and lubrication of the enclosed mechanism.

Housing support. The housing support supports the housing, the synchronizing dial housing, and the gun elevation order transmitter. It encloses the clutch, gun elevation order shaft bearings, elevation order transmitter gears, and synchronizing dial gears. An inspection cover provides access for service.

Trainer's station. The principal components of each sight trainer's station are described below.



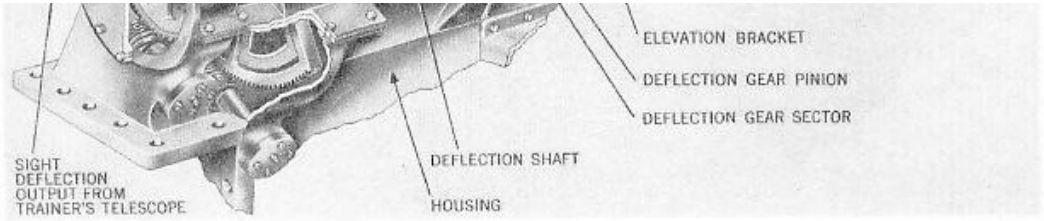


Figure 13-5. Sight Pointer's Telescope and Telescope Holder - Sectional View

Telescope holder. The telescope holder, figure 13-6, is similar to the sight pointer's station telescope holder except that there is provision for the telescope to rotate within the holder about its longitudinal axis. This rotation is limited by two stops on the holder and can be prevented by a locking pin mounted on the holder cap. The holder is driven through a sector by a pinion on the deflection worm-wheel shaft. Supported by the elevation bracket, the holder provides a ball bearing mount for the telescope (line-of-sight elevating movement).

Elevation bracket. The elevation bracket differs from the pointer's station elevation bracket only in the shape of the arm skirt and in the length of the shaft portion of the bracket. The skirt is cut away to permit motion of the telescope in elevation independent of the elevation bracket motion.

Deflection and elevation movement mechanisms. The deflection pinion and sector, the sight deflection worm wheel, and the sight elevation arc are virtually identical with the same parts of the sight pointer's station.

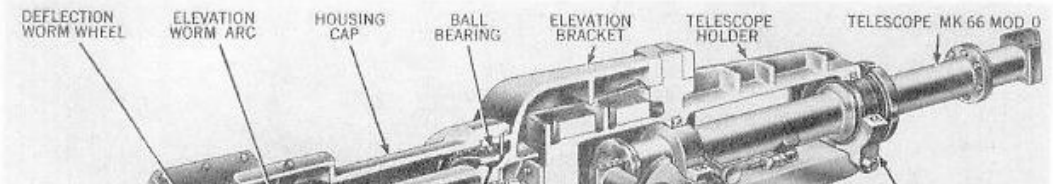
Sight trainer's station differential. The compensating differential (fig. 13-3) compensates for deflection movement of the telescope caused by rotary movement of the deflection gear sector around its pinion in response to sight angle input.

Handwheel and order shaft gearing. The handwheel and order shaft gearing, enclosed and supported by the handwheel bracket, connects the handwheels to the train order shaft. The gear system consists of two sets of bevel gears with a handwheel and connecting shaft, ball-bearing mounted on the handwheel bracket.

Housing assembly. The housing cap, housing, housing support, pedestal, and shaft enclose and support the various elements of the sight trainer's station, synchronizing clutch, and sight setter's indicator. These parts are arranged in the order mentioned from top to bottom of the sight trainer's station. The shaft guard fastens to the housing and to the pedestal by means of a bracket. The seat pedestal and foot rests are also attached to the pedestal.

Sight angle synchronizing clutch assembly. The sight angle synchronizing clutch (fig. 13-2), located at each sight setter's station, enables either station to be clutched into correct engagement with the sight angle cross-shaft system. Electrical interlocks described in chapter 15 prevent simultaneous engagement of both clutches. Each clutch is a 180 degree engagement, positive jaw type. The gearing arrangement is shown in figure 13-3.

Shaft and gear box transmitting systems. Starting at the two sight stations, shaft systems (fig. 13-3) extend down through the shelf plate and transversely across the turret through all gun girders. These shafts transmit gun laying and turret train orders and sight angle movements into a series of gear brackets mounted on the gun girders. Outputs from these extend down to connect with the indicators at the gun layer and turret train operator's stations and to the receiver-regulators of the gun and turret drives.



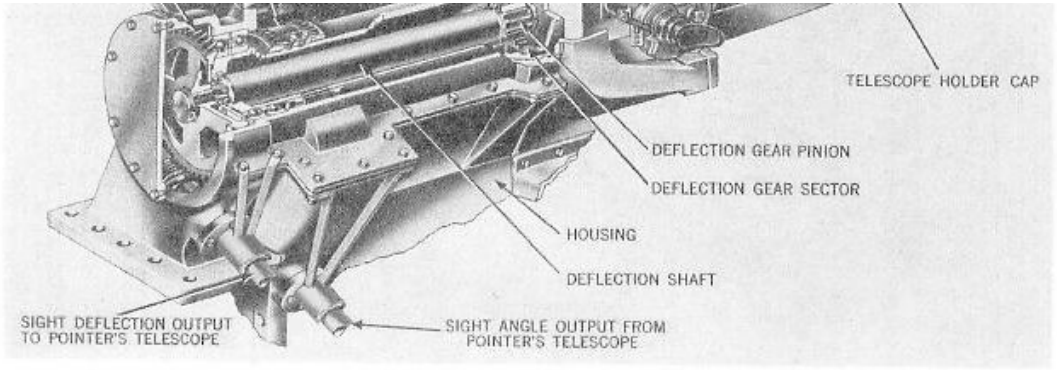


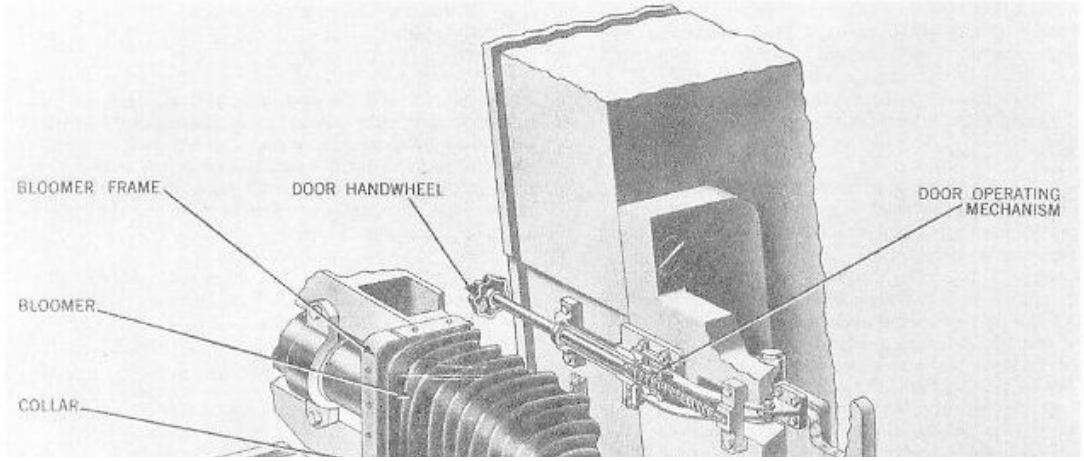
Figure 13-6. Sight Trainer's Telescope and Telescope Holder, Sectional View

System arrangement. The extent of the shafting and the locations and mountings of the gear housings are as follows:

Gun elevation from each sight pointer's handwheels is transmitted by shafting down through bearing brackets to gun elevation order bevel gear brackets, mounted on the circular girder of the pan floor. From here, shafting runs forward to the two sight angle, gun elevation, and turret train order bevel gear housings. Each housing is mounted, right and left respectively, on the outboard gun girder. The gun elevation order cross shaft passes transversely across the turret between these housings and through three sight angle and gun elevation cross shaft brackets. These brackets are mounted on a beam above the pan floor. Vertical shafts from these brackets transmit gun elevation orders to the input shafts of the three gun elevation indicators.

A vertical shaft transmits turret train orders from each sight trainer's handwheels down through bearing brackets to turret train order upper bevel gear brackets mounted on the circular girder of the pan floor. From this point a horizontal shaft transmits motion forward to the sight angle, gun elevation, and turret train order bevel gear housings. The turret train order cross shaft extends transversely across the turret between these housings. At the center of the shaft, the turret train order selector clutch is mounted on a beam above the pan floor. From this clutch, shafting extends down through bearing brackets to the turret train order lower gear bracket. A shaft runs horizontally from this gear bracket to the turret train indicator and transmitter.

Sight angle is transmitted from each sight setter's indicator through bearing brackets to sight angle bevel gear brackets, mounted on the circular girder.



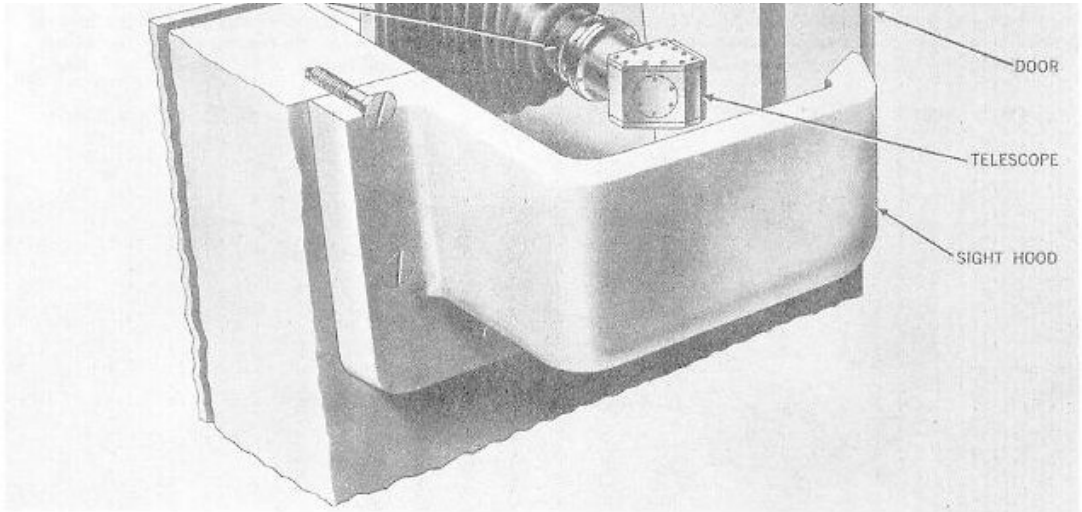


Figure 13-7. Sight Pointer's Sight Hood, Sectional View

From this point shafting extends forward to the two sight angle, gun elevation, and turret train order bevel gear housings. The sight angle cross shaft extends trasversely across the turret between these housings and through the three sight angle and gun elevation cross shaft brackets. Vertical shafts transmit motion from these brackets to the three gun elevation indicators.

Turret train order selector clutch. The turret train order selector clutch is a combination of two jaw-type clutches and a bevel gear arrangement which provides a means for selecting control from either the right or left sight trainer's station. The jaw-type clutches are each composed of a movable jaw, spline-mounted on its train order cross shaft, and a combination jaw and bevel gear, bearing-mounted on this same train order shaft and geared to the shaft from the turret train order lower gear bracket. The two movable jaws are fork positioned, the forks being connected and controlled together by a sector gear and spur gear on a shaft. The unit is manually operated by a control lever located overhead at the train operator's station. The control shaft, positioned by a lever and detent, provides adjustment for the clutch by means of an adjustable coupling.

Sight hoods. The sight hood assembly (fig. 13-7) comprises the sight hood, sight hood door and seal assembly, bloomer, bloomer collar and frame, and door operating mechanism. All sight hood assemblies are similar. Each sight hood is mounted on the provides a gas and weather seal for the opening and has a slit to permit wiping of the telescope objective lens.

Instruments

The sight optical and instrument assemblies attached and associated with the sights are the Ordnance designated units listed on page 13-3. Their arrangement and features are described below and in the references mentioned.

Telescope. Telescope Mk 66 Mod 0, figure 13-8, is installed in the telscope holders of all sight stations.

Components. Each telescope consists of the following:

Optical system
Body tube and prism housings
Eyepiece
Color filter housing

Optics. The telescope is a prismatic, fixed power, single eyepiece type, containing a 90 degree adjustable head prism, a compound objective lens, a crossline lens (in the focal plane of the objective), an erecting lens system, a 90 degree eyepiece prism, and an eyepiece. The system has the following optical characteristics:

Magnification 11.8X

turret armor over the sight port. Hinged to the sight hood is a bullet-proof steel door operated by a double screw and link operating mechanism which opens and closes the door and secures it in either position. The inside face of the sight hood door is recessed and a rubber weather seal cemented in the groove. When the door is closed, the seal bears against the sight hood face, effectively sealing the interior of the hood from the weather. The sight hood bloomer is secured by a frame to the armor plate. A collar and lashing secures it to the telescope. The bloomer

Magnification	11.8X
True field	4°15'
Exit pupil mm	5.0
Eye distance, mm	32.0
Eyepiece adjustment limits, diopters	+2 to -4
Weight, pounds	60

Structure. The optical system excluding the eye piece and color filters, is housed and sealed within an airtight assembly of a body tube and two prism

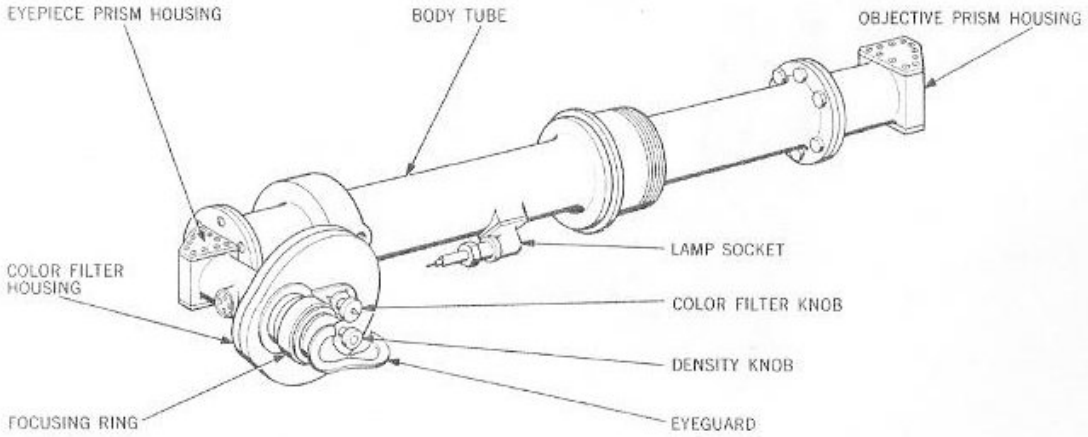


Figure 13-8. Telescope Mk 66, Mod 0, Rear View - Trainers Station

housings (fig. 13-8). Two concentric cylindrical seats are provided for mounting the telescope in the telescope holder. The objective lens is mounted on a double eccentric so that the optical axis of the telescope may be adjusted to correspond with the axis of the bearings.

Illumination. The crossline lens is illuminated by an electric lamp mounted in Lamp Socket Mk 9 Mod 0. Correct illumination requires a two candlepower six- to eight-volt lamp.

Color filter. The color filter housing comprises a manually operated arrangement of four color filter selections, designated CLEAR, RED, YELLOW, and POLARIZER. They are rotated into position by two knobs, the "ray filter" knob and the "density" knob (fig. 13-8). The latter permits any desired degree of light transmission when the "ray filter" knob is turned to "POLARIZER."

References. Additional data and information concerning the telescopes and their care are published in OP482, First Revision, Turret Sight Optical Instruments.

Gun elevation indicator. A gun elevation indicator is located at each gun layer's station. These instruments, Gun Elevation Indicator Mk 33 Mod 3 at the right and center gun controls and Mk 33 Mod 4 at the left gun control, are functionally identical. They operate to give orders for the gun layer and provide correction to the gun response before it is indicated as elevation on the dials. Each receives gun elevation orders electrically from the controlling director or from the sight pointer's gun elevation order transmitter. When the turret is operating in LOCAL control each also receives gun elevation orders mechanically from the sight pointer's stations. For further details, refer to chapter 12 and to OP 854, Fire Control Equipment, Gun Elevation Indicators Mk 33 and Mk 33 Mods 1 and 4; Description.

Gun elevation order transmitter. Gun Elevation Order Transmitter Mk 2 (right hand) and Mk 2 Mod 1 (left hand) are located at the sight pointer's stations. In LOCAL fire control, one instrument transmits gun elevation order electrically to the three gun elevation indicators. The order is equal to the depression of the sight pointer's sight which, in turn, equals the sight angle set plus a selected value of level (director correction). Thus the sight pointer's sight acts as a local director transmitting gun elevation order to the gun layer's gun elevation indicator. In

Sight setter's indicator. Sight Setter's Indicators Mk 3 Mod 2 or 4 (right hand) and Mk 3 Mod 3 or 5 (left hand) are located on the forward side of the respective sight trainer's stations (fig. 13-2). The instruments are described in OP880. Each indicator receives sight angle, sight deflection, and battle orders electrically from the main battery fire control systems, and transmits sight angle and sight deflection mechanically to the sight pointer's station, the sight trainer's station, and gun elevation indicators. The instrument receives sight angle and sight deflection from the plotting room computer and battle orders from the plotting room battle order transmitter. The instrument is provided with handcranks for setting values of sight angle and deflection into the sights. Dials indicate sight angle, deflection, and battle orders. Dial graduations and limits are: sight angle, 2000 to 4800 minutes; deflection, 350 to 600 mils. Mil calibrations are spaced at two mils. Zero sight angle is 2000 minutes; zero deflection is 500 mils.

Sight setter's clutch warning and interlock system. Each sight setter's synchronizing clutch is equipped with a clutch position indicator and interlock system. This is an electrical circuit arrangement of two switches and two signal lights which indicate to each sight setter the position of the other sight setter's sight angle synchronizing clutch. Each switch is mounted on the clutch case with a plunger in the way of and actuated by the clutch control lever. Two other switches and two solenoids are arranged to actuate and control interlocking mechanisms at each clutch. These systems are further described in chapter 15.

Flexible adjustable coupling assembly and shaft. The flexible adjustable coupling assembly and shaft are located adjacent to the sight setter's indicators. They provide a means of adjusting the lines of sight in deflection relative to the indicators.

SECONDARY control, the local gun elevation order transmitter in any selected turret can be switched to transmit gun elevation order to other turrets. Further details are given in chapter 12.

Turret train indicator and transmitter. Turret Train Indicator and Transmitter Mk 37 Mod 4, 5, or 6 is located at the turret train operator's station in each turret. The instrument indicates train order and shows, by a zero reader, when turret train (corrected for parallax) is the same as train order. It transmits corrected train angle and supplies the necessary correction to turret train to give the correct train angle. It also indicates the actual turret train with parallax subtracted and transmits these values for use in multiple turret train indicators. In SECONDARY control, these values are transmitted for direction of other turrets. Further details are contained in chapter 12 and in OP 851, Turret Train Indicator and Transmitter Mk 37 Mods 0 and 1.

Multiple turret train indicators. Multiple Turret Train Indicators Mk 12 Mod 5 (turrets I and II) and Mk 12 Mod 6 (turret III) are located in the turret officer's compartment. They indicate as a direct reader and also as a zero reader that the turret has been trained in accordance with orders received. In turrets I and II, the indicators show the train angle of both turrets so that the turret officer can control train and elevation to prevent interference between the guns of the two turrets. The direct reader dial indicates the train of the turret. The zero reader dial, when pointing to zero (vertical position), indicates that the turret is trained on the same target as the controlling director. Refer to chapter 12 for further details.

Battle order indicator. A Battle Order Indicator Mk 28 Mod 0 is located in each turret officer's compartment. The instrument indicates range, deflection, and battle orders transmitted by the battle order transmitter in the plotting room computer.

Turret train receiver-regulator. Train Receiver-Regulator Mk 18 Mod 5 (turret I), Mod 6 (turret II), and Mod 7 (turret III) provide automatic control of turret train. For a detailed description of this instrument refer to chapter 6.

Gun elevation receiver-regulator. All gun elevating gears are equipped with Elevation Receiver-Regulator Mk 10 Mod 0. This instrument provides automatic control of gun laying. Refer to chapter 5 for further details.

OPERATION

Personnel, stations

The personnel primarily concerned in the operation of the sights are, in each right and left station, the sight setter, the sight trainer, and the sight

Alternative sight operations

The sight function can be accomplished in three ways: by the sight setter, the sight pointer, and the sight trainer on the same side of the turret; by combinations using the sight stations on both sides of the turret; or by the sight stations in one turret acting through transmitters and indicators to direct other turrets. When using the sight stations on either side of the turret, the sight setter, sight pointer, and sight trainer on one side perform the sight function entirely independent of the other side. The sight pointer can either follow the target continuously, causing the sight trainer's telescope to follow his telescope in elevation, or fire on selected level, making it necessary for the sight trainer to unlatch his telescope and use his handgear to position his telescope in elevation. The sight pointer on one side can operate with the sole purpose of keeping his sight trainer on the target in elevation while the sight pointer on the other side is fixed in elevation

pointer. The sight stations are located in the forward corners of the turret. The sight setter, at his position in front of the sight, stands facing aft. Seated on the trainer's station pedestal is the sight trainer, the sight pointer sits, also facing forward.

LOCAL control

The relation of the sight to other fire control equipment is defined by its function in LOCAL control. Starting with values of true compass course, speed, own ship's target bearing, target angle, target speed, wind angle, wind speed, present range, range spot, deflection spot, nominal velocity, and initial velocity, the auxiliary computer supplies values of sight angle and sight deflection by oral order to the sight setter. The sight setter (in either station), by setting dials on the sight setter's indicator, transmits sight angle and sight deflection mechanically to his respective sight pointer's and sight trainer's stations. The sight pointer and the sight trainer, in laying their sights on the target, develop gun elevation order and turret train order, respectively. The sight trainer directly controls the turret training gear to train the turret. The sight pointer transmits elevation orders, electrically by means of gun elevation order transmitters or mechanically through shafts and gears, to the gun elevation indicator of each of the three gun layers. At the gun elevation indicators, factors are added for erosion correction, roller path compensation, and elevation screw angularity to indicate elevation order and gun elevation on follow-the-pointer dials. Each gun layer then operates the elevating gear control to lay the gun by matching dials (gun elevation indicator).

PRIMARY and SECONDARY control sight operation

The sights are not employed in PRIMARY and SECONDARY fire control methods except for one sight setter. This sight setter receives orders electrically and operates the indicator to supply sight angle correction for gun erosion. The guns are controlled in elevation by the gun layers and controlled in train by the turret train operator in INDICATING control. All operate by matching pointers in their respective indicators. The sight pointers and sight trainers "stand by." In AUTOMATIC operation, the gun layers and the train operator also "stand by."

for selected level firing. Any telescopes not being used in the sight operation can be used for checking. However, in all combinations where both sides are used, both sight setter's indicators must be in operation. Under "director" control from one turret to other turrets, the sights of the controlling turret are used as in LOCAL control; gun elevation orders and turret train orders are transmitted to all turrets by the controlling turret's sight station elevation order transmitter and turret train transmitter. All of these various selections and combinations of sight control operation are made by use of the synchronizing clutches (sight angle and sight pointer's elevation order), the turret train order selector clutch, the turret train operator's selector clutch, and the turret officer's selectors (chap. 15). There is a synchronizing dial in connection with each synchronizing clutch which must be matched before engagement of the clutch. It is not intended to have two synchronizing clutches of the same system engaged during operation. All clutch engagement combinations are evident from the operation. However, note that sight angle is supplied to the elevation indicators by the sight setter on the side where the sight pointer is firing, in all combinations.

Operation of the sight station differentials

The differential at the sight pointer's station (fig. 13-3) combines the sight pointer's handwheel and sight angle line of sight inputs to elevate and depress the telescope line of sight. The differential at the sight trainer's station compensates for movement of the telescope in deflection due to the planetary rotation of the deflection sector around the pinion when the telescope is rotated in elevation.

INSTRUCTIONS

General maintenance

Mechanisms of the class of the sights and gun attachments require high mechanical accuracy and must have exacting care. The designs include ample provision for precise alignment adjustments and for retaining the adjusted position of all elements. The designs have virtually no backlash and are capable of long service without appreciable increase in lost motion. These features have been attained by exceedingly high standards of manufacture. They provide accurate signal transmission and parallelism

of the lines of sight throughout the full range of movement. All elements have been verified by test installation,* collimation of the optical instruments, and check of the complete assemblies before acceptance and mounting in the turret. Misalignments and mechanical errors (larger than those accepted at manufacture) will not develop if the assemblies are correctly operated; if they are not deranged or otherwise damaged by misuse of shafts, brackets, and any other exposed parts; and if they are constantly serviced as prescribed by these instructions and the regulations of the Bureau of Ordnance Manual.

Operating precautions

The sight, gun attachments, and associated instruments are to be operated in accordance with the regulations of the Bureau of Ordnance Manual and the instructions below.

Sight.

1. Ascertain that all parts of the signal transmission system are properly lubricated and that all

Inspection.

1. Keep all bracket bolts tight. Inspect for looseness after firing and at least once monthly.

2. Prevent vibration stress, which will occur while underway, by setting up the slide securing devices and by seating the centering pins.

3. Perform bore sight alignment check at least once quarterly and always before and after firing.

Exercise operations. Exercise all elements of the sights, training gun attachments, and elevation gun attachments through the full range of movements at least once weekly.

Lubrication.

1. Lubricate the assemblies with the lubricants and according to the periodic frequency prescribed by the lubrication charts.

2. All points of shaft support, all gear brackets, all gearing, and all moving elements of signal transmission and optical instruments have been provided with means for lubrication. In many instances, correct lubrication is obtained only with the use of lubricants prescribed on the charts. This is particularly important with respect to the internal mechanisms of the housings at the sight pointer's and sight trainer's stations. Oil is required at certain fittings; grease must not be substituted. Lubricants should be applied sparingly, but regularly.

Preservation.

1. When stowing, dry out and ventilate the sight hoods; dry the objectives; secure the movements at zero sight angle and deflection positions; close and secure the hood shutters.

2. Maintain a complete record in the turret journal of all sight misalignments and shaft errors together with data as to shimming, fitting, and adjustment.

3. Observe the following instructions as to care of the optics.

shafts operate without binding or lost motion.

2. Make sure that the sight hood doors are fully open to permit the full visual range of the telescopes.

3. When preparing for operation, operate the sight pointer's and sight trainer's hand cranks through the full range of movement.

4. The sight setter's indicator hand crank mechanisms include limit stop devices. Never attempt to force any crank if a restriction is encountered; check the dial and output positions and adjust to operate within the limit stops.

Gun attachments. Make certain that all shafting is properly lubricated and operates without binding and lost motion.

Instruments.

1. Be sure that all instrument dials are properly illuminated to facilitate dial readings.

2. Train the turret and elevate and depress the guns before firing to verify the adjusted settings of turret train, parallax, and sight angle inputs at the roller path tilt correctors, gun erosion corrections, and parallax mechanisms of the indicators and regulators.

3. Never operate the sights and gun attachments after coupling an uncoupled shaft until the dials and shaft transmitters have been synchronized.

Installation care

Telescopes. Instructions as to the care of telescopes for turret sights are contained in OP 482. This pamphlet includes instructions for the guidance of optical repair ship personnel as to maintenance and adjustment of optical systems. The following extracts are for care of the instruments by turret personnel.

1. Telescopes should be treated with the greatest possible care, should not be handled unnecessarily, and should be kept clean, dry, and covered (door closed) except when in use.

*A report of these tests, including data of accepted backlash, is provided with each turret assembly; compare with recorded data for all subsequent dial accuracy and sight alignment checks. It is of extreme importance that the shafting and brackets should not be disturbed. Any deformation may alter the adjusted positions of the lines of sight. An assembly that performs satisfactorily should not be disturbed. Refer all lubrication, adjustment, and servicing of interior elements of the elevation, train, and sight setter's indicators to fire control equipment maintenance personnel. These instruments must not be opened by turret personnel. Maintenance care of the sights and gun attachments includes the instructions prescribed on this page.

2. The object glass and the eye lens must be kept dry. Never touch them with the fingers. When necessary, clean them with drops of alcohol and lens paper.

are checked and synchronized, each gun and the turret must be trammed as well as bore sighted. Alignment of the guns and sights by bore sighting has the following objectives:

3. Great care must be observed to prevent deformation of the bearing rings of the telescope bearings; keep these surfaces clean, free from paint, coated lightly with the prescribed lubricant, and use no emery cloth or other abrasive. Always make bore sight sight alignment check after mounting a telescope.

4. Cleaning of exterior surfaces of the telescopes should be performed with a dry, clean cloth. Never use solvents, detergents, or abrasives.

5. Eye shields should not be exposed to the sun's rays, to extremes of temperatures, nor to perspiration. Remove perspiration, oil, or grease as soon as possible, with a clean cloth soaked in gasoline. Rust should be removed by washing the shield in soapy water and rinsing in fresh water; such washing at frequent intervals will delay deterioration. Eye shields can be made pliable by steeping them in warm water.

6. Small dust particles in the field of view (interior optical surfaces) should be tolerated, unless such dirt, fogging, or other similar defect seriously interferes with efficient use of the instrument. Cleaning, drying out, or other correction is to be performed exclusively by optical repair ship personnel.

Shafts, couplings, and gears.

1. Shafts, couplings, and critical spiral bevel gears are fitted and punch marked to designate correct position at assembly. After removal of any such parts for repair or other purposes these reference marks must be matched when reinstalling.

2. When installing new shafts or couplings, fit the splines by dressing them down with a fine file to obtain a slip fit.

3. Shafts should be installed with clearance between the ends of the shafts to prevent abutments.

4. Coupling bolts should be properly secured to prevent lost motion from developing in service.

5. After final adjustments have been made on an adjustable coupling, secure the clamp screw to preserve the adjustment.

Adjustments

Sight alignment. The sights and gun attachments require periodic check and adjustment to correct for deviations of the line of sight and for elimination or compensation of lost motion. Verification of alignment and test of dial accuracy must always be performed before and after firing the guns. The necessity for such checks, the reasons for structural and other changes affecting alignment, and the theory and method of alignment operations are fully discussed in OP762, Alignment of Ordnance Installation on Board Ship; General Instructions.

General instructions. When an alignment check is made, each gun must be bore sighted. When dials

1. To position the telescopes so that all instruments, when at zero sight angle, zero deflection, and zero gun elevation, have their lines of sight parallel to the gun bores and to each other (or, for short ranges, converge to a point at a designated range).

2. To elevate and depress the lines of sight from the position described in (1), in planes perpendicular to the gun trunnion axis.

3. To deflect the lines of sight from the position described in (1), in planes parallel to the gun trunnion axis.

4. To obtain indicator readings corresponding to all gun and line-of-sight positions as in (1), (2), and (3), and to synchronize them with the electrical and mechanical transmitters and receivers.

Bore sight equipment. The bore sight equipment used is a 16-inch Bore Sight Mk 2 Mod 0 (figure 13-9). It comprises a telescope, a telescope holder, and a muzzle disc. The telescope is either Telescope Mk 75 Mod 0 or Telescope Mk 8 Mod 6. The telescope holder is a steel bar approximately 32 inches long. A hole at each end of the bar provides a means of fastening it to the gun and a hole in the center is provided for insertion of the telescope. The aluminum muzzle disc, approximately 16 inches in diameter, has a 1/16-inch hole bored through its center.

Preparations for bore sighting. Any convenient target may be used for bore sighting, such as the horizon, a star, or a specially prepared target. When in port, many targets on shore are available. When dry-docked, a batten board target should be used for precise survey and verification of all line-of-sight motions. The batten board should be substantially constructed, with horizontal and vertical lines or wires for each line of sight and bore sight. Small targets should be provided for zero positions in elevation and deflection for each line of sight and scales equivalent to each minute of error should be calibrated adjacent to each target. The structure should be adjusted so that the vertical and horizontal lines are respectively perpendicular and parallel

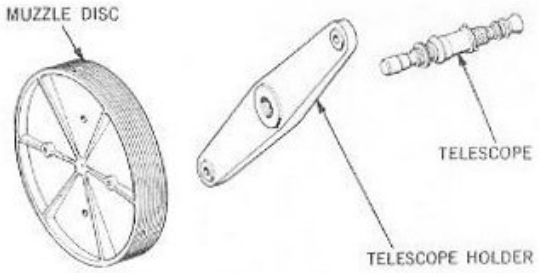


Figure 13-9. 16-Inch Bore Sight Mk 2 Mod 0, General Arrangement

to the plane of the roller path, the turret being trained on the batten with any roller path errors compensated for as prescribed in OP 762. These arrangements should be on the basis of a batten emplacement located at least 200 feet from the gun muzzle. The batten board target should establish that sight angle movements follow traces that are normal to the gun slide trunnion axes throughout the full range of gun and sight movements and that dial indications are without excessive lost motion errors, that is, that they do not indicate errors greater than those listed in the sight test acceptance report. A chase-mounted batten (center gun) is a convenient alternative device for proving the sight angle movements.

Before bore sighting, it is essential to inspect, test, service, and exercise the assemblies as follows:

1. Examine the telescopes to see that they are clean, properly focused, free from parallax, and that the crosslines are clearly visible and in horizontal and vertical positions.

2. Run the sights, at one station, through full arcs in elevation and deflection to see that they work freely and are properly lubricated; shift the clutch controls to the other station and repeat.

3. Verify that the telescope holder (bore sight) is true, that it has not been bent or damaged.

4. Inspect the bore sight telescope.

The installed arrangement of the bore sight is shown in figure 13-10. Installation procedure is as follows:

1. Insert the muzzle disc in the gun muzzle with the position marked TOP uppermost.

2. Attach the telescope holder to the gun by means of two bolts passed through the holes in the ends of the holder and screwed into the threaded holes provided in the screw box liner face.

3. Insert the telescope in the telescope holder.

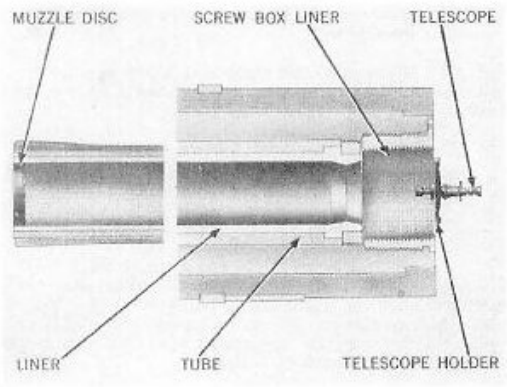


Figure 13-10. 16-Inch Bore Sight Mk 2 Mod 0, Installed in Gun

Bore sighting procedure. The procedure described below is initiated by bore sighting the center gun on the selected target, verifying parallelism of each telescope line of sight by bringing it on the same target, and checking for deviation of dial indications from the desired readings of 2000-minute sight angle and 500-mil sight deflection. This procedure is repeated for each of the two wing guns. (Deviations of triple gun bore alignment are averaged as explained in OP 762.) The operations prove alignment or error for zero sight angle and sight deflection only and enable sight system adjustment of dial indications and lines of sight to agree with the gun bore at that position only. These purposes are accomplished as follows:

Man the sight pointers' and sight trainers' telescopes. (Normally the turret officer takes the station at the bore sight telescope with the regular personnel at their stations.) Set the sights at 2000-minute sight angle and 500-mil deflection. Using one sight station, check one set of lines (horizontal or vertical) and then the other. This checking is done by the officer or man at the bore sight telescope calling out "Mark!" when on the target, with the others observing differences. Right, left, and vertical errors of the sight telescopes are then separately adjusted at their shaft inputs until they are on the target when "Mark" is given. When the adjustments are complete it is good practice for the sight pointer and sight trainer to call "Mark," separately, so that the bore sight observer can see the effect of their adjustments. The procedure is then repeated using the other sight station. Vertical and horizontal adjustments of the lines of sight established by this means are made as described in the following paragraphs.

Sight movement adjustments. Inaccuracies and errors revealed by the bore sight and dial checks are adjustable at the sight mountings and shaft inputs and outputs. The sight mountings are adjusted by refitting and shimming the sight station pedestal brackets and the shaft inputs and outputs by the adjustable couplings provided. Telescope holder bearings and elevation brackets are not adjustable and must not be altered. Refitting and shimming operations are authorized only when sight errors are confirmed by precise survey (batten board bore sighting in drydock). Following any adjustments of the sight system pedestals or shafts or both, the entire assemblies must be accurately rechecked and the elevation indicators reset. The adjustments of the indicators are described below. These include all operations incident to coupling a new installation; readjustment operations for installed units, to correct dial inaccuracies, are apparent from the routine.

Gun elevation indicator adjustments. The following instructions refer only to mechanical alignment with the sight assembly; see OP 854 for adjustment of other elements. When installing the gun elevation indicators, the units must be coupled and adjusted in the sequence of operations described in the routine below, particularly observing the precautions specified.

Coupling the elevation response shaft. This shaft receives its drive from the elevating gear B-end. It operates a cam in the instrument which compensates for the lack of proportion between the travel of the elevation lead screw and the travel of the gun, so that the dials will give true elevation of the gun before additional correction is added for velocity lags and roller path compensation.

ed for velocity loss and roller path compensation.

Before coupling the instrument to the response gear, the following is necessary:

1. Elevate the gun to 2000 minutes (zero elevation).

2. Turn the velocity loss knob until the velocity loss dial reads zero foot-seconds velocity loss.

3. Lock the velocity loss knob.

4. Turn the elevation response shaft by hand until the angle reader dial is exactly 2000 minutes. The shaft should turn freely.

5. Remove the lower side cover. Check the scribed line on the cam for coincidence with the fixed index when the angle reader dials are exactly at 2000 minutes.

6. With the gun at 2000 minutes and the indicator set at 2000 minutes, the response shaft from the hydraulic unit may be coupled to the response shaft of the indicators. A micrometer is provided to permit coupling the shafts together in their proper relation.

7. After connections have been made, the dial should be rechecked for 2000 minutes, the indices should be checked for matching, the gun retrammed for 2000-minute positions.

8. The depression stops for guns of turret II should be set at 2000 minutes to prevent damage to the periscope located in turret I.

Coupling the sight angle input shaft. This shaft receives its drive from the sight setter's indicator through connecting gearing and shafting. The sight angle input shaft drives through a worm to a carriage which operates a multiplying mechanism. If this input shaft is turned so that the sight angle dial reading is greater than 4800 minutes, serious damage to the mechanism of the instrument will result. Therefore, before connecting the shafts:

1. Set all three gun elevation indicators in the turret so that all sight angle dials in the upper right-hand corner of the instruments read similarly at some angle between 2300 and 3000 minutes. For purposes of description, it is assumed that all dials will be set at 2500 minutes.

2. Operate the right sight setter's sight angle handle, turning it to the 2000-minute dial position, and set the index pointer on the switch carrier of the clutch synchronizing mechanism at the equivalent position shown on drawing number 343418. Match the index pointer on the cam carrier with the index on the switch carrier. Engage the right sight angle synchronizing clutch (the left clutch being disengaged and locked out by the solenoid plunger). Operate the sight angle handle until the sight angle dial reads 2500 minutes.

4. Check that the right sight setter's synchronizing clutch is engaged. (The left station should be disengaged and the shafts uncoupled.) Check that the right sight setter's indicator sight angle dial and the sight angle dial in each of the gun elevation indicators read 2500 minutes accurately.

5. Disengage the synchronizing clutch at the right sight setter's station.

6. Operate the left sight setter's sight angle handle, turning it to the 2000-minute dial position, and set the index pointer on the switch carrier of the clutch synchronizing mechanism at the equivalent position shown on drawing 343736. Match the index pointer on the cam carrier with the index on the switch carrier. Engage the left sight angle synchronizing clutch.

7. Operate the sight angle handle until the sight angle reads approximately 2500 minutes.

8. Connect the remaining sight angle shafting from the left clutch to the micrometer coupling in the left gun pocket and the elevation indicators.

9. Operate the sight angle handle at the left sight setter's indicator to give exactly 2500 minute dial reading.

10. By means of the micrometer coupling in the left gun pocket, simultaneously set all three gun elevation indicator sight angle dials accurately at 2500 minutes.

11. Verify sight angle indications as follows:

a. Disengage the left clutch and engage the right clutch.

b. Set 2000 minutes sight angle and check at each gun elevation indicator.

c. Set 4700 minutes sight angle and check at each gun elevation indicator.

d. Return to 2000 minutes sight angle; any variation of the elevation indicator readings is indicative of lost motion. If it exceeds plus or minus 2 minutes, inspect all gear brackets and gear housings. Interchanged or incorrect assembly of left and right gear elements of the gear train will result in accumulation of error and cause serious damage to the indicator concerned.

12. Disengage the right clutch and engage the left clutch. Verify minimum sight angle errors as described in step (11).

Coupling the train angle input and adjusting roller path tilt compensation. Connect the shafting between the training gear A-end and the gun elevation indicator.

1. Train the turret to some angle such as 0 degrees or 180 degrees and set the roller path azi-

3. Connect all sight angle shafting between the right sight setter's indicator and the three gun elevation indicators, the latter instruments being positioned as in step (1). If necessary, fine adjustments may be made at the micrometer coupling located in the sight angle shaft leading to each elevation indicator, but not at the micrometer coupling located in the right gun pocket on the transverse sight angle shaft.

muth scale to the same angle before coupling the final shaft to the gun elevation indicators. This procedure will save time in making accurate adjustment through the micrometer couplings.

2. After all train angle shafts have been coupled, the gun elevation indicator roller path azimuth scale should be checked in all three indicators to see that they agree with the train indicator.

3. When delivered for initial installation, all gun elevation indicators have the roller path azimuth scale set at zero (zero index matching "C," fixed index), the tilt scale set at zero (the adjustable "A" index set on zero of the fixed scale), and the high point set at 180 degrees on the 0 to 360 degree graduated dial. When the high point and the amount of tilt have been determined for the turret roller path (refer to OP 762), adjustments are made according to the following steps.

4. Remove the rectangular cover below the dial cover. Use the special spanner wrench provided with the gun elevation indicators to remove the slotted nuts.

5. Loosen, but do not remove, the two bolts (158337-7) which clamp the tilt scale mechanism to the azimuth scale (315964).

6. By turning the worm, rotate the "B" index to the desired high point on the azimuth scale. After this adjustment is made, tighten the tilt scale bolts.

7. To adjust the tilt scale, turn the screw (158338-8) and match graduations on scale "A" with the index. It is not necessary to loosen the clamping guides when adjusting the tilt scale.

8. For simplicity in making the adjustments in steps (5) and (6), the train drive shaft may be disconnected at the coupling where it enters the instrument. This makes it possible to turn the azimuth scale without rotating the turret. After all adjustments have been effected, reset the roller path azimuth scale by observing the angle of train on the train indicator.

Coupling the gun elevation order input (mechanical). Before coupling the input, it is first necessary to set the sight trainer's and sight pointer's telescopes at zero sight angle (2000 minutes). If this position has not been predetermined, it may be accomplished by bore sighting or by placing battens on the guns. (See New York Navy Yard Sketch #A-1376).

1. After the sight pointer's and sight trainer's sights have been established, start at the right station and recheck the setting of sight angle and deflection on the sight setter's indicator for zero.

2. Engage the clutch at the right sight pointer's station. The clutch in the left sight pointer's station must be in neutral.

3. Connect the shafting to the gun elevation indicator from the right station only.

7. Engage the clutch at the left sight pointer's station.

8. Check the sight setter's indicator for 2000-minute reading of the sight angle dial and for zero deflection on the deflection dial.

9. Couple the shafting from the left sight pointer's station to the gun elevation indicators without disturbing the gun elevation order dial settings.

10. By turning the micrometer coupling on the shaft running behind and parallel with the sight pointer's sight mount (120-speed sight angle shaft, dr. no. 235200), bring the sight pointer's and sight trainer's telescopes simultaneously to 2000 minutes.

11. Verify that all settings for mechanical gun elevation order are as follows: Right sight pointer's station clutch in neutral, sight pointer's and sight trainer's telescopes on 2000 minutes. Sight setter's indicator (right station) at 2000 minutes sight angle and 500 mils deflection. Left sight pointer's station clutch engaged and sight pointer's and sight trainer's telescopes on 2000 minutes. Sight setter's indicator (left station) at 2000 minutes sight angle and 500 mils deflection. Elevation order dials at each gun elevation indicator set at 2000 minutes. Elevation angle dials at each gun elevation indicator set at 2000 minutes.

12. Check the gun order movements by operating to full limits in both directions from each station. If lost motion errors exceed plus or minus two minutes, examine the gear train for incorrect assembly.

DISASSEMBLY AND ASSEMBLY

General instructions

The positions of all telescope mounts, gear housings, gun attachment brackets, bearing brackets, shafting and couplings, and attached instruments are fixed by design. All were established at ship's installation by tests and bore sight alignments. Alteration of relative position of these parts may not be made. They are to be reassembled in the same positions after any repair or disassembly, mark-

4. With all guns and sight on 2000 minutes, turn all three mechanical gun elevation order input shafts on the gun elevation indicators so that the mechanical follow-the-pointer and zero-reader dials read 2000 minutes.

5. Set the gun elevation order dials by removing the front cover and, using a dial wrench, reset the zero-reader and the high speed mechanical follow-the-pointer inner dial. Do not disturb the setting of the outer mechanical elevation order dial.

6. Disengage the clutch at the right sight pointer's station. Do not disturb the sights or shafting until the final settings in the left sight pointer's station have been accomplished.

positions after any repair or disassembly work.

Dismantling of any of the elements of the sight, gun attachments, and associated instruments is to be discouraged. It must never be attempted except under supervision of the gunnery officer, experienced fire control men, or home yard staff. Instruments attached to the assemblies may be dismantled only by authorized personnel familiar with such optical and fire control equipment. Disassembly and reassembly of most parts of the sight mechanism and gun attachments are apparent from the illustrations of this text and the general arrangement and design detail drawings. It is particulary important to observe the assembled positions of deflection and elevating sectors and worms, and bevel and spur gears. These are lap-fitted parts. All such mating parts should be punch marked and tagged as removed.

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OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

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CHAPTER 14 RANGEFINDER MOUNT ASSEMBLIES

Chapter 14

RANGEFINDER MOUNT ASSEMBLIES

Rangefinder Stand Mark 52 Mod 0

Rangefinder Stabilizer Mark 4 Mod 1

GENERAL DESCRIPTION

Turrets II and III are equipped with rangefinder mount equipment located and arranged at the rear of the turret. All installations are identical. The equipment is adapted to mounting 46-foot base length instruments of either stereoscopic or coincidence type, the objectives of both types being identically housed in shuttered hoods with port openings. These hoods permit limited deflection and elevation movement of the lines of sight. Stereoscopic Rangefinder Mk 52 Mod 0 is installed in the mount.

Components

Each rangefinder mount assembly comprises two assemblies:

Rangefinder Stand Mk 52 Mod 0
Rangefinder Stabilizer Mk 4 Mod 1

Functional arrangements

The stand 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 may be manually operated by hand

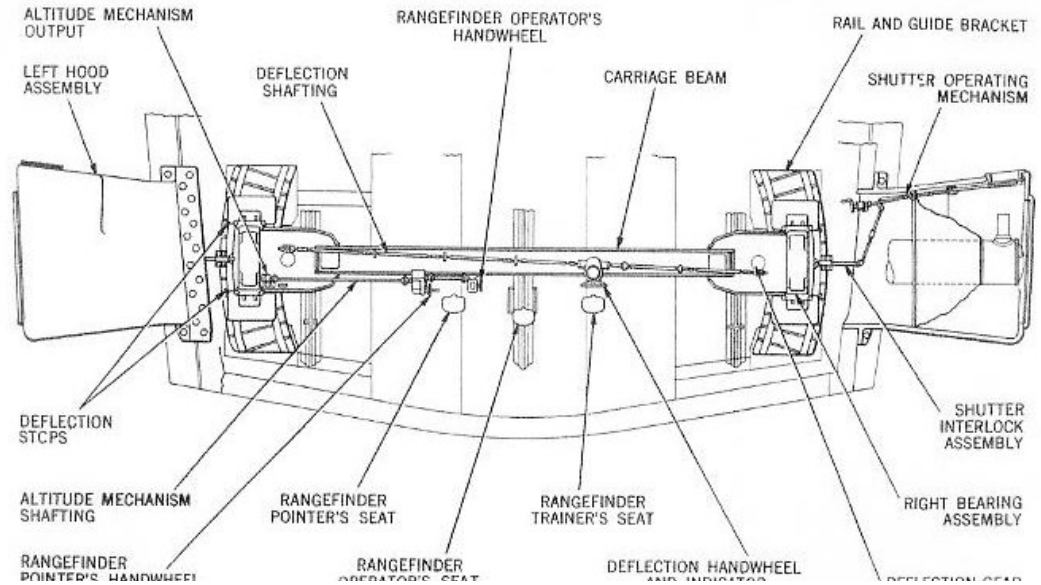
large ports in the side armor plates. These two rangefinder ports are enclosed by hoods bolted to the shield armor plate at the top rear corners of the turret. The entire stabilizer assembly is located in the compartment. Three elements, a control panel, a motor-amplidyne set, and a motor-alternator set are mounted on step brackets behind the rangefinder. A fourth element, the stabilizing unit, is secured to the rangefinder stand carriage.

DETAIL DESCRIPTION

Stand

Components. Each rangefinder stand (fig. 14-1) comprises the elements listed below; they are described in this chapter in the order given.

Rail and guide brackets
Carriage assembly
Right and left bearing assemblies
Connecting carriage beam
Altitude mechanism
Deflection gear
Locking devices



POINTER'S HANDWHEEL OPERATOR'S SEAT AND INDICATOR DEFLECTION GEAR

Figure 14-1. Rangefinder Stand Mk 52 Mod 0, General Arrangement

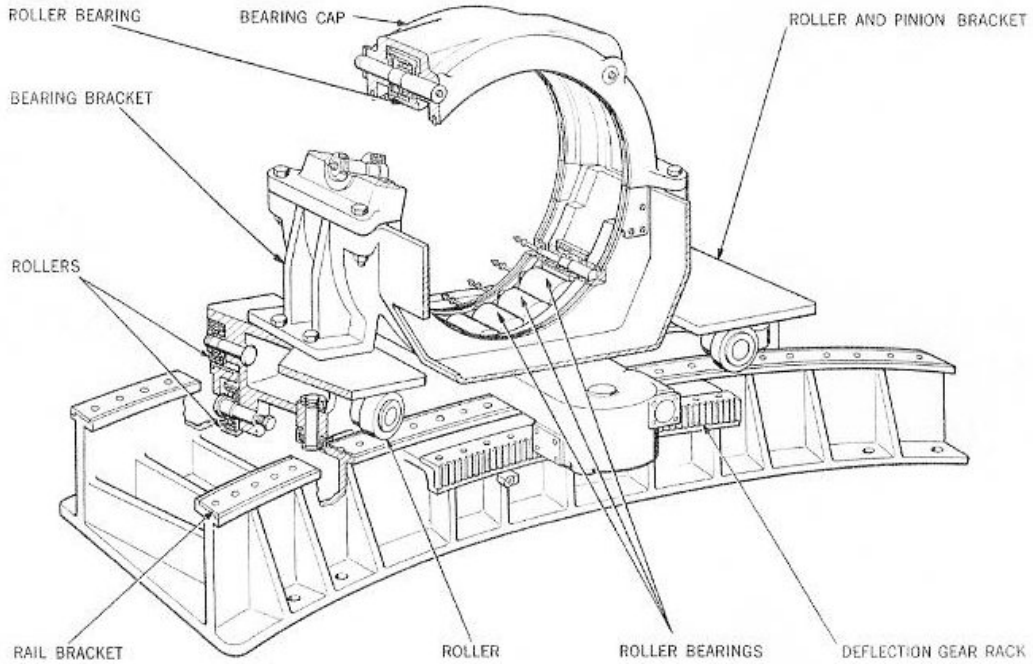


Figure 14-2. Left Rail Bracket and Bearing Assembly. Sectional View.

Right and left bearing assemblies. The right and left bearing assemblies provide roller bearing support for the rangefinder. Each assembly has eight rollers located in the bottom arc of the instrument bearing and two rollers equally spaced in the bearing cap. Thus, when mounted in the bearings, the rangefinder is supported and restrained in each bearing but is capable of frictionless rotation about its axis. The rangefinder bearings are rigidly attached to the bearing bracket by means of angle brackets.

Connecting carriage beam. The carriage beam is a welded steel, box-section beam approximately 20 feet long. It is attached to the right and left bearing brackets. The deflection shafting and the deflection drive are mounted in the beam. The deflection handwheel and indicator are mounted on the right rear side. The altitude mechanism differential, the two altitude mechanism handwheels, and the stabilizing unit of the stabilizer are secured to the left rear side.

Altitude mechanism. Line-of-sight elevating and depressing motion (to follow the roll of the ship), is produced manually through an altitude mechanism or automatically through a stabilizer.

Manual drive. The manual mechanism, figure 14-3, comprises rangefinder pointer's and rangefinder operator's handwheels connected by gearing and shafting to a pinion and rack. The pinion is enclosed in a bracket mounted on the left bearing bracket. The rack attaches to the rangefinder.

Automatic drive. Elevation movement of the rangefinder by means of the stabilizer is described later in this chapter.

Deflection gear. At the center of the carriage beam is a handwheel-operated deflection setting and indicator assembly, figure 14-4. It consists of a bevel gear and shaft drive from the handwheel to each of two deflection drive pinions meshed with the respective racks of the rail and guide brackets. The deflection gear provides equal simultaneous traverse for the two bearings, the movement being centered at the midpoint of the beam.

Locking devices. Altitude mechanism and deflection gear locking devices are provided for securing the carriage and rangefinder when not in use.

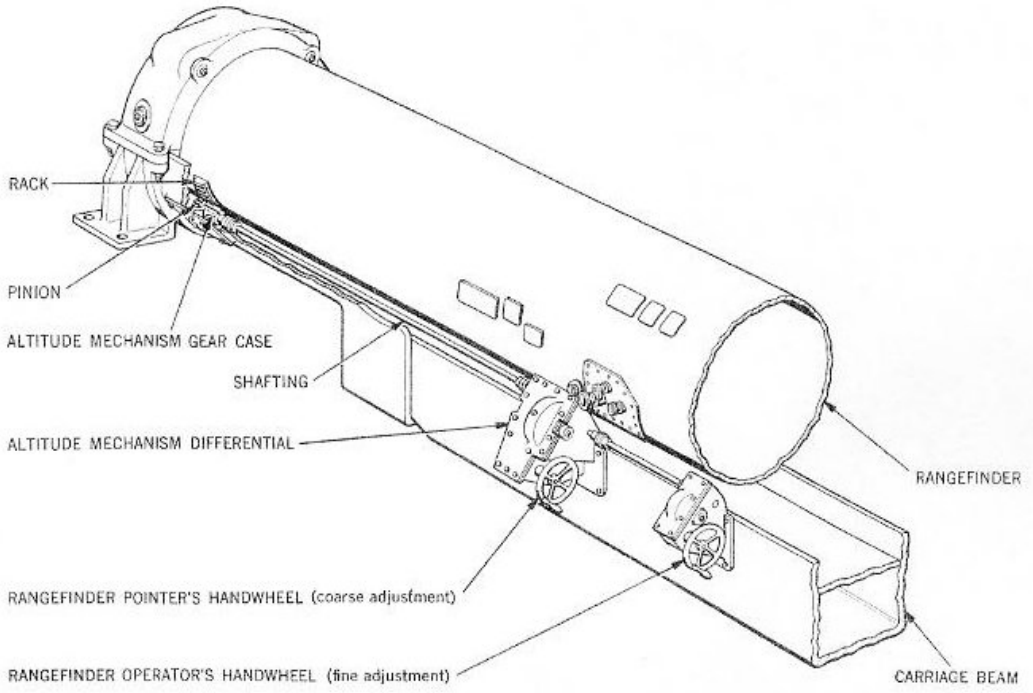
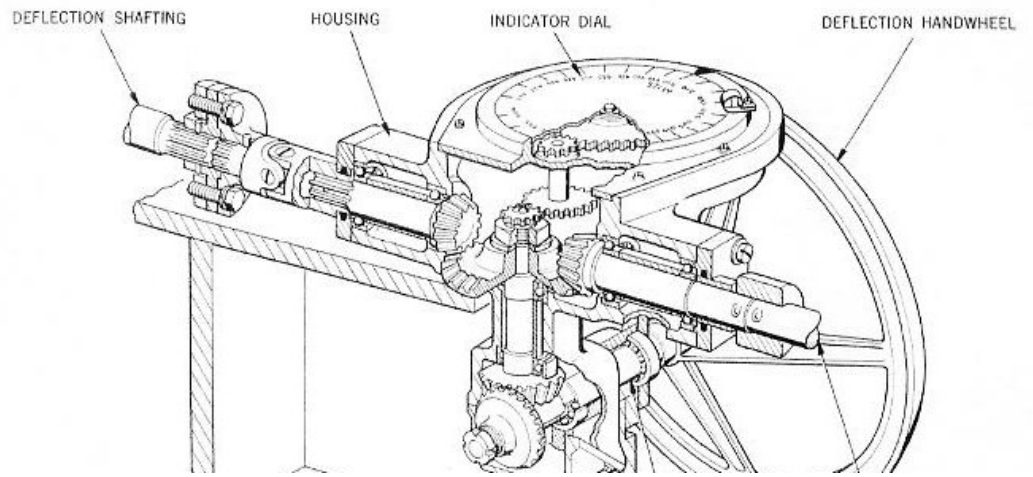


Figure 14-3. Altitude Mechanism, General Arrangement

14-3



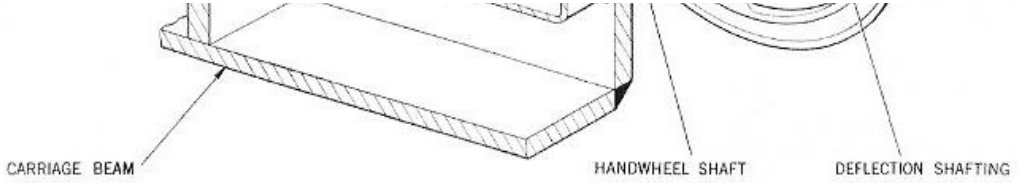


Figure 14-4. Deflection and Deflection Indicator Drive, Sectional View

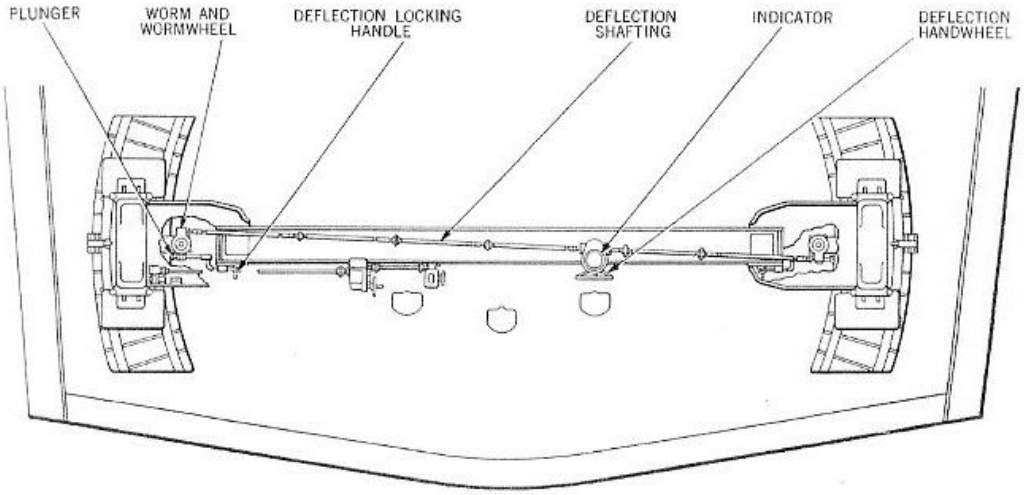


Figure 14-5. Deflection Drive and Deflection Drive and Deflection Locking Mechanism

Altitude mechanism. The rangefinder stand does not include provision for locking the altitude movement but the attached stabilizer assembly operates to prevent movement of the instrument in the bearings when the stabilizer is secured.

Deflection gear. The deflection gear locking device (fig. 14-5) is a hand-crank mechanism with eccentrics and locking shafts. At zero deflection, these elements can be operated to thrust a plunger shaft, located in each bearing bracket, into an aligned hole in each rail bracket.

Hoods. Each hood assembly, as shown in figure 14-6, comprises a cast steel hood, cover plate, shutter frame, and a bronze shutter with a shaft and screw mechanism operated by a handcrank. Fitted fabric sleeves secured to the rangefinder close the hood apertures against the admission of gas and weather.

Stabilizer

Type. The stabilizer is a self-contained assembly of commercial manufacture with functional arrangement of its parts as shown in figure 14-7. Electrical circuit arrangements and details of electric equipment are given in chapter 15 and in paragraphs below.

Components. The stabilizer assembly comprises five principal units designated as follows:

Stabilizing unit
Rangefinder drive
Amplifier control panel
Motor-amplidyne generator set
Motor-alternator set

Stabilizing unit. The stabilizing unit consists of a gyroscope unit and a power drive. It is a large enclosed case, mounted on the left side of the car-

Stabilizer

Purpose. Rangefinder Stabilizer Mk 4 Mod 1 is an automatic assembly, controlled by a gyroscope and driven by an electric motor, which holds the rangefinder lines of sight horizontal.

flage beam, with an external flange-mounted power motor and an "AUTO-HAND" manual selector. Two manual input shafts, designated "hand drive" and "added hand input," are located on one side; an output shaft, common to power and hand drive, is located on the opposite side.

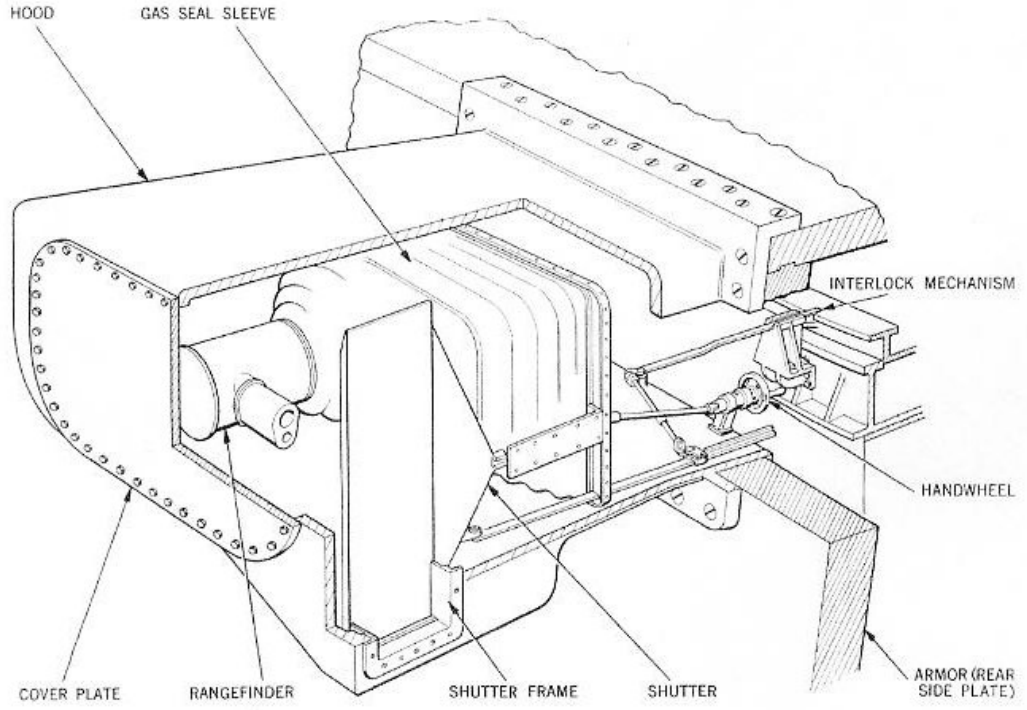


Figure 14-6. Hood Shutter Operating Mechanism and Interlock

Gyroscope unit. The gyroscope unit consists of a gyroscope, gimbal, erecting magnet, ring gear, an exciting coil, and a pick-up coil.

Gyroscope. The gyroscope has a balanced rotor with considerable inertia, with a conducting disc fastened to the lower end. It receives power from the 24-volt, 230-cycle output of the motor-alternator, rotating at a speed of approximately 13,600 revolutions per minute. The gyroscope is non-pendulous and is erected to a vertical position by means of an averaging pendulum coupled electro-magnetically to the gyroscope but not physically connected to it. The conducting disc is a shell (formed of iron over which is spun a thin sheet of copper) in the form of a segment of a sphere.

Gimbal. The gyroscope is pivoted in the gyroscope gimbal which, in turn, is pivoted in the pendulum gimbal. The pendulum bail, to which the erecting magnet is attached, also pivots in the pendulum gimbal. The pendulum gimbal is pivoted about a fixed axis in the case, perpendicular to the line of sight and parallel to the deck. The pendulum gimbal swings in a plane through the line of sight normal to the deck, in response to acceleration of roll or pitch. The mean position of the electro-magnet is then in a vertical plane normal to the line of sight. The gyroscope gimbal pivots about an axis perpendicular to the line of sight and parallel to the deck, and establishes a plane which is maintained parallel to the line of sight.

Erecting magnet. The erecting magnet is mounted on the pendulum bail and excited with 100 volts alternating current. If the pendulum is displaced by any amount from the gyroscope axis, the rotation of the conducting disc in the field produced by the magnet causes eddy currents to flow in the conducting disc. The interaction of these currents with the magnetic field produces a force on the disc which tends to precess the gyroscope into line with the pendulum. The magnitude of this torque depends on the displacement between the gyroscope and pendulum, on the strength of the magnetic field, and on the speed of the disc (constant in this instance). As a result of this torque, the gyroscope precesses toward the pendulum in a dead beat manner without spiralling. Thus the gyroscope tends to assume the average direction of magnetization of the electro-magnet. So long as the gyroscope axis coincides with the average position of the erecting magnet the gyroscope is acted upon by torques of short period, of which the time integral is zero and which exercise a negligible effect upon it. However, if the gyroscope departs from this position the pendulum exerts on it a torque, increasing with the magnitude of departure, which does not average to zero but which causes precession into the mean position of the pendulum.

Ring gear. The ring gear is mounted on the gyroscope gimbal shaft. Attached to the ring gear is a light leaf spring. This spring, when coming to rest against one of the two eccentric stops located on one side of the gyroscope unit, exerts a pressure on the ring gear teeth tending to reengage the gears when the detent area is reached.

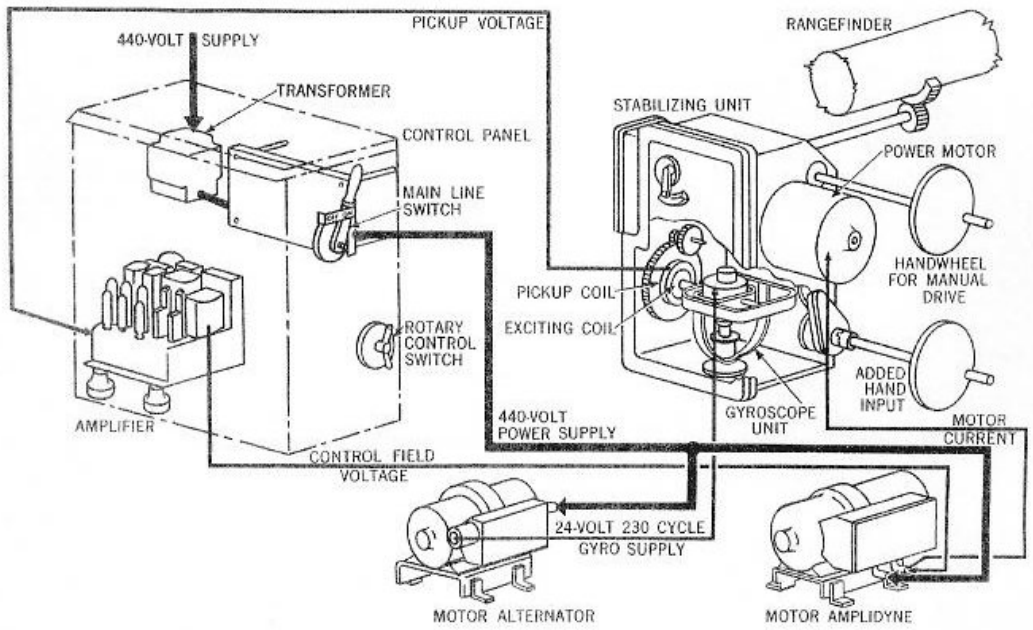


Figure 14-7. Rangefinder Stabilizer Mk 4 Mod 1, Schematic Arrangement

Exciting and pick-up coils. Secured to the pivot shaft of the gyroscope level bail and constrained to rotate with the bail is a cylindrical exciting coil excited with 100 volts alternating current. Concentric with the exciting coil is a pick-up coil, mounted in the ring gear, in which a voltage is induced proportional to the angular displacement between the axes of the two coils. This voltage is the input signal to the vacuum tube amplifier located in the control panel. The output of the amplifier is fed to the control fields of the amplidyne generator which in turn controls the power motor located in the stabilizing unit. The voltage induced in the pick-up coil depends upon the direction and the magnitude of the rotation of the exciting coil. Thus, if the exciting coil is rotated with respect to the cylindrical pick-up coil, the voltage in the pick-up coil can be reduced to zero by moving it the same amount and direction that the exciting coil has been moved. By suitable gearing, the power motor rotates the pick-up coil into correspondence with the exciting coil, thereby measuring and transmitting to the rangefinder the rotation of the gyro level bail relative to the case.

Power drive. The power drive drives the rangefinder through an adjustable friction clutch and through a gear train in the upper part of the stabilizer.

Electric motor. The power motor is externally flange-mounted against the right side of the stabilizing unit.

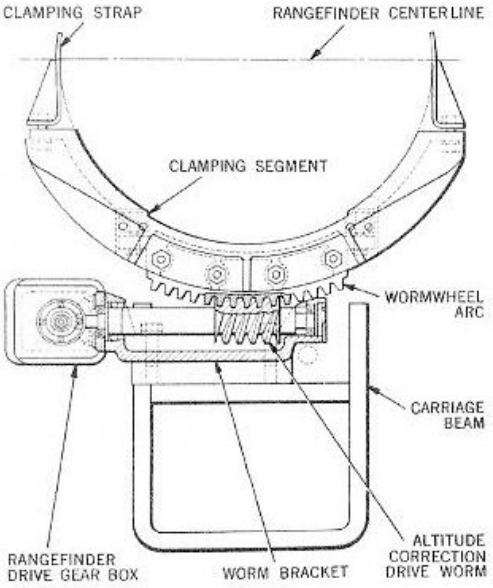


Figure 14-8. Rangefinder Stabilizer Drive

Motor data:

Type	Permanent magnet field
Design features	Horizontally mounted, direct drive, waterproof enclosure, natural draft ventilation
Horsepower	1/6
R.P.M.	1725
Rotation	Reversible
Voltage	0.75
Ambient temperature, C	50
Weight, lbs	42
Manufacturer	General Electric Co.
Manufacturer's designation	5BBY47AB10
Drawing	351101

Adjustable friction clutch. The adjustable friction clutch permits the power motor to reach operating speed before starting to drive the gear train. It comprises a disc, clutch plate, gear, spring, and nut. The clutch is adjusted by varying the tension of the spring, which is held in place by the nut.

Gear train. The gear train includes a clutch shifting mechanism, a clutch switch, a limit stop mechanism, and the "added hand input" shaft.

Clutch shifting mechanism. The clutch shifting lever has two positions, AUTO and HAND. When the lever is moved to HAND, a shifting fork disengages a gear from the power motor gear train and meshes it with the auxiliary hand drive gear train.

Clutch switch. The clutch switch is operated by an arm attached to the shaft of the clutch shifting lever. When the lever is turned to HAND, the switch de-energizes the system.

Limit stop mechanism. The limit stop mechanism is of the travelling nut stop type. The travelling stop is guided by a rod which rides in a rubber bushing in the travelling stop. When the rangefinder reaches its limits of elevation or depression, a pin on the stop strikes a dog at the end of the threaded shaft. The rubber bushing lessens the shock.

"Added hand input" shaft. The power motor is geared to a 1-speed ring gear through one side of a differential; the other side of the differential is geared to the "added hand input" shaft. This shaft permits correction of the line-of-sight when considerably below or above level. A friction brake, arranged to drag on a small drum, prevents the shaft from turning when not in use.

Rangefinder drive. Figure 14-8 illustrates the drive attachment of the stabilizing unit output shaft by which the altitude movement of the rangefinder is controlled. It comprises a worm bracket element mounted on the carriage beam and a meshed wormwheel arc element clamped on the instrument. The speed ration of this drive, worm to instrument, is 56 to 1.

Amplifier control panel. The control panel unit is a waterproof enclosure which contains a supply

transformer, a line switch, an amplifier unit, a selenium rectifier, a selector switch, and protective fuses. It is mounted behind the rangefinder on the rear armor plate bulkhead of the gun house.

Arrangements. The line switch (fig. 14-9) controls the 440-volt supply to the motor elements of the two generator sets described below and to the supply transformer. The selector switch is a 3-position type with the positions designated OFF, START GYRO AND STAND BY, and AUTO. The amplifier is an electronic assembly which includes power, grid, filament, and plate transformers, power supply and stabilizing filter capacitors, limit relays, and six vacuum tubes. The unit picks up gyroscope oscillation signals, amplifies the signals, and transmits them to the field coils of the amplidyne. These control-field voltage inputs unbalance the generator field and provide amplidyne power output to the power motor as indicated below.

Motor-amplidyne generator set. The motor-amplidyne generator set generates the power outputs for driving the power motor of the stabilizing unit. It comprises a 3/4 horsepower, 440-volt, 3-phase, 60-cycle motor driving a 1.5-ampere, 250-volt, 375-watt direct current amplidyne generator at 3450 revolutions per minute. It is mounted on the rear armor plate bulkhead of the gun house. The unit is a 2-bearing horizontal assembly (both armatures on a common shaft). The set operates (fig. 14-7) to vary power-motor input in response to control-field voltage changes of polarity and magnitude, the field changes being derived from the amplified pick-up coil signals. It thus produces motor-driving current to level the rangefinder whenever the gyroscope gimbal moves in response to motion of the hull.

Data.

Type	Squirrel cage, induction
Design features	Horizontally mounted, direct drive, semi-enclosed natural draft ventilated
Horsepower	3/4
R.P.M. synchronous	3600
R.P.M. full load	3450
Speed class	Constant
Voltage	440
Phases	3
Cycles	60
Ambient temperature, C	50°
Torque class	Normal
Weight, lb	80*
Manufacturer	General Electric Co.

the gyro (fig. 14-7). It is mounted on the rear armor plate bulkhead of the gun house.

Data.

Type	Squirrel cage, induction
Design features	Horizontally mounted, direct drive, semi-enclosed natural draft ventilated
Horsepower	1/4
R.P.M. synchronous	3600
R.P.M. full load	3450
Speed class	Constant
Voltage	440
Phases	3
Cycles	60
Ambient temperature, C	40°
Weight, lb	60*
Manufacturer	General Electric Co.
Manufacturer's designation	5K36HD31
Drawing	351103

* Includes entire motor-alternator

The alternator is of the permanent magnet excited type and is rated as follows:

Volts	24
Cycles	230
Watts	100

Controls and interlocks

Rangefinder controls. The rangefinder stand and stabilizer provide the means of moving the rangefinder in deflection (azimuth movement) and altitude (elevating movement).

Deflection gear (azimuth movement). The rangefinder trainer, seated to the right of the rangefinder operator, operates the deflection gear handwheel

Manual control. The deflection handwheel is mounted on the right rear side of the carriage beam. Turning the wheel provides a maximum movement of 6 degrees on each side of a line normal to the turret fore-and-aft centerline. Mil graduations on the indicator dial, directly above the handwheel, show the direction and amount of deflection setting.

Altitude mechanism (elevating movement). Elevation or depression of the rangefinder is accomplished manually by handwheels or automatically by the stabilizer

CONTROL PANEL

RECTIFIER

Q	SELENIUM STACK SH4AM4	

STABILIZING UNIT

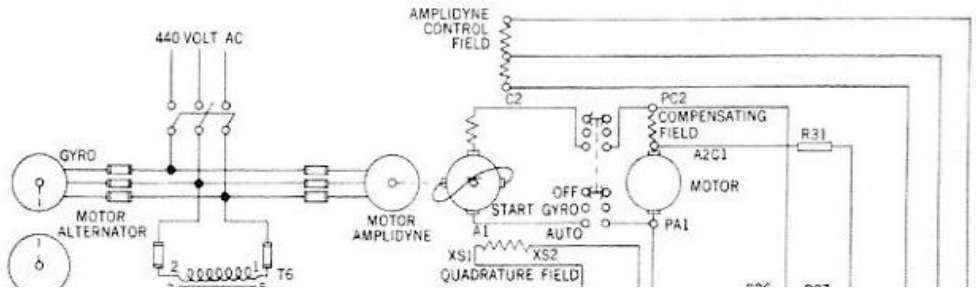
RESISTOR	OHMS	WATT
R31	1,000	1
R32	THYRITE	

AMPLIFIER

CAPACITORS	MFD	VOLTS
C1	0.1	600
C2	0.25	600
C3	1.0	600
C4	1.0	600

AMPLIFIER

RESISTOR	OHMS	WATT
*R1	25,000	2
R2	500,000	1
R3	560	1
R4	30,000	2
R5	100,000	1
R6	500,000	1
R7	560	1
R8	25,000	2
R9	10,000	2
R10	25,000	1
R11	100,000	1
R12	2,000	1
*R13	2,500	25
R14	25,000	1
R15	25,000	1
R16	600	4.8
R17	350	4.8
R18	6,900	12



C5	0.1	1000
C6	0.1	1000
C7	0.1	1000
C8	0.1	1000
C9	10.0	1000
C10	4.0	1000
C11	10.0	1000

R19	2500	4.8
R20	10,000	2
R21	10,000	2
R22	200	20
R23	200	20
R24	100,000	1
*R25	5,000	25
*R26	5,000	25
*R27	5,000	25
*R28	5,000	25
*R29	100,000	2

TUBES	TYPE
V1	6N7
V2	6N7
V3	5T4
V4	6L6
V5	6L6
V6	6SN7GT

RELAYS

K1	3 N.C. 115 V.A.C. COIL
K2	3 N.C. 115 V.A.C. COIL

*THESE ITEMS ARE POTENTIOMETERS

TRANSFORMERS		RATING
T1	68G418	60 ∿ – 132/110/83V. PRI. 46/23 V.C.C. 46/23 V.C.C. SEC. 75 KV INS.
T2	68G384	60 ∿ – .014 KVA – 115V. PRI. 300/150V. 300/150V. SEC. 75 KV INS.
T3	68G81	60 ∿ – .090 KVA – 115V. PRI. 800/400V – 212 SEC.
T4	68G82	60 ∿ – 101 HENRYS – 1 AMP. D.C. – D.C. RES. 200 OHMS
T5	68G79	60 ∿ – .049 KVA – 115V. PRI. 6.3-6.3-6.3-6.3-6.3-6.3-0-5.0/2.5 SEC. 75 KV INS
T6	68G692	60 ∿ – .300 KVA – 440V. PRI. 115/100V. SEC.

SYMBOLS

R — RESISTOR, DESIGNATED BY "R" NUMBER. RESISTANCE VALUE STAMPED ON RESISTOR.

R — POTENTIOMETER, DESIGNATED BY "R" NUMBER STAMPED ON CHASSIS BY POTENTIOMETER. RESISTANCE VALUE STAMPED ON POTENTIOMETER.

C — CAPACITOR, DESIGNATED BY "C" NUMBER. CAPACITANCE VALUE STAMPED ON CAPACITOR.

T — TRANSFORMER, DESIGNATED BY "T" NUMBER STAMPED ON CHASSIS BY TRANSFORMER TERMINALS. TRANSFORMER RATING ON NAMEPLATE ON TOP OF TRANSFORMER.

V — TUBE, DESIGNATED BY "V" NUMBER STAMPED ON CHASSIS BY TUBE SOCKET TERMINALS. TUBE TYPE STAMPED ON TOP OF CHASSIS BY TUBE.

K — RELAY COIL, DESIGNATED BY "K" NUMBER STAMPED ON CHASSIS BY RELAY SOCKET TERMINALS. RELAY K STAMPED ON TOP OF CHASSIS BY RELAY.

K — RELAY CONTACT, NORMALLY OPEN, DESIGNATED BY "K" NUMBER TO SHOW WHICH RELAY COIL ACTUATES THE CONTACT.

K — RELAY CONTACT NORMALLY CLOSED.

Q — DRY DISK SELENIUM RECTIFIER, DESIGNATED BY "Q". DIRECTION OF CURRENT FLOW DESIGNATED BY DIRECTION OF ARROW ON RECTIFIER. CURRENT FLOWS FROM YELLOW TERMINAL TO RED TERMINAL. RECTIFIER NUMBER STAMPED ON RECTIFIER.

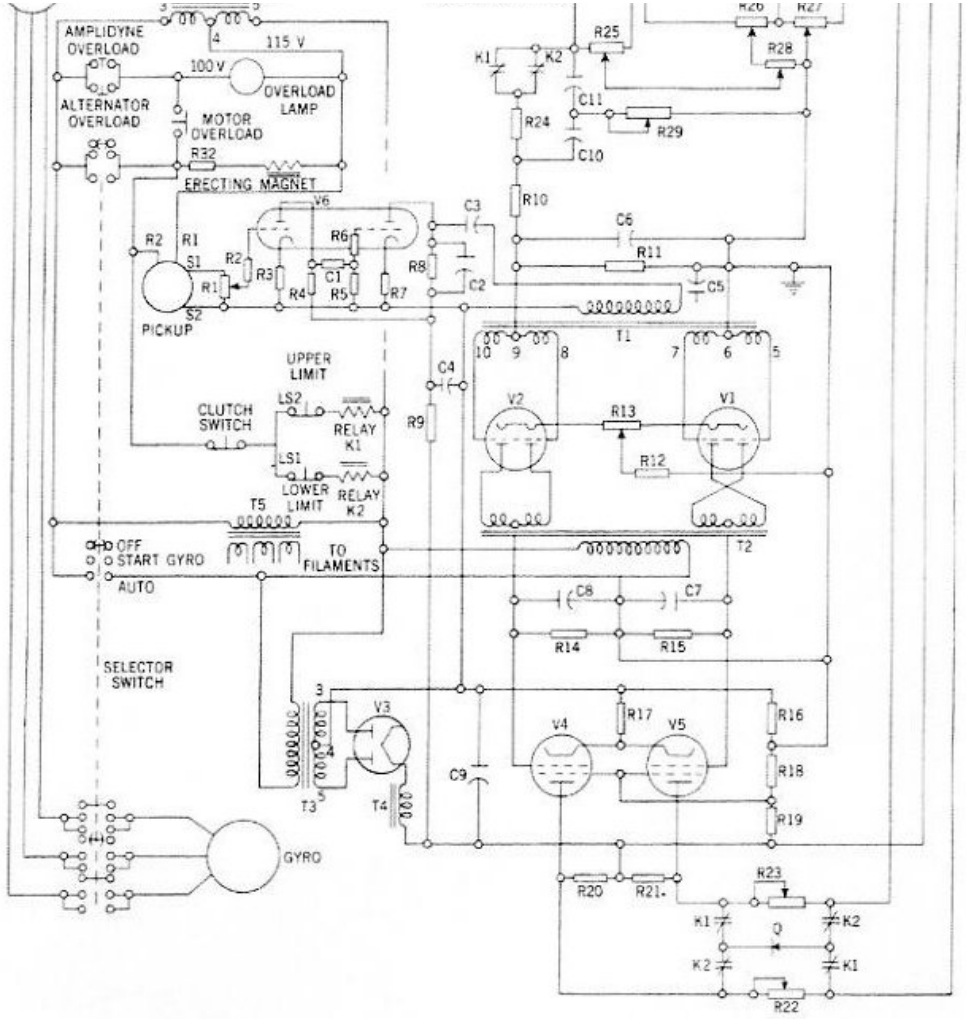


Figure 14-9. Stabilizer Circuit, Wiring Diagram

14-8A/B

Automatic control. Under automatic control the stabilizer unit keeps the rangefinder line of sight in a horizontal position.

Control panel selector switch. The control panel selector switch has two operating positions, START GYRO AND STAND BY and AUTO. In the START GYRO AND STAND BY position, the gyro and the erecting magnet are energized. When thrown to the AUTO position, the power motor is connected to receive power from the amplidyne and the plate supply of the amplifier is energized.

Start-stop control. Closing the line switch, referred to as the start-stop control, starts the motor-amplidyne generator set and the motor-alternator set.

Stabilizing unit manual selector. The stabilizing unit manual selector has two positions, AUTO and HAND. In the AUTO position, the power motor is connected to the rangefinder drive and in the HAND position, the power motor is disengaged and the handwheel for manual drive is made operative.

Handwheel for manual drive. This handwheel provides a means of emergency operation in the event of a breakdown.

"Added hand input" handwheel. By means of this handwheel, a vernier correction may be made to bring the line of sight to the desired position.

Interlocks. There are three interlocks in the stand and stabilizer: the shutter mechanism interlock, the stabilizing unit clutch shifting lever interlock, and the stabilizing unit limit stop interlock.

Shutter mechanism interlock. Each shutter mechanism includes an interlock device which locks the rangefinder stand at neutral position until the shutters are opened. When the shutter handwheel is turned, opening the shutter, a connecting rod and bell crank assembly retracts a locking bar, permitting the carriage to move in deflection.

Clutch shifting lever interlock, stabilizing unit. When the clutch shifting lever is turned to HAND, the auxiliary hand drive is made operative. The clutch switch is also operated and the system is de-energized.

Limit stop interlock, stabilizing unit. Two adjustable hex-headed posts are attached to and extend from each side of the travelling limit stop. Each post actuates a limit switch. When the limit stop

used automatically. However, if failure of any kind makes the use of hand drive necessary, it is preferable to completely shut down the equipment until repairs can be made.

Manual control

In manual control, the rangefinder trainer, operating the deflection handwheel, keeps the rangefinder on target in azimuth. The rangefinder pointer, using the pointer's handwheel, makes the rapid adjustment necessary to elevate or depress the rangefinder line of sight. The rangefinder operator then makes a fine adjustment in elevation through the handwheel at his station.

Automatic control

Before starting the stabilizer, the control panel s elector switch must be in the OFF position. The line switch is turned to ON, starting the motor-amplidyne generator and the motor-alternator. The selector switch is then moved to START GYRO AND STAND BY. After the gyro has come up to speed, the stabilizing unit clutch shifting lever is moved to AUTO. The control panel selector switch is turned to AUTO. (It requires approximately two minutes for the gyro to erect itself; however, the selector switch may be turned to AUTO almost immediately after the gyro is energized. The rangefinder will wander in elevation until the gyro has reached full speed.) If the rangefinder is not exactly on level or on target the rangefinder operator turns the "added hand input" handwheel to bring the line of sight to the desired position.

WARNING

Do not attempt to move the stabilizing unit clutch shifting lever to HAND while the rangefinder is in motion. Before shifting gears, the control panel selector switch must be in the START GYRO AND STAND BY position. If the gears do not mesh easily, work the manual drive handwheel back and forth until they slide in smoothly.

To stop the stabilizer, the control panel selector switch is turned to START GYRO AND STAND BY or to OFF. If the stabilizer is to be operated immediately thereafter, the switch should be left at START GYRO AND STAND BY. This procedure eliminates the necessity of the two-minute warm-up period.

WARNING

Before any operation, operate the locking gear, the shutter mechanism, deflection gear, and altitude mechanism through a complete cycle. Check that all parts have normal movement and adequate lubrication. Perform the lubricating schedule as prescribed in chapter 18. Lubrication of the stabilizer assembly is to be performed only by authorized and experienced fire control equipment maintenance personnel. It should be checked every six months or before any

loosening the locknut, and moving the screw until it actuates the clutch switch. Secure the screw in position by tightening the locknut.

DISASSEMBLY AND ASSEMBLY

General instructions

period of heavy use.

Adjustment of stabilizing unit clutch switch

The toggle arm, rigidly attached to the clutch shaft, has a screw and locknut on its end, perpendicular to the axis of the clutch shaft. Adjustment is made by turning the clutch switch to AUTO,

All parts of the rangefinder stand may be readily disassembled and assembled by reference to the general arrangement and detail drawings. When disassembling, mark all gears, shafts, bearings, and pinions for reassembly in their proper places. Dismantling of the stabilizing unit is to be discouraged. It should only be attempted under supervision of the gunnery officer, experienced fire control equipment maintenance personnel, or home yard staff.

GENE SLOVERS
US NAVY PAGES

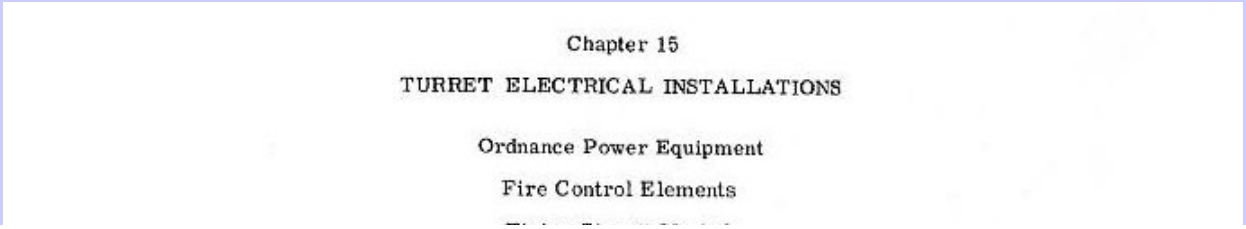
OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

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TITLE AND FORWARD

CHAPTER 15 TURRET ELECTRICAL INSTALLATIONS

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Chapter 15

TURRET ELECTRICAL INSTALLATIONS

Ordnance Power Equipment

Fire Control Elements

GENERAL DESCRIPTION

Turret electrical installations consist of the equipment and transmission facilities for power, heat, ventilation, illumination, sprinkling, communication, and fire control. Installations vary in detail between various ships of the class but all facilities in all turrets are of like arrangement, purpose, and capacity. Power equipment, fire control devices, portions of the firing circuit, and the battle lighting system are elements of Ordnance cognizance. All other wiring systems and attached fixtures and devices are elements of Bureau of Ships cognizance. Detailed descriptions of equipment, the arrangements of circuits, and instructions for maintenance are contained in the text and illustrations of this chapter.

Electrical systems

Turret electrical installations comprise six main systems, which are described in the following sequence:

Power system
Fire control system
Interior communication system
Lighting system
Magazine sprinkling system
Turret ventilating equipment

Turret structural arrangements

The mounting arrangements and supply services for the equipment of the six electrical systems include special turret structural details. They are structural brackets, foundation platforms, and other elements that secure motors, panels, and cabinets in correct alignment or protect them from shock vibration or other causes of trouble. They are also structural and installation details that protect units from drippings and from chafing, and that seal, or isolate, or support equipment and its wire leads, so that trouble-free service will be assured. The principal unit of such structural arrangements is the turret central column, described below. This column and its upper and lower wiring recess facilities are service lead-in arrangements that are common to all six electrical systems.

Turret central column. The central column provides a means for routing and supporting the feeder cables of the power system and other electrical circuits between their fixed structure sources and their rotating structure connections.

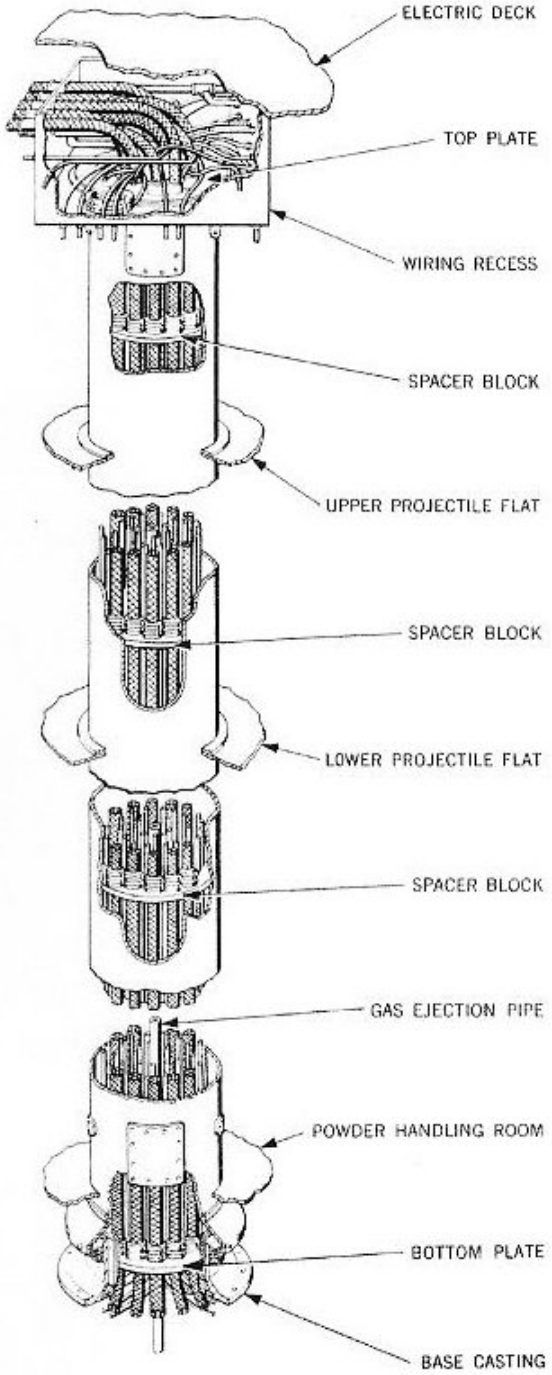
Cables within the column are flexible. They attach to ships' wiring at connection boxes located in a wiring trunk below the pivot casting at the base of the column, and are routed upward to a wiring recess at the top of the column. These arrangements are shown in figure 15-1.

All cables are suspended and separated in the column by an arrangement of drilled plates. These are the column top and bottom plates and the circular spacer blocks (fig. 15-1). The intermediate spacer blocks are of smaller diameter than the inside of the column. They are supported by clamps attached to the heavy feeder cables of the power system, as shown in figure 15-2. This arrangement permits limited revolving movement of the blocks within the column and, at the same time, prevents entanglement as the cables twist.

The cable holes of the fixed plate at the base of the center column, and those of the spacer blocks, are counter-bored to form holes of hour-glass shape. They are large enough to permit free sliding of the cables through the holes, as shown in figure 15-2. Sufficient slack is provided at the base of the column to allow for twisting and flexing of the cables when the turret is rotated through its training arc.

Each cable is supported at the top by means of a woven-wire cable grip and supporting hooks, arranged beneath the top plate. This arrangement is shown in figure 15-3.

Above the cable grip, each cable passes through the top plate in a stuffing tube which is a specially packed fitting. Another stuffing tube is fitted at the exit hole from the wiring recess. Both stuffing units are similar to the ones illustrated in figure 15-4. The cable terminal tubes and packing details of this illustration are characteristic of all terminal fittings at power panels, controllers, switches, and other electrical elements of the turret. They provide a vaporproof, watertight enclosure for each such unit and, in this instance, seal the wiring recess in a similar manner. Packing of the top plate stuffing tubes is not accomplished until after each cable is supported by its cable grip.



Cable and conductor details. Turret wiring radiating from the central column comprises an elaborate system of electrical cables of different sizes and capacities. Each cable consists of one or more insulated conductors enclosed within an outer covering of tough, flexible insulation, or within an insulating material sheathed by an armor covering of woven metal.

The flexible cables are utilized principally in the central column. Armored cables are installed throughout the rest of the turret, except when connections are required to moving elements, in which case flexible cables are used.

Cables of both types vary in outside diameter according to the number of individual conductors, the extent of the internal insulation, and the thickness of the external covering. All cables are resistant to moisture, heat, and flame. Some are also especially resistant to oil and abrasion.

Cables in central column. Forty-one electrical cables are suspended in the central column. Of this total, 39 are active and two are spares. They comprise four highly flexible types which are not readily damaged by repeated twisting and bending. The four types, and the principal characteristics indicated by their designations are:

Cable Type	Principal Characteristics
TCOP	Triple conductor, oil resistant, portable
MHFF	Multiple conductor, heat and flame resistant, flexible
TTHFF	Twisted pair, telephone, heat and flame resistant, flexible
MCOS	Multiple conductor, oil resistant, shielded

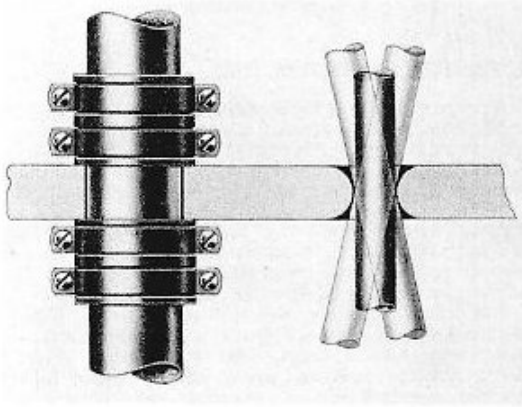


Figure 15-1. Base Casting and Central Column Wiring Tube Arrangements

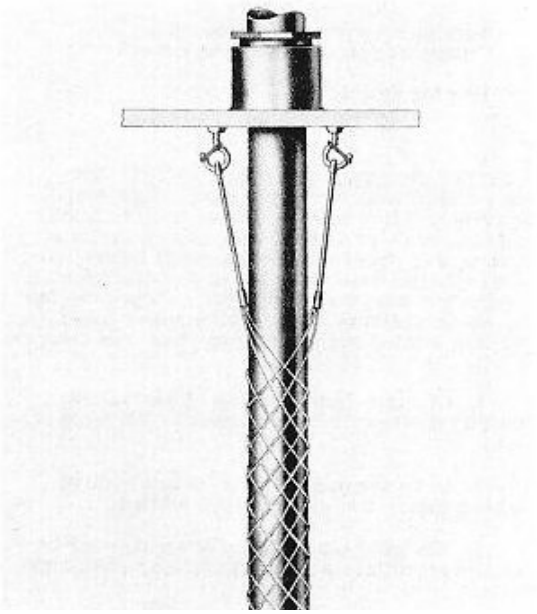
Figure 15-2. Spacer Block Arrangement for Fixed and Free Cables

DETAIL DESCRIPTION

Power system

The power system consists of the electric motors, controllers, push-button stations, and power supply equipment for the turret installations listed below:

Gun elevating gear (3)
Turret training gear
Rammers (3)
Projectile ring drives (2)
Parbuckling gear drives (2)
Projectile hoists (3)
Powder hoists (3)
Rangefinder stabilizer
Ventilating fan units (8)



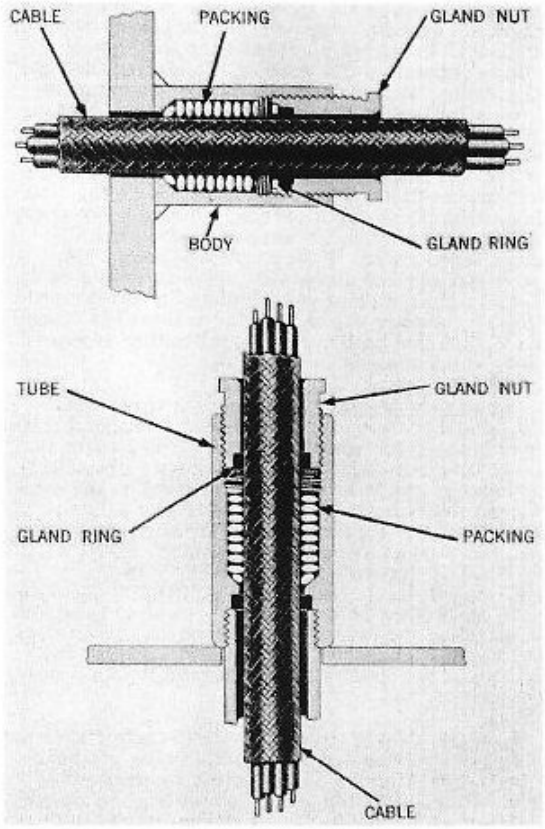


Figure 15-4. Stuffing Tubes. Typical Designs Sectioned

The power system also includes 15 Calrod type T heaters* and supply circuits for Normal and Emergency power to the turret's Interior Communication and Fire Control (IC and FC) Power Panel.* These power units and their respective control and supply sources are indicated in figure 15-5.

Main power supply. Power is supplied to each turret from the ship's main 440-volt, 3-phase, 60-cycle, twin turbo-generator units.

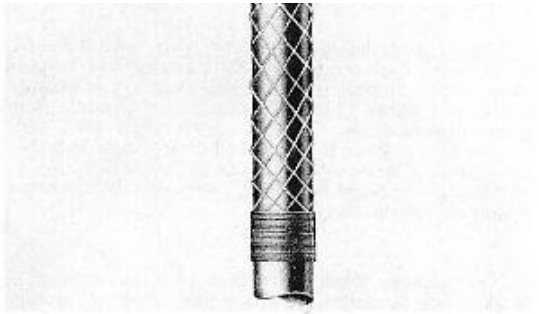


Figure 15-3. Cable Supporting Arrangement

Normal and alternate. Each turret has two sources of supply, normal and alternate, from two of the four ship's turbo-generator units, as indicated in the table below. Bus tie connections at the main switchboards make possible a rearrangement of these sources of supply.

	Main Switchboard and Generator	
Turret	Normal	Alternate
I	1	2
II	2	1
III	4	3

*Bureau of Ships cognizance

Manual bus transfer panel. Power supply selection of either of the two sources is made at the manual bus transfer panel, figure 15-6. It comprises a large steel cabinet located in the machinery compartment of the upper shell handling flat, mounted on floor brackets to the rear of, and facing the central column. It houses 2000-ampere bus transfer switch mechanisms for manual changeover from NORMAL to ALTERNATE. Two interlocked switch elements, each with an external handle, are utilized to effect the transfer. Each is so arranged that the load must be disconnected from one before the other can be closed. A small opening, immediately above each operating handle, reveals a mechanical ON and OFF indicator. Power available on the two supply circuits and connected loads are indicated by a 3-dial light indicator described in the paragraph following. Power is fed from the manual bus transfer panel to five ACB type circuit breaker power panels which are described below.

Manual bus transfer indicator. A three-dial light indicator is used to indicate the energized main power feeders and connected load. It is located in the machinery compartment of the upper projectile handling flat and is mounted at eye level on the center gun powder hoist trunk, near the manual bus transfer panel. Its three vertically aligned glass dials are marked and colored NORMAL POWER AVAILABLE (green), ALTERNATE POWER AVAILABLE (red), and LOAD CONNECTED (white). These dials show which source of power is available for operating the turret's power system and whether that supply is connected to the turret's load. The indicator is a triple bull's-eye assembly in a watertight case.

Power available indicator. Two single dial light indicators are mounted on the transverse bulkhead in the turret officer's compartment, opposite the turret officer's station. One indicates when the normal main power supply feeder is energized, the other when alternate power is available.

Training gear power panel. The training gear power panel is of the same type as the gun equipment power panels, but is set to trip at 400 amperes. It is fed from the manual bus transfer panel and supplies the training gear system. The panel is located in the machinery compartment of the upper shell handling flat on a longitudinal bulkhead to the left and forward of the central column.

Miscellaneous equipment power panel. The miscellaneous equipment panel is fed from the manual bus transfer panel. It is of the same type as the gun equipment panels and the training gear equipment panel previously described, but is adjusted to cut out at a load of 300 amperes. The panel is located in the machinery deck, rear center sector, on the circular bulkhead. It serves to supply power to the following assemblies:

Sump pump motors (elevating and training gear)

Projectile ring drives (upper and lower)

Parbuckling gear (upper and lower)

Rangefinder stabilizer

Ventilation systems (turret officer's compartment and machinery deck)

Heating system

Feeder distribution box Type XXXIII. Three feeder distribution boxes are used to feed respective groups of five heaters (fifteen heaters in all). Each has six fused single-phase branch circuits, including a spare circuit, and a cutoff switch interlocked with the door. The boxes are watertight enclosures and are rated at 500 volts. They are fed

Gun equipment power panels. Three ACB type circuit breaker power panels, designated as gun equipment power panels, figure 15-7, are fed by the manual bus transfer panel. Each serves to supply power to the following assemblies of the respective guns:

Elevating gear
Rammer
Projectile hoist
Powder hoist
Gun chamber ventilating system

All three panels are located on the machinery deck in a forward compartment formed by bulkhead extensions of the left gun girder box. These panels automatically disconnect their respective branches of the power system upon prolonged or excessive overload. Each is set to trip when the currecnt rises to 600 ampers. A switch lever in each unit permits manual cutoff of power. A small circular window in the front cover immediately above the switch-operating handle reveals a mechanical indicator plate to show whether the circuit breaker is open or closed. In addition, an electrical indicator, consisting of a lamp with a blue glass bull's-eye, located adjacent to the handle, indicates when the circuit breaker is closed.

from the miscellaneous equipment power panel. All three are located in the turret gun house as follows:

1. On right-hand bulkhead of passageway from turret officer's compartment to left sight station.

2. In center gun chamber on longitudinal bulkhead adjacent to gun captain's station.

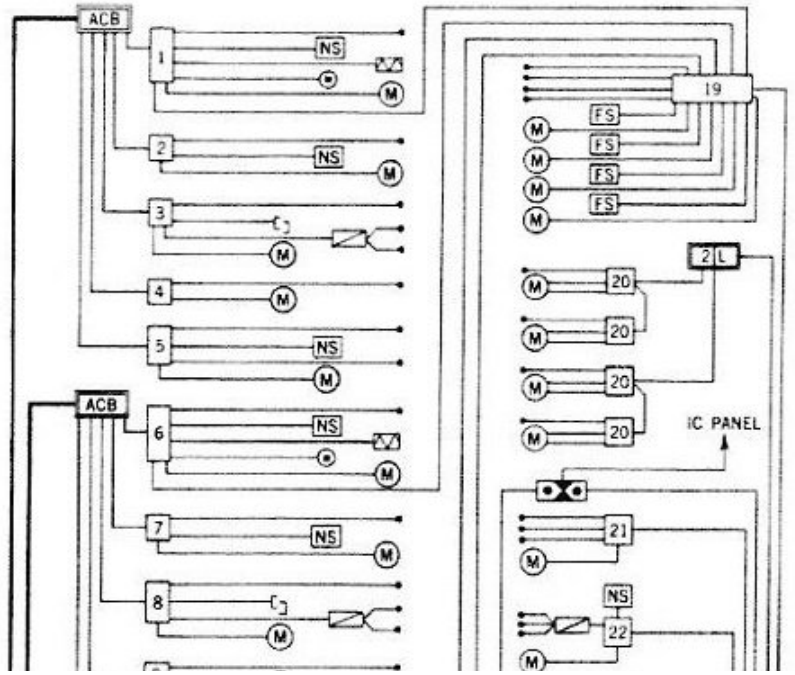
3. On left-hand bulkhead of passageway between turret officer's compartment and right sight station.

Feeder distribution box Type NNN. An unfused, two-branch, 3-phase feeder distribution box is used in the supply circuit from the miscellaneous equipment power panel to the two ventilation groups on the machinery deck. This is a watertight enclosure rated at 500 volts. It is located on a diagonal bulkhead, immediately over a hatch in the top of the right gun girder box weldment, adjacent to the center gun captain's station.

Controllers. Each turret has 17 motor controllers. These serve to control starting and stopping of the various hydraulic and mechanical power drive motors. All controllers are housed in watertight steel cabinets

MOTOR CONTROLLERS:

1	RIGHT ELEVATING GEAR
2	RIGHT RAMMER
3	RIGHT PROJECTILE HOIST
4	VENTILATING SYSTEM (RIGHT GUN CHAMBER)
5	RIGHT POWDER HOIST
6	CENTER ELEVATING GEAR
7	CENTER RAMMER
8	CENTER PROJECTILE HOIST
9	VENTILATING SYSTEM (CENTER GUN CHAMBER)
10	CENTER POWDER HOIST
11	LEFT ELEVATING GEAR
12	LEFT RAMMER
13	LEFT PROJECTILE HOIST
14	VENTILATING SYSTEM (LEFT GUN CHAMBER)
15	LEFT POWDER HOIST
16	TRAINING GEAR
17	AUTOTRANSFORMER



18	LUBRICATION PUMP
19	ELEVATION AND TRAIN SUMP PUMPS
20	VENTILATING SYSTEM (ELECTRIC DECK)
21	LOWER PARBUCKLING GEAR
22	LOWER PROJECTILE RING
23	UPPER PROJECTILE RING
24	UPPER PARBUCKLING GEAR
25	VENTILATING SYSTEM (TURRET OFFICER'S BOOTH)
26	RANGEFINDER STABILIZER

ACB	AIR CIRCUIT BREAKER
NS	NEUTRAL START INTERLOCK
	BRAKE SOLENOID
FS	FLOAT SWITCH
	1000-WATT HEATER AND SWITCH
	MANUAL TRANSFER SWITCH
2J	FEEDER DISTRIBUTION BOX (UNFUSED)
6J	FEEDER DISTRIBUTION BOX (WITH SWITCH, FUSED)
	FEEDER CONNECTION BOX
	INDICATING LIGHT
	BRANCH BOX
M	MOTOR
	PUSH-BUTTON STATION
	PROJECTILE HOIST BRAKE
	TRANSFORMER

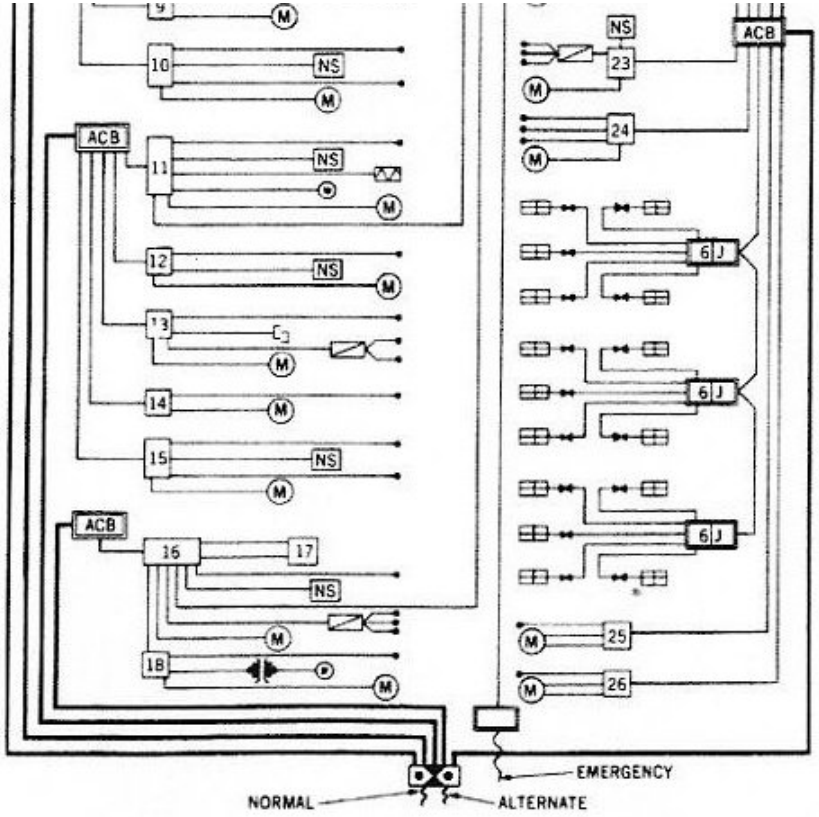


Figure 15-5. Power System Elementary Wiring Diagram

15-4A/B

All but the training gear controller are magnetic type, across-the-line starters. The training gear controller is of the autotransformer type. All have overload, undervoltage, and short-circuit protection. For safety, each controller has an external handle-operated disconnect device, consisting of either a circuit breaker or switch, interlocked with the door so that the door can be opened only after the handle has been positioned at "OFF."

Controller data. Data and references for all Bureau of Ordnance controllers are given in the following tabulation:

TABLE 15-1. ELECTRIC CONTROLLER DATA

Controller for	BB Nos.	Ampere rating, full load	Overload Protection		Short circuit protection	Undervoltage Protection		Shock rating	Weight lbs.	Manufacturer	Drawing No.
			Adjustable range	Normal setting		Drop-out voltage	Sealing voltage				
Elevating gear	61/64	60	80/95	90	675 amp circuit breaker	44	374	50	165	Cutler-Hammer	365736
Training gear	61/64	355	360/440	400	None	220	372	2000	1400	Ward Leonard	318740
Rammer	61/64	83.5	78/95	92	675 amp circuit breaker	44	352	50	165	Cutler-Hammer	273545
Projectile ring	61/62	48	59.1/71.0	60	400 amp fuses	110	374	50	130	Ward Leonard	231756
	63/64	48	47.5/58.1	52.8	250 amp fuses	110	374	2000	150	Ward Leonard	293881
Parbuckling gear	61/64	19.9	23.6/28.3	25	800 amp fuses	110	374	150	110	Ward Leonard	231774
Projectile hoist	61/64	95	99.5/134.5	113.5	AQB	50	370	150	235	Westinghouse	268589
Powder hoist	61/64	126	125.8/170.2	128.5	1600 amp circuit breaker	50	370	150	235	Westinghouse	274360

Push-button stations. The push-button station and starting circuit arrangements function the same in most installations. (Interlocks are part of the starting circuits of elevating, training, rammer, projectile ring, projectile hoist, and powder hoist starting circuits.) With the safety switch closed (assuming all interlocks are correctly positioned), a motor may be started by pushing the START-EMERG button. In all magnetic type across-the-line controllers, this action closes the line contactor magnetic circuit and connects the motor directly across the line. In the autotransformer type of controller, for the training gear motor, momentary pressing of the START-EMERG button energizes an auxiliary line contactor circuit which closes to energize a "start" solenoid contactor. The start contactor then closes and connects the motor to the line through the reduced voltage tap of the autotransformer. The start contactor, upon closing, starts a mechanical mercury timer, adjustable from 2 to 15 seconds, which closes to energize a second auxiliary contactor. Upon closing, the second auxiliary contactor energizes the "run" contactor which then connects the motor directly across the line.

Momentary pressing of the STOP button of all controllers opens the line contactor magnetic circuit and immediately disconnects the motor from the line. The controllers of the elevating gear, training gear, parbuckling gear, projectile ring, and the powder and projectile hoists are provided also with emer- sector of the circular bulkhead. The controller for the left gun elevating gear motor is located on the left rear sector of the circular bulkhead, in the machinery space of the upper shell handling flat.

and projectile hoists are provided also with emergency STOP switch station which function to stop their respective drive systems from one or more remote secondary control points. All push-button master control station START-EMERG buttons may also be used for EMERGENCY RUN in the event of a sustained overload sufficient to trip the overload relay mechanism. By holding closed the START-EMERG button, the overload relay system is bypassed and the motor will continue to run as long as the button is held closed.

Controller design arrangements. The specific function, design features, and location of the various controllers and their related push-button stations and interlock arrangements are described and illustrated in the following paragraphs:

Elevating gear motor controllers. The wiring arrangements of the elevating gear motor controller are shown in figure 15-8. Each is a conventional, magnetic, across-the-line type arranged with a manually operated disconnect switch and devices protecting the controlled motor. Each controller controls the starting and stopping of an elevating gear power motor.

The controllers for the right and center gun elevating gear motors are located in the machinery space of the upper shell handling flat, on the rear

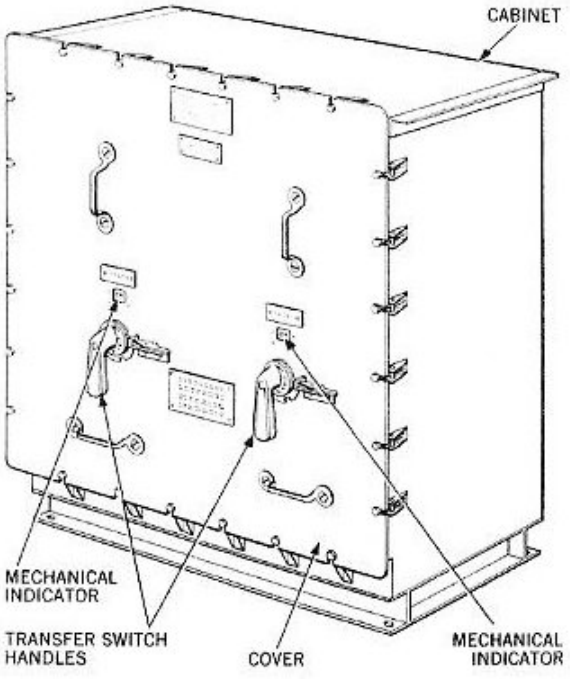


Figure 15-6. Manual Bus Transfer Panel

A circuit-breaker with a non-adjustable trip point of 675 amperes provides short-circuit protection. For other pertinent data, refer to chapter 5 and to the controller data table of this chapter.

The master push-button switch for each elevating motor controller is located at the respective gun layer's station on the machinery deck. Each unit is a watertight assembly which includes the START-EMERG and STOP switch mechanism, a transformer, and a pilot light. The transformer primary is wound for a 440-volt input; the secondary delivers a 6-volt supply to a type TS52, 1.5-candlepower, 6-volt lamp of the pilot light.

An emergency STOP switch is located at each gun captain's station to provide a means of bringing the gun to a quick stop to prevent damage to equipment or personnel. The switch is a single, normally closed, push-button type. Two series-connected neutral start interlock switches, in the starting circuit of the elevating motor controller, function to

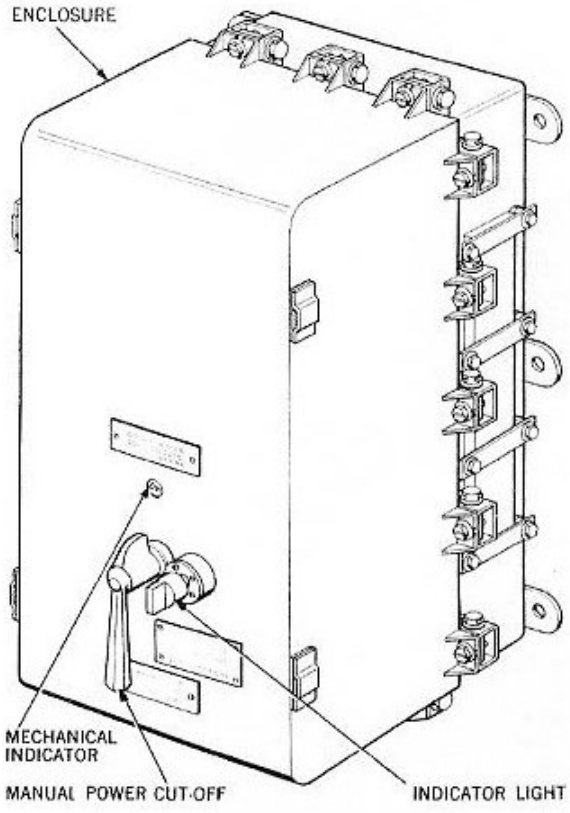
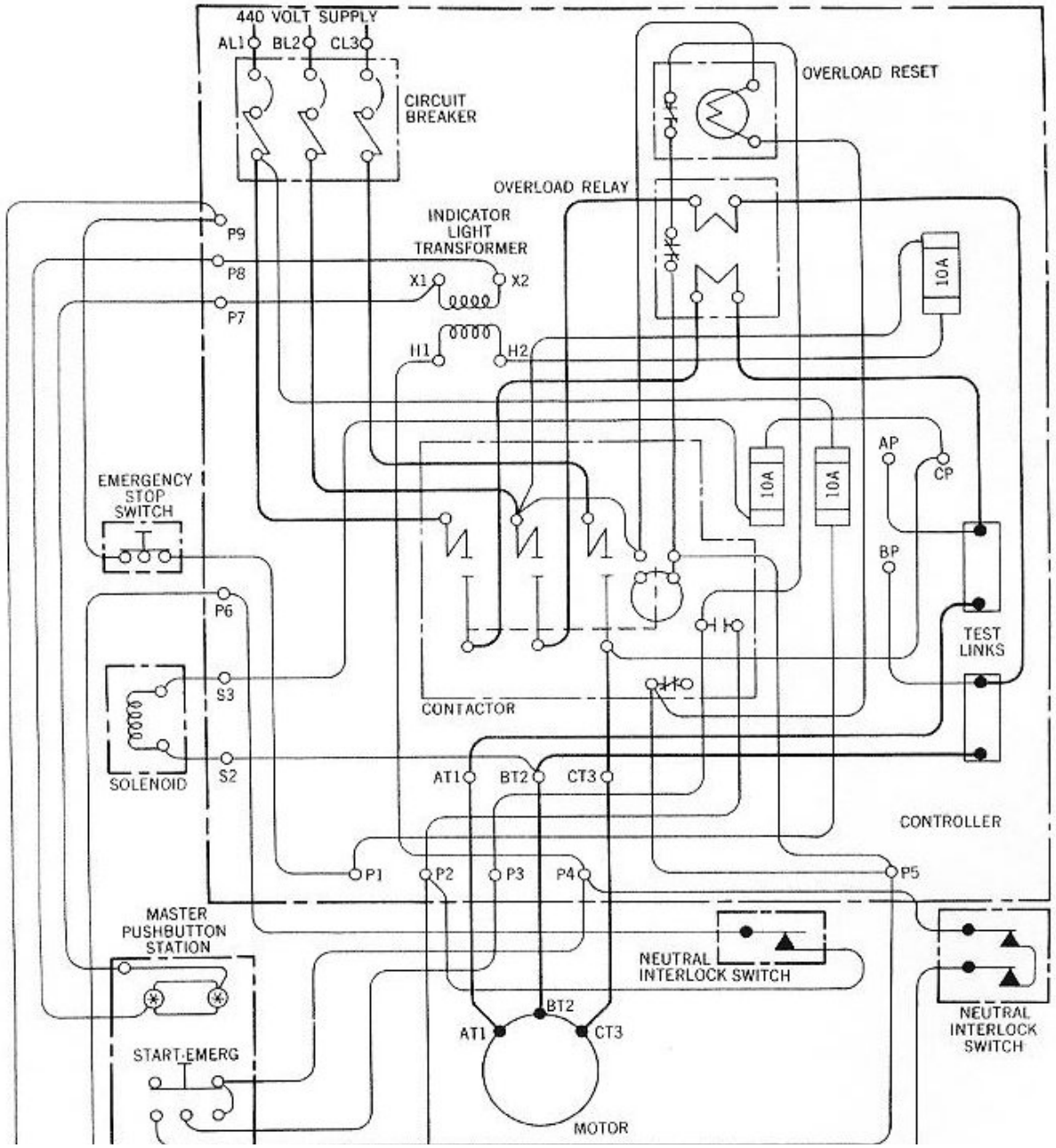


Figure 15-7. Gun Equipment Power Panel


440 VOLT SUPPLY
AL1
BL2
CL3
CIRCUIT BREAKER
OVERLOAD RESET
OVERLOAD RELAY
INDICATOR LIGHT TRANSFORMER
P9
P8
P7
X1
X2
H1
H2
10A
10A
10A
AP
CP
BP
EMERGENCY STOP SWITCH
P6
S3
S2
SOLENOID
CONTACTOR
TEST LINKS
AT1
BT2
CT3
CONTROLLER
P1
P2
P3
P4
P5
MASTER PUSHBUTTON STATION
START-EMERG
NEUTRAL INTERLOCK SWITCH
NEUTRAL INTERLOCK SWITCH
BT2
AT1
CT3
MOTOR

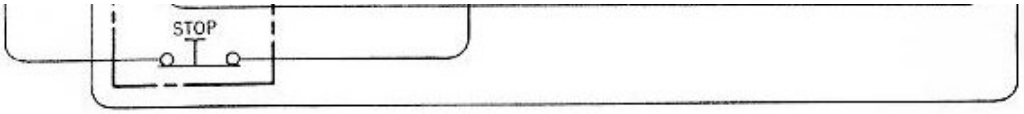


Figure 15-8. Elevating Gear Motor Controller. Practical Wiring Diagram

prevent starting when either or both the tilting box and the control valve are off center. The tilting box neutral interlock switch is located on top of the A-end assembly immediately forward of the neutral return hand lever. The control valve neutral interlock switch likewise is located on top of the A-end assembly, but farther forward. Both switches are watertight, commercial type units.

A spring-loaded power failure solenoid, located on the forward face of the A-end assembly, acts when power fails to position a blocking valve in the hydraulic system to bring gun movement to a sudden stop. The solenoid is energized by 440 volts, single-phase, tapped from two leads of the 3-phase supply to the power motor.

Training gear motor controller. The training gear motor controller is located in the machinery compartment of the lower projectile handling flat, mounted on floor brackets rearward of and facing the central column. Short-circuit protection is not included in the controller but is provided by the ACB type training gear power panel which supplies it (see previous description). The wiring arrangement of the controller is shown in figure 15-9. For reference data, refer to the controller data table and to chapter 6.

The autotransformer associated with the training gear controller is in a separate watertight enclosure, mounted on the circular bulkhead, rearward of the controller.

The master push-button switch for the training gear controller is located at the train operator's station on the machinery deck. It is a watertight unit, identical with the master switch assemblies of the elevating gear control system described above.

Two series-connected neutral start interlock switches, in the starting circuit of the training gear motor controller, prevent starting when either or both of their respective A-end actuating mechanisms are off neutral. These switches are the tilting box neutral interlock switch, located on the left side of the A-end housing, and the servo pilot valve twin micro switch assembly, located on the rear face of the control valve block at the top of the A-end assembly. The tilting box switch is a commercial unit.

The rammer motor controllers for the right and center rammers are mounted in the machinery space of the lower projectile handling flat, on the rear sector of the circular bulkhead. The controller for the left rammer is installed on the center powder hoist trunk in the lower shell handling flat.

The master push-button switch for each rammer controller is located at the respective rammer operator's station at the rear of each gun chamber. Each is a watertight, two-button type (START-EMERG and STOP) switch.

A neutral start interlock switch in each rammer controller starting circuit functions through a cam arrangement in the power drive A-end to prevent starting when the tilting box is off neutral. The switch is located on the left side of the A-assembly the right rammer and on the respective right side of the center and left rammer (see fig. 10-6). Each switch is housed in a watertight case.

Projectile ring motor controllers. The two projectile ring motor controllers, figure 15-11, are magnetic across-the-line type starters, with short-circuit protection provided by 400-ampere fuses. The wiring arrangements are illustrated in figure 15-12. Other data is given in the controller data table of this chapter and in chapter 7.

The controller for the lower projectile ring drive is installed on the center powder hoist trunk. The controller for the upper projectile ring drive is mounted on the right rear sector of the circular bulkhead enclosing the machinery space in the upper projectile handling flat.

The master push-button switch for each projectile ring controller is of the conventional two-button watertight design and in each case is located on the center projectile hoist at the respective upper and lower projectile handling flats. Two emergency STOP switches are provided for each controller. They are located one on each side of the projectile handling platforms of both the upper and lower projectile handling flats. The switches are single-button, normally closed type.

Parbuckling gear motor controllers. The two parbuckling gear motor controllers, figure 15-13, are magnetic across-the-line type starters with short-circuit protection provided by 80-ampere

The servo control valve switch assembly comprises a pair of micro switches designed and arranged so that both are closed only during an extremely limited portion of the servo control valve movement at the center of its stroke.

A spring-loaded power-off solenoid, upon power cut-off, functions through a hydraulic valve to set spring-actuated brakes on the training pinions. The solenoid is normally energized from the single-phase contro circuit supply of the controller. It is located in the center gun pocket on the transverse bulkhead, immediately forward of the center oscillating bearing.

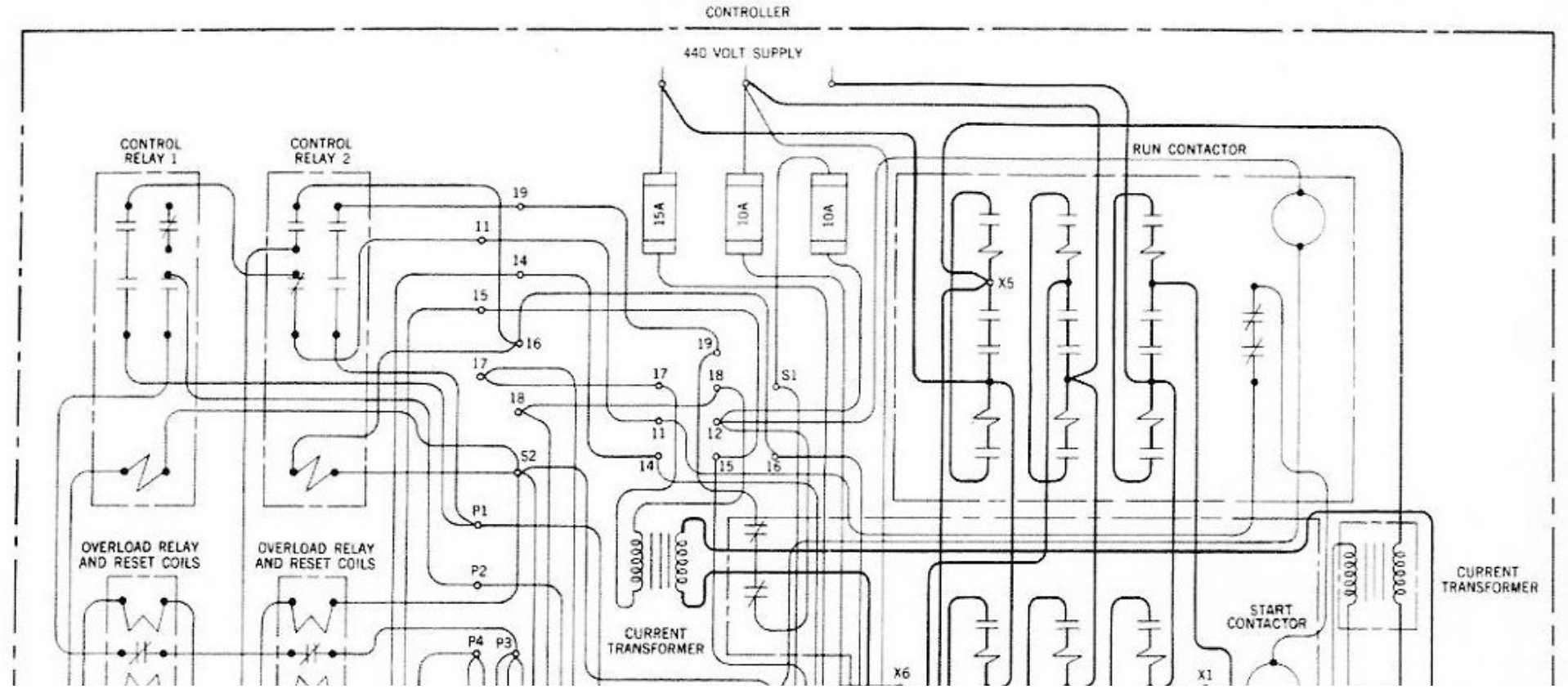
Rammer motor controllers. The rammer motor controllers are magnetic across-the-line type starters, with a short-circuit trip set at 675 amperes. The wiring arrangement is shown in figure 15-10. For further details, refer to chapter 10 and to the controller data table of this chapter.

15-8

fuses. Figure 15-14 illustrates the wiring arrangement. Specification data are included in chapter 8 and in the controller data table of this chapter.

The lower parbuckling gear motor controller is located on the right powder hoist trunk, in the lower projectile handling flat, the upper parbuckling gear motor controller on the right powder hoist trunk, in the upper projectile handling flat.

The master push-button switch for each controller is a conventional two-button type. It is located on the center projectile hoist assembly at its respective projectile handling flat. Three emergency STOP single push-button switches are included in the control circuits of each parbuckling gear motor controller. These are located on their respective lower and upper projectile handling flats at the following points: one on the left and one on the right projectile hoist assemblies, and one adjacent to the parbuckling gear motor controller in the machinery compartment.



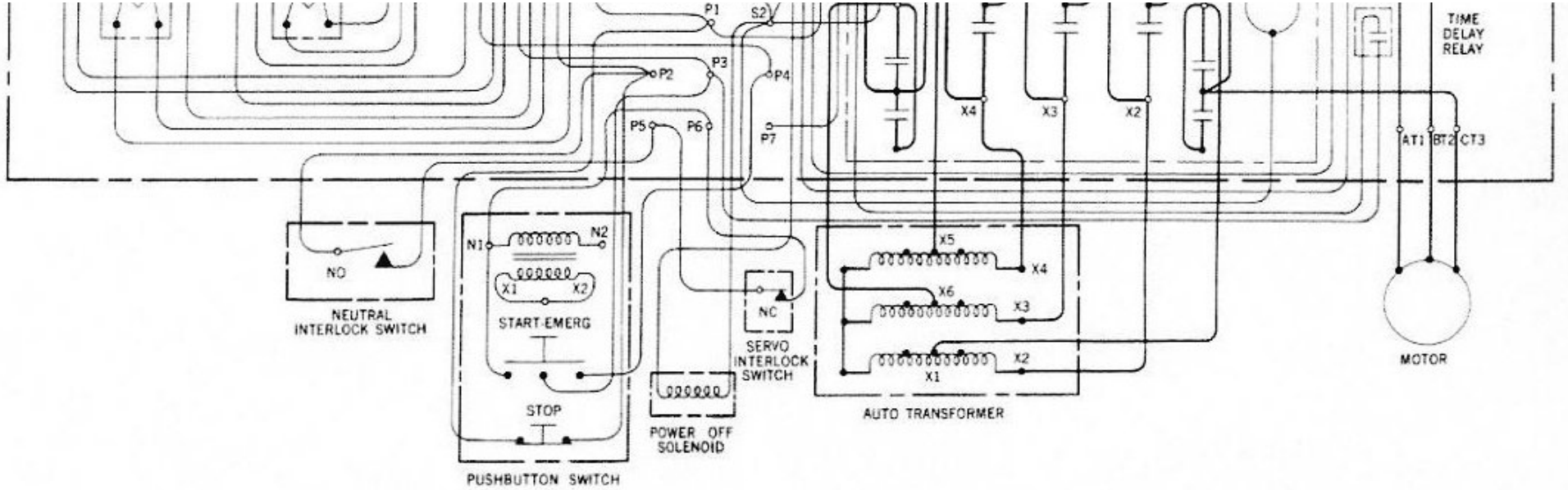
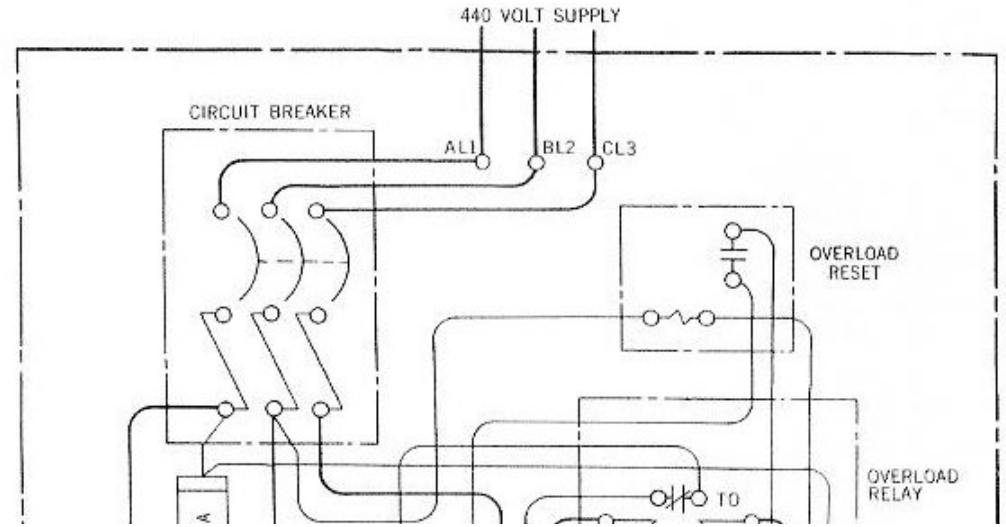


Figure 15-9. Training Gear Motor Controller. Schematic Wiring Diagram

15-8A/B



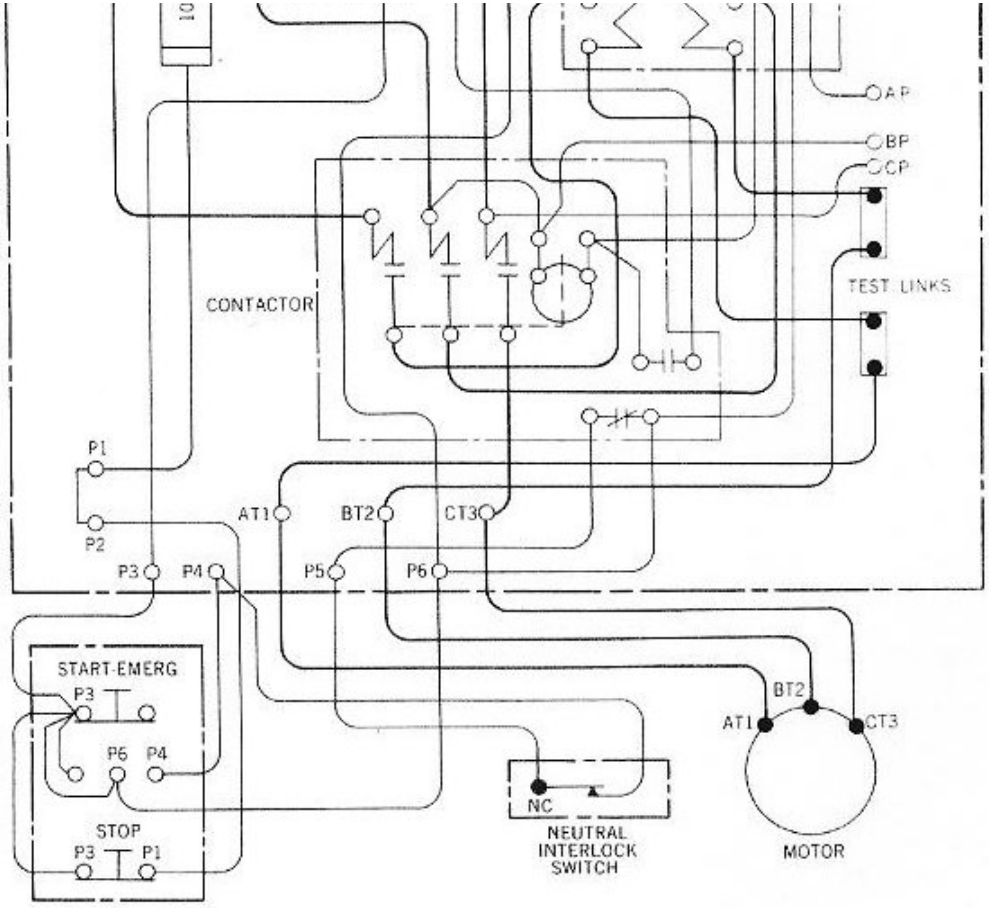


Figure 15-10. Rammer Motor Controller. Schematic Wiring Diagram

Projectile hoist motor controllers. The three projectile hoist motor controllers serve to control starting and stopping of their respective projectile hoist motors. They are mounted on the forward c circular bulkhead in the machinery space of the lower projectile handling flat. Short-circuit protection is provided by a circuit breaker with trip set for instant release at 1350 amperes. Further data is included in chapter 9 and in the controller data table of this chapter.

The master push-button switch for each controller is installed at the rear of each respective gun are located one at each of the lower and upper loading stations of their related hoist assemblies. Projectile hoist interlock circuit QE is described later in this chapter. Its wiring arrangements are shown in figure 15-15.

Powder hoist motor controllers. The three powder hoist motor controllers, figure 15-16, are similar to the projectile hoist controllers. Each serves to control starting and stopping for its respective powder hoist motor. The three controllers are mounted forward on the circular bulkhead in the

chamber. These switches are of the watertight, lever-operated type. Two emergency stop switches are provided for each hoist assembly. They are of the normally closed, lever-operated type. They

machinery compartment of the upper projectile handling flat. The wiring arrangements are shown in figure 15-17. Further information is included in chapter 11 and the controller data table of this chapter.

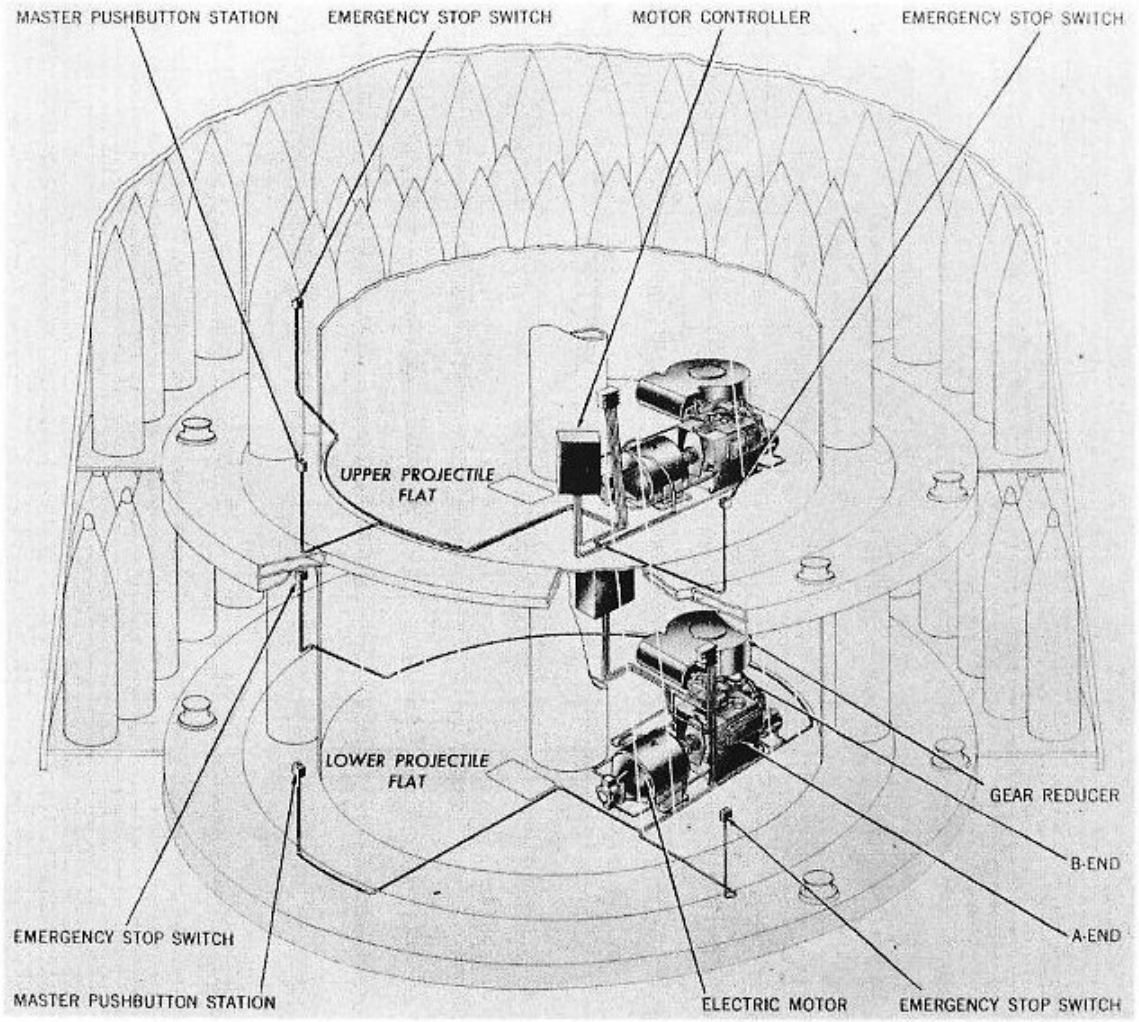


Figure 15-11. 16-inch Projectile Ring Mk 2 Mod 0 Electrical Installation

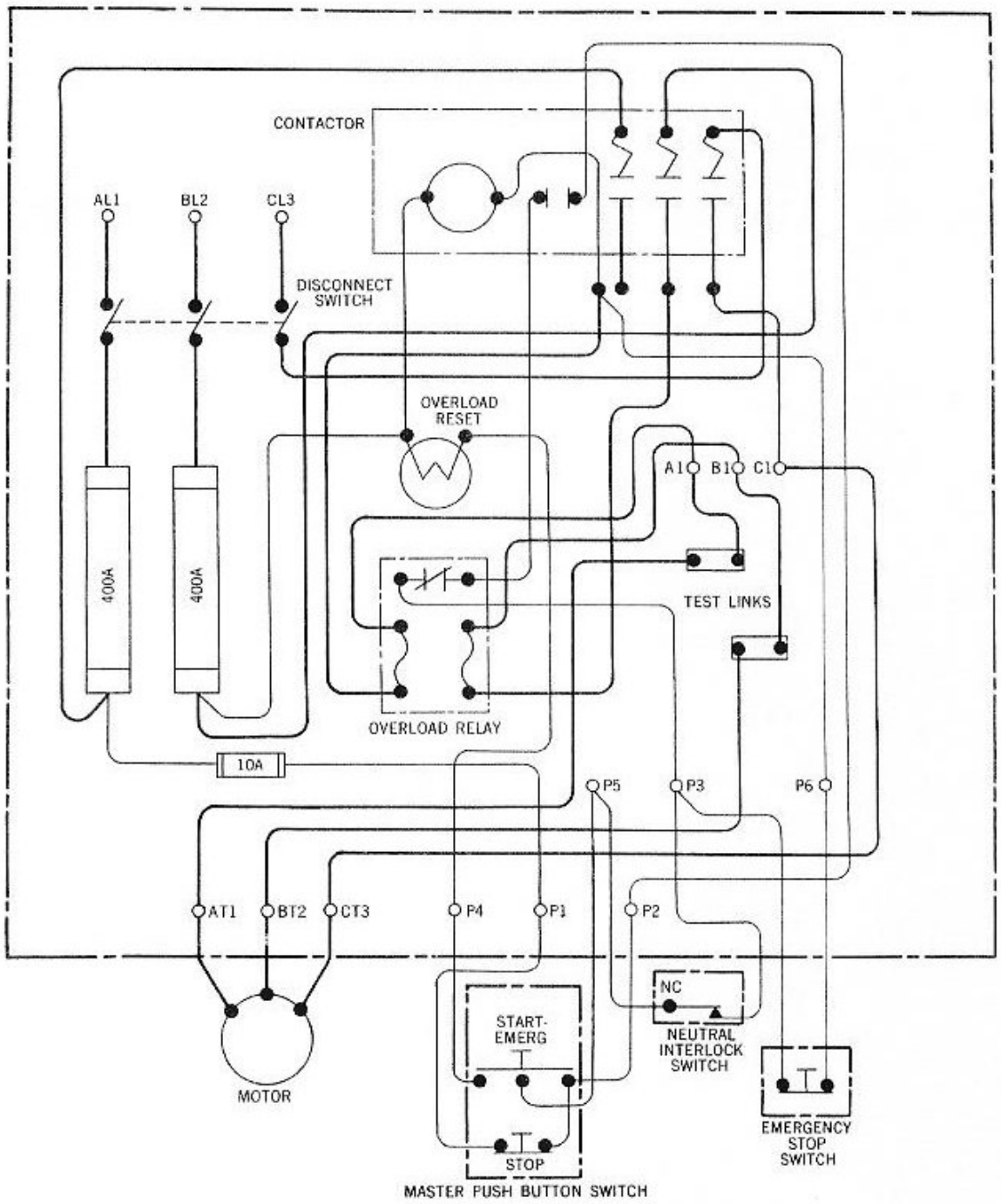


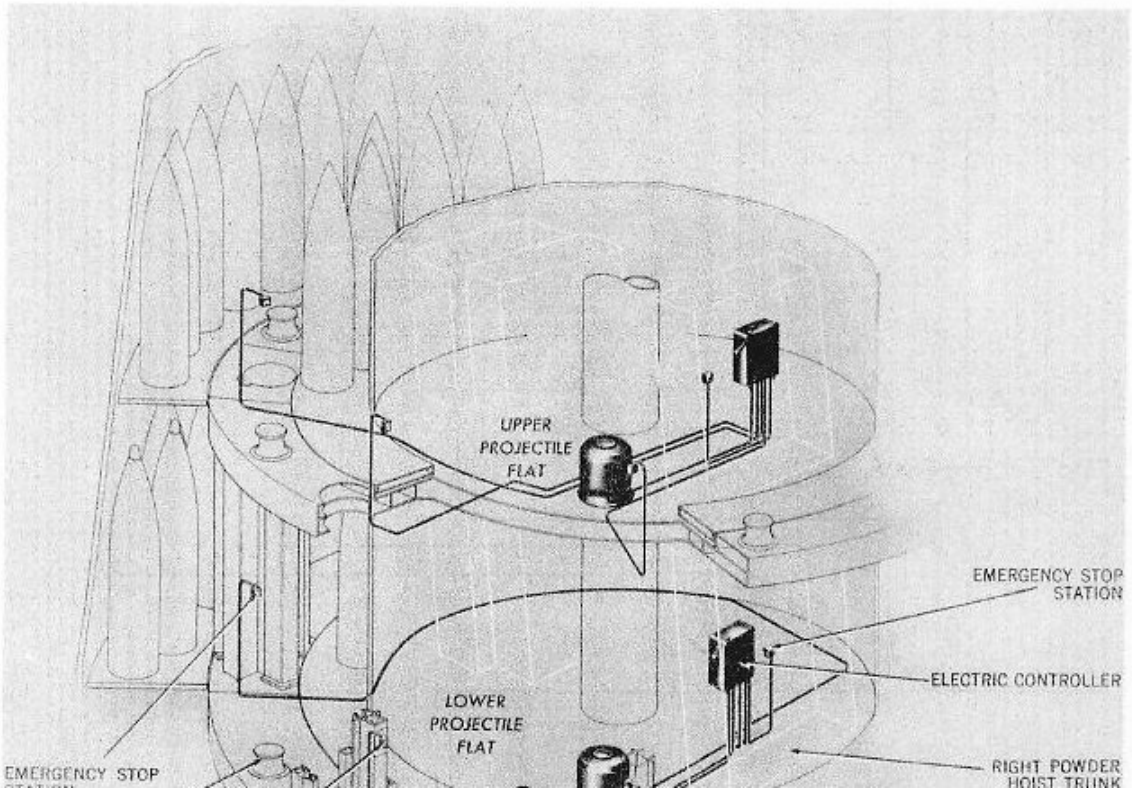
Figure 15-12. Projectile Ring Motor Controller, BB 61-62, Schematic Wiring Diagram

The master push-button switches are the lever-operated type. Each is located at the hoist operator's station, powder trunk upper end. A STOP switch, normally closed, is located at each hoist trunk lower end, at the door operator's station. The interlock arrangements of the powder hoist system are described on page 15-35.

Power motors. The power system of each turret includes 20 motors of Bureau of Ordnance cognizance and nine motors of Bureau of Ships cognizance. Motors of Bureau of Ordnance cognizance consist of three elevating gear motors, three elevating screw lubricating motors, one training gear motor, three rammer motors, two projectile ring motors, two parbuckling gear motors, three projectile hoist motors, and three powder hoist motors. Motors of Bureau of Ships cognizance consist of eight ventilating fan motors and the training gear lubrication motor.

All motors of the power systems are of the 440-volt, 3-phase, 60-cycle, squirrel-cage induction type. They are of normal torque with low starting current characteristics. The ambient temperature rating of each is 40 degrees centigrade. Each motor is provided with a waterproof enclosure and is designed to withstand shocks of high impact. Cooling is provided either by an integral fan or by natural draft.

Elevating gear motors. These motors are horizontally mounted and logitudinally aligned on the machinery floor. The left gun motor is near the left side, the center gun motor in the rear sector, and the right gun motor near the right side.



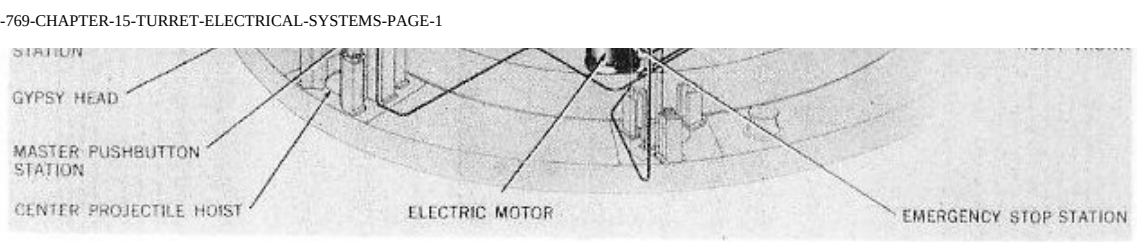
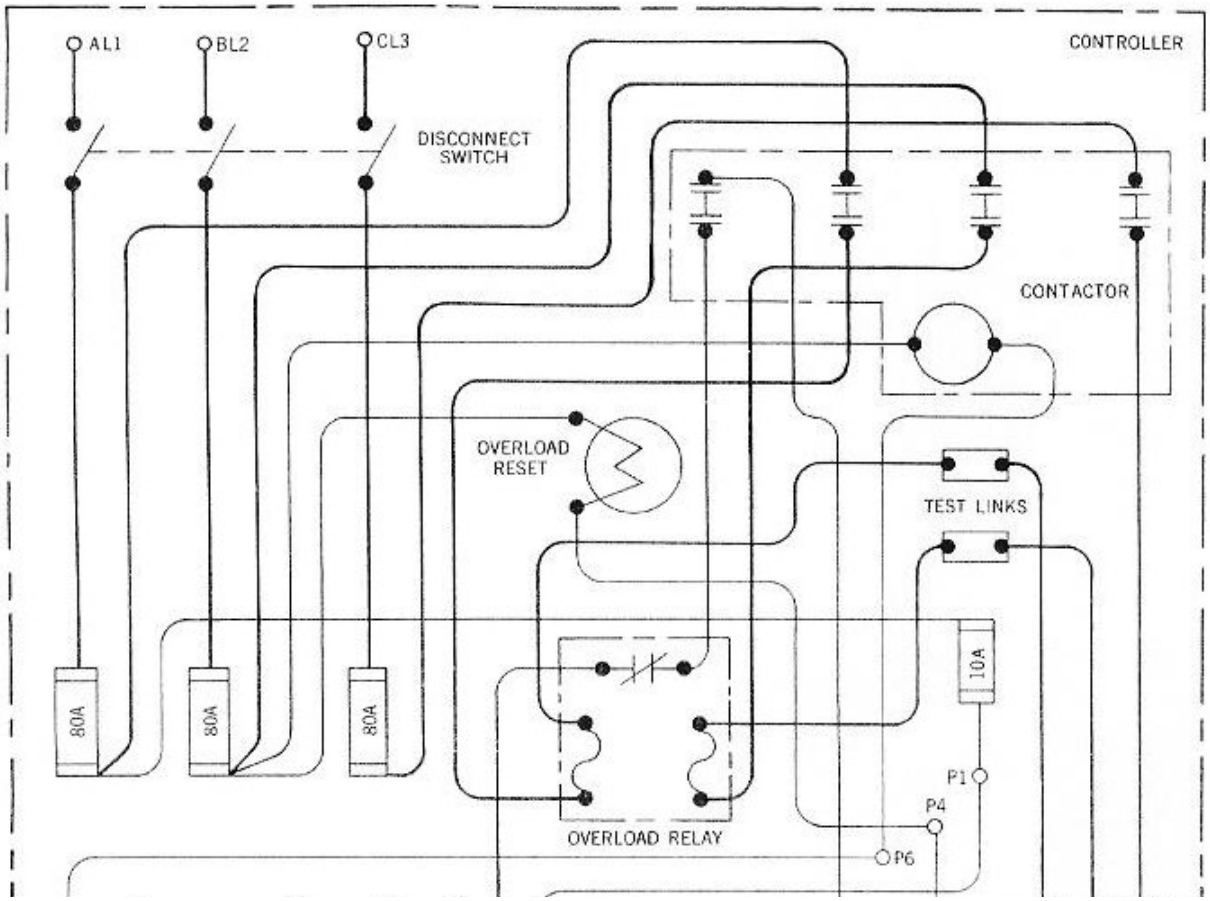


Figure 15-13. Parbuckling Gear Electric Installations, General Arrangement



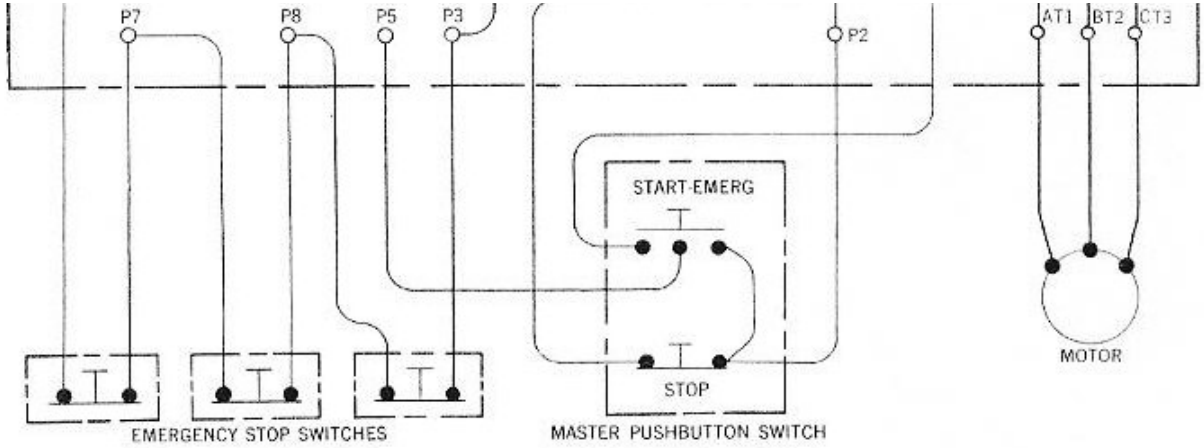
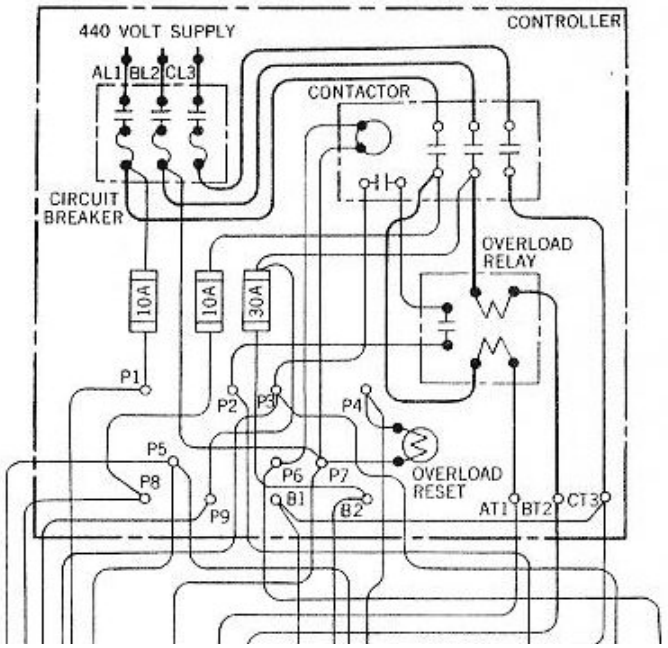


Figure 15-14. Parbuckling Gear Motor Controller. Practical Wiring Diagram

15-13



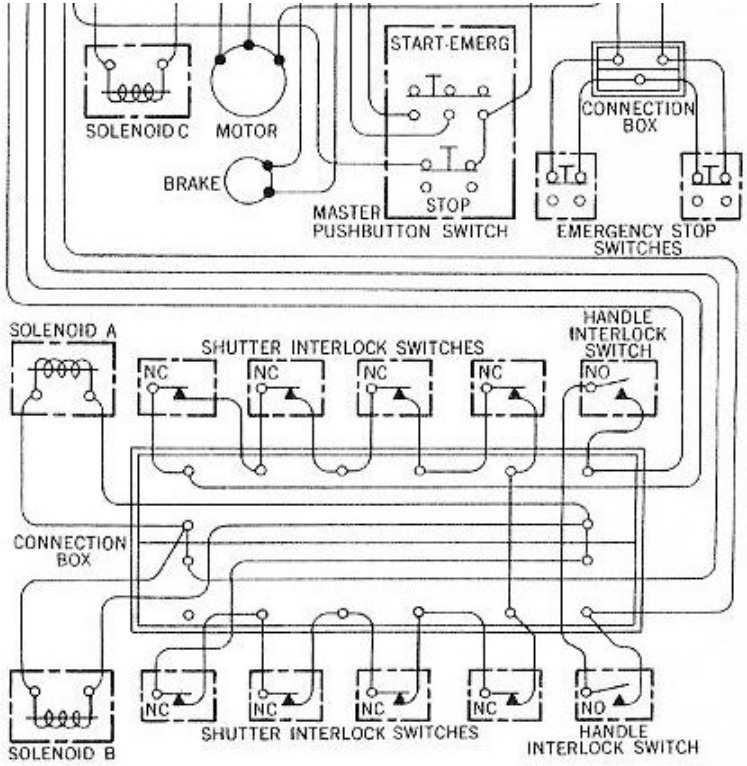


Figure 15-15. Projectile Hoist Motor Controller. Schematic Wiring Diagram

Training gear motor. The training gear motor is horizontally mounted and longitudinally aligned near the rear center of the machinery floor.

Rammer motors. Each of the rammer motors is horizontally mounted and longitudinally aligned immediately adjacent to its respective rammer chain housing under the turret officer's compartment in the overhang.

Projectile ring motors. The projectile ring motors are located in their respective machinery compartments of the lower and upper projectile handling flat machinery compartment. In both cases they are horizontally mounted adjacent to the left side of the right powder hoist trunk.

Parbuckling gear motors. The parbuckling gear motors are located in their respective machinery compartments of the lower and upper projectile handling flats. In each case they are vertically positioned and flange mounted at floor level near the left rear end of the right powder hoist trunk.

Projectile hoist motors. The projectile hoist motors are horizontally mounted on the machinery floor level. The left hoist motor is longitudinally aligned near the left side, the center hoist motor diagonally aligned in the left rear sector, and the right hoist motor longitudinally aligned near the right side.

Powder hoist motors. The powder hoist motors are vertically positioned and flange-mounted in the spaces formed by the upper extensions of the gun girder box weldment and are immediately forward of the upper ends of their respective powder hoist trunks.

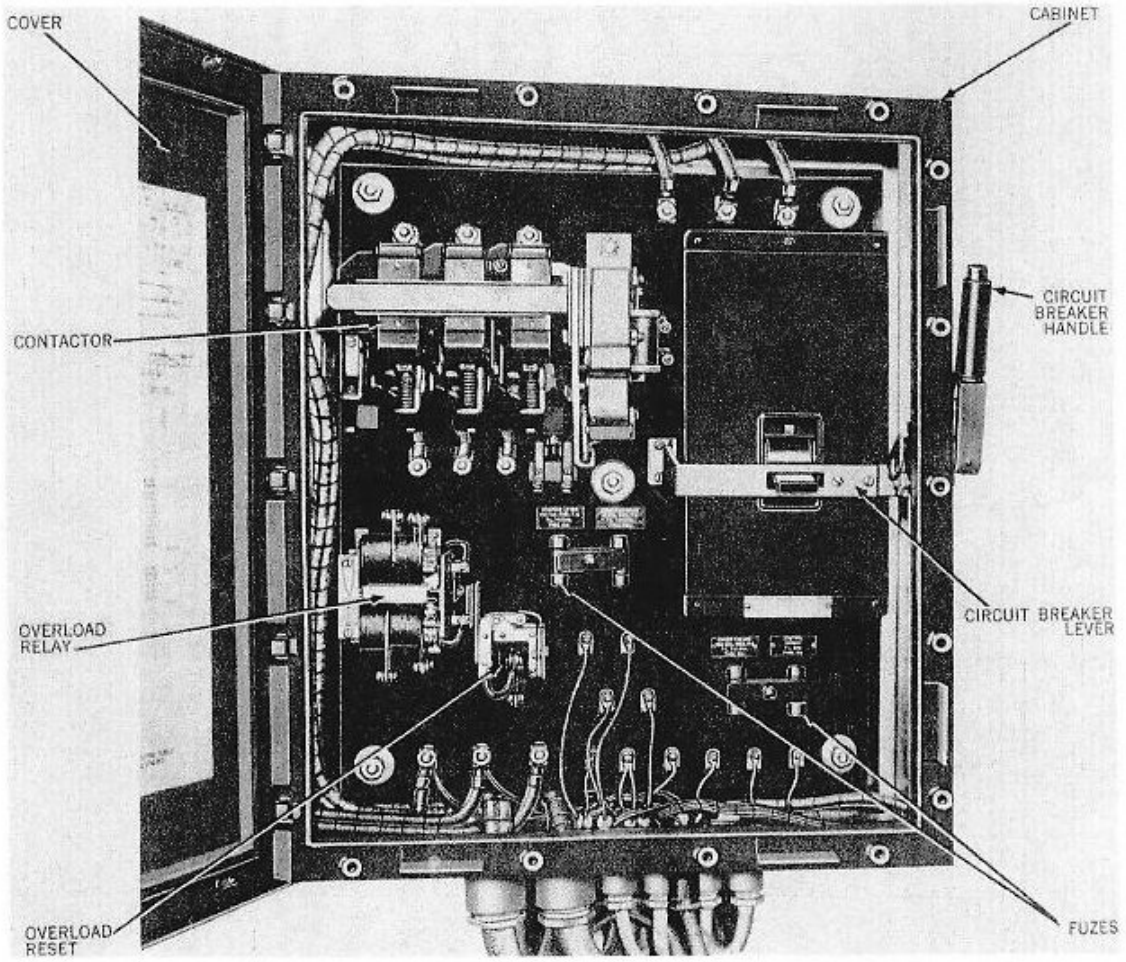


Figure 15-16. Powder Hoist Motor Controller. General Arrangement

15-15

CONTROLLER

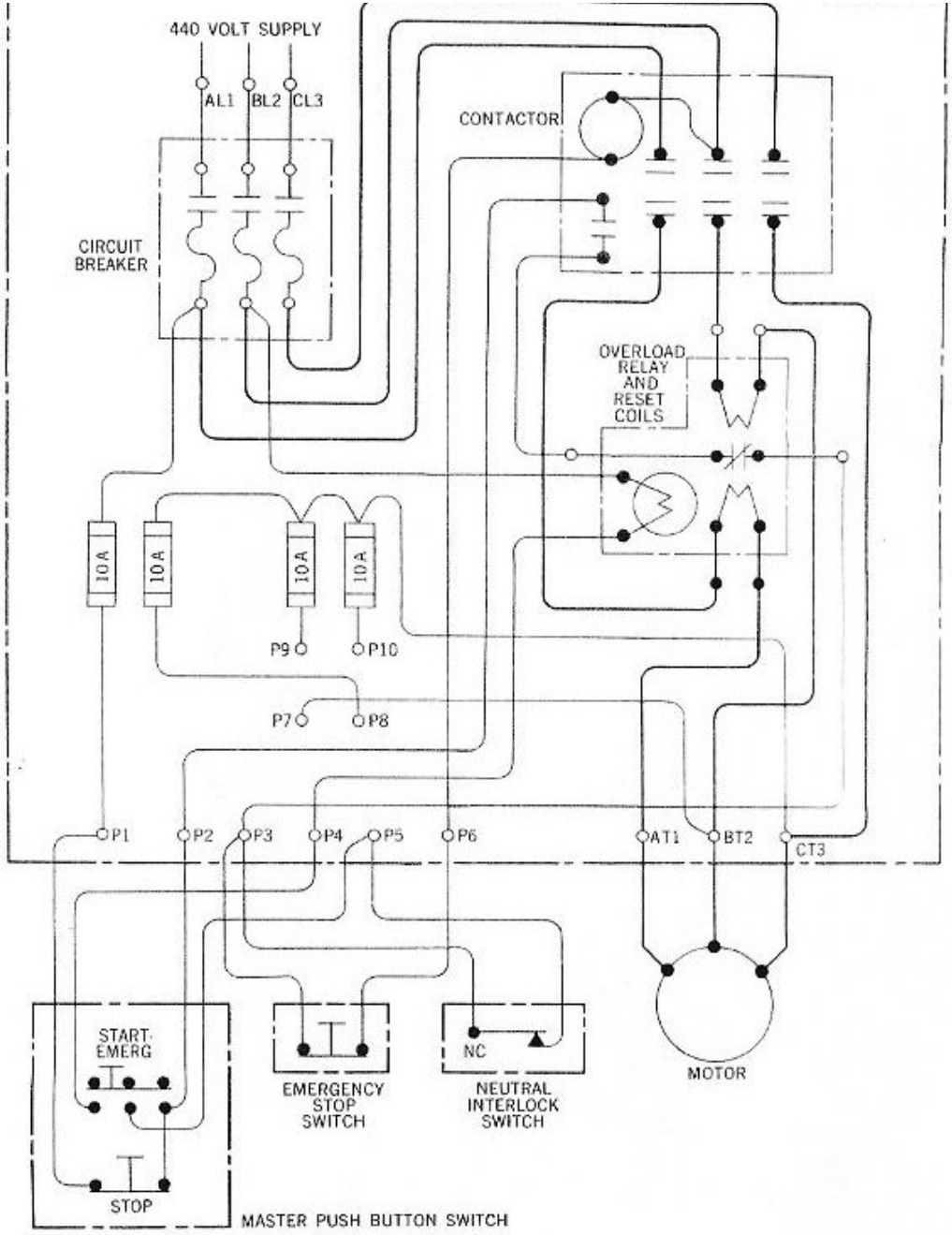


Figure 15-17. Powder Hoist Motor Controller. Practical Wiring Diagram

Fire control system

The fire control system in each turret comprises electrical arrangements through which gun orders are received and transmitted and by means of which guns are positioned and fired, together with related protective interlock circuits.

Circuits. Fire control circuits, figure 15-18, and their designating symbols are listed below and are described in subsequent paragraphs and in chapter 12.

Fire Control Circuits

Symbol	Circuit Name
GE	Gun control system
GEP	Gun remote control system
1PA	Gun firing system
1R	Ready light
1VB	Salvo signal
1U	Cease firing signal
CS	Sight setter's clutch indicator
CP	Sight pointer's clutch indicator
RP	Projectile ring ready light
QE	Projectile hoist interlock
Q	Projectile hoist control interlock
QB	Shell latch indicator
QC	Powder hoist interlock
--	Rangefinder stabilizer

Power supply. Four sources of power are available for operation of the firing circuit in the turret. Two are 120-volt, 60-cycle sources, one from the forward and one from the after main battery control switchboard. The third is an emergency supply from a 24-volt, 100-ampere hour batteries in series source, located in the turret. The fourth source of power is for the operation of the cradle control and powder hoist door solenoids, and is a 117-volt, single-phase, alternating current, from a 1 KVA transformer and does not go through the turret officer's control panel.

The first and second (forward and after) power supplies are duplicate systems, each in turn comprising two divisions with a common return; one, a normally energized supply for local (turret) firing, and the other, a normally open circuit which is energized only upon momentary closing of "director fire" contact makers. Selection of these supplies through the forward or after switchboards is made by a switch on the turret transfer switchboard. To utilize either division of the main 120-volt supply, the turret transfer switch must be positioned to AFT or FWD and the turret officer's selective switch lever turned to A.C. SUPPLY. Choice of DIRECTOR or LOCAL fire is effected by the turret officer's selective switch knob with pointer. Thus, by means of these switches, the guns may be fired by director fire through either the forward or after main battery control switchboards, or they may be fired locally by the normally energized supply from either of these fore or aft sources.

The third supply of the firing circuit, for emergency use only, is from the 24-*volt* storage battery located in the turret officer's booth. Selection of this supply is made by turning the turret officer's selective switch to BATTERY. On battery supply, gun firing can be effected only from the firing keys in the turret.

The fourth power supply, for the operation of the cradle control and powder hoist door solenoids, is from a 1 KVA 440/117-volt, single-phase transformer on the intercommunication panel, located on the upper projectile flat.

Components of fire control circuits.

Multiple turret train indicator (2GE). The turret officer's instrument for advising as to the position of own turret and other turrets is a standard type of multiple turret train indicator. The instrument not only shows modified turret train response (turret train response from which the connection for horizontal parallax has been removed), but also shows whether the turrets are following gun train orders. In turrets I and II, the indicators show the train angle of both turrets so that the turret officer can control train and elevation to present interference between the guns of the two turrets.

These instruments are electrical receivers with one-speed and 36-speed synchros. Each operates a calibrated dial; one to show modified turret train response and the other, a zero reader, to show the difference between the train order and modified turret train response. Signals received originate in own turret gun train indicator, other turret gun train indicators, and gun train order transmitters in the rangekeeper or computer of the controlling plotting room.

One-speed train signals are routed locally to provide the turret position indication in all methods of control. But the signals used to drive the zero



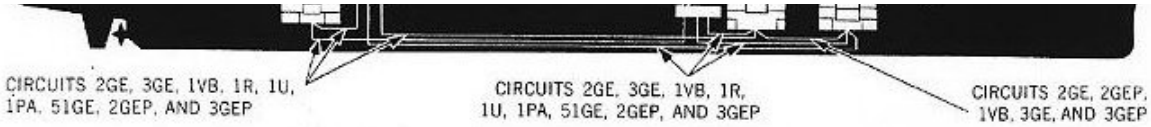


Figure 15-18. Fire Control Circuits. Plotting Room - Turret Connections

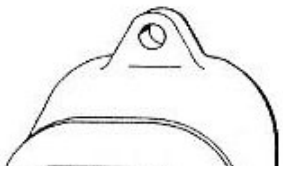
reader dials are routed to the turret from the controlling plotting room. The latter signals are separate signals, separately received from the turret officer's transfer switchboard and "mixed" in the 36-speed differential synchro receivers.

These instruments function in the same way in all methods of turret control, provided communications are available.

Turret transfer signal indicator (51GE). Circuit 51GE provides visual signals for positioning the transfer switches which select control circuits from the forward or after plotting rooms. These visual signals comprise two 2-dial indicators, as shown in figure 15-19, located in the turret officer's compartment. They are mounted on the transverse bulkhead to the right of the right powder hoist station door. Supply for the system derives from the 120-volt, 60-cycle current at the forward or after IC switchboard and is controlled from either the forward or after main battery control transfer signal switch panel in the respective main battery plotting room.

Auxiliary computer (GE). Auxiliary Computer Mk 3 Mod 2 is a computing and indicating mechanism used by the computer operator and his talker to solve fire control problems. It generates indicated values of sight angle and sight deflection, based upon three electrical inputs and 13 manual inputs.

Inputs of own ship speed, own ship course, and turret train are received electrically in the instrument. These inputs are routed to the computer through the turret officer's transfer switchboard. Inputs of own ship course and own ship speed are derived through controlling plot from the master gyro compasses and the underwater log transmitter, respectively. The turret train input is received from the gun train indicator.



Thirteen inputs to the computer may be introduced manually by the thirteen control knobs located on the instrument. Three of the manual inputs duplicate corresponding electrical inputs to provide an emergency source for these input components. These are true bearing (in lieu of own ship course), own ship speed, and turret train. Other inputs are: time, target angle, initial velocity, wind speed, target speed, range correction, projectile, present range, deflection correction, and wind angle.

Outputs of the computer are sight angle and sight deflection. These values are indicated on counters of the instrument dial face and are transmitted by telephone from the computer talker to the sight setter.

Gun elevation order transmitter (3GE). Gun elevation signals may originate at a director or at the sight pointer's stations in own turret or in other turrets. The gun elevation order transmitters (page 13 - 9) transmit the signals originated in turret throught the turret transfer switchboard to gun elevation indicators located at the left, center, and right gun layer's stations.

Gun elevation indicators (3GE). Gun elevation indicators, located at each gun layer's station, receive gun elevation orders from the controlling director or from one of the sight pointer's gun elevation order transmitters.

Turret train indicator and transmitter (2GE). The turret train indicator and transmitter, located at the train operator's station in each turret, receives train order signals from either the forward or after plotting rooms or from other turrets. It transmits parallax range and modified turret train response signals to the train receiver-regulator.

Turret officer's indicator panel (1PA) (1R). The turret officer's indicator panel, figure 15-21, is located in the turret officer's compartment in a recess of the transverse bulkhead opposite the turret officer's station. The panel has 15 indicator lights (circuit 1R) and five control switches (circuit 1PA).

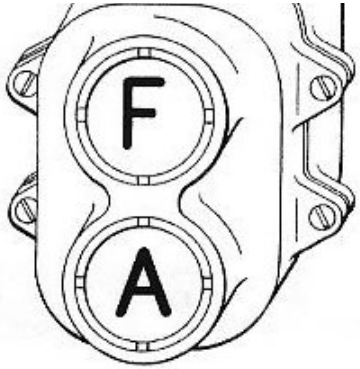


Figure 15-19. Fire Control Transfer Signal Indicator

15-18

Turret officer's selective switch (1PA) (1R). The turret officer's selective switch, figure 15-20, comprises two rotary switch assemblies. The upper switch assembly, controlled by a handle with a pointer, is labeled DIRECTOR-OFF-LOCAL. The lower switch assembly, controlled by a handle with a pointer, is labeled A.C. SUPPLY-OFF-BATTERY. By rotating these switches to their respective positions, the turret officer may select either director or local fire and the source of power for energizing the gun firing circuit.

Turret captain's indicator panel (1PA) (1R). An indicator panel, connected in parallel with the turret officer's indicator panel, is provided at the turret captain's station. It has no switches but otherwise is identical to the turret officer's indicator panel, figure 15-21.

Gun captain's ready switch (1PA) (1R). Located at each gun captain's station is a gun captain's ready switch (fig. 15-22). This switch is a two-position, spring return lever-operated, rotary-type unit housed in a watertight case. It has an integral unlocking solenoid (wired into circuit 1R) which prevents the lever from being shifted to the opposite position until this solenoid is energized, and this can only occur when the gun is in battery and the breech is closed. One position of the lever is SAFE (meaning "safe to load"), and the other position is READY (meaning "ready to fire"). This lever is spring-returned to the SAFE position when the unlocking solenoid is energized. A manual PULL TO RELEASE button, located on the switch, can be pulled out to release the lever if the unlocking solenoid should fail to function. The gun captain's ready switch is arranged in circuit 1PA with the firing key circuit and with the control circuit. In circuit 1R the switch is arranged with the gun elevation ready, gun ready and load indicator lights, the turret officer's indicator panel, and the turret captain's indicator panel. The switch also causes the gun to return to loading position when it is turned to SAFE.

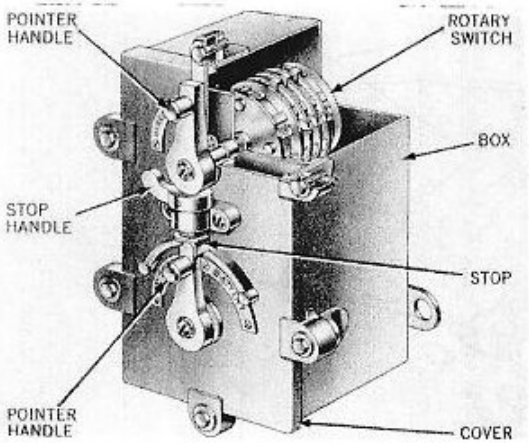
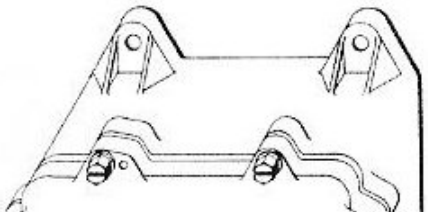


Figure 15-20. Turret Officer's Selective Switch



Gun elevation ready, gun captain ready, and load indicators (1PA) (1R). A three-dial indicator light is located at each gun captain's station and each gun layer's station. These indicate, from top to bottom, respectively, gun captain ready, gun elevation ready, and load. The indicators are watertight enclosures with three glass window discs, behind each of which are pairs of illuminating lamps. The indicator for the left gun layer's or left gun captain's station is shown in figure 15-23. The top, center, and lower dials for indicators at the center gun layer's and gun

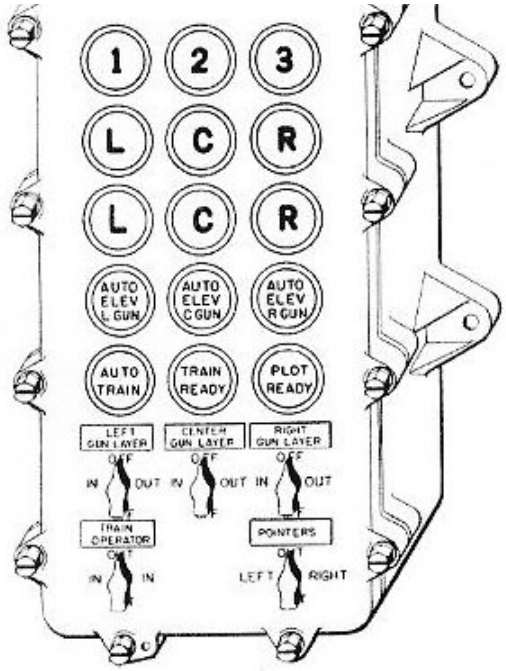


Figure 15-21. Turret Officer's Indicator Panel

captain's stations are marked C, C, and LOAD, respectively. Similarly, for indicators at the right gun layer's and gun captain's stations they are marked R, R, and LOAD. From top to bottom, the dials of the gun captain's indicators are colored as follows:

Left gun captain's indicator	- Red, blue, clear
Center gun captain's indicator	- Red, blue, clear
Right gun captain's indicator	- Red, blue, clear

The dials of the gun layer's indicators are colored as follows:

Left gun layer's indicator	- Blue, red, clear
Center gun layer's indicator	- Blue, white, clear
Right gun layer's indicator	- Blue, green, clear

15-19

TURRET ELECTRICAL INSTALLATIONS PAGE 2

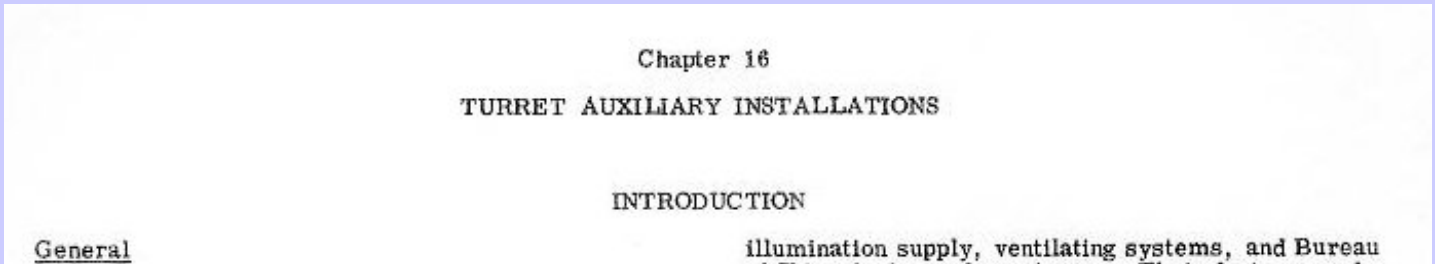
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OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

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CHAPTER 16 TURRET AUXILIARY INSTALLATIONS



Chapter 16

TURRET AUXILIARY INSTALLATIONS

INTRODUCTION

General

illumination supply, ventilating systems, and Bureau

This chapter contains a description of turret auxiliary installations which include power supply, of Ships design and cognizance. Their features and general arrangement are described in the following paragraphs.

DESCRIPTION

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 panel, 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 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 from 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 vice versa, when required.

Ventilating system

Eight self-contained ventilating systems (fig. 16-1) 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 pushbutton 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 pushbutton 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 gunhouse with an air supply passage leading to the fan set and duct. The ON-OFF and speed selection pushbutton control is located in the turret officer's booth on the transverse bulkhead (left end).

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 gunhouse 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 right gun chamber adjacent to the gun captain's station.

Set 4 supplies air to the center gun chamber of the gun chamber below the shelf plate. The system intake and supply trunk is at the rear of the gunhouse (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 gunhouse with a vertical air passage aft of the fan set. The ON-OFF and speed selection pushbutton control for this system is located in the turret officer's booth on the transverse bulkhead (right end).

LEGEND FOR FIGURE 16-1.

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 projec-

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

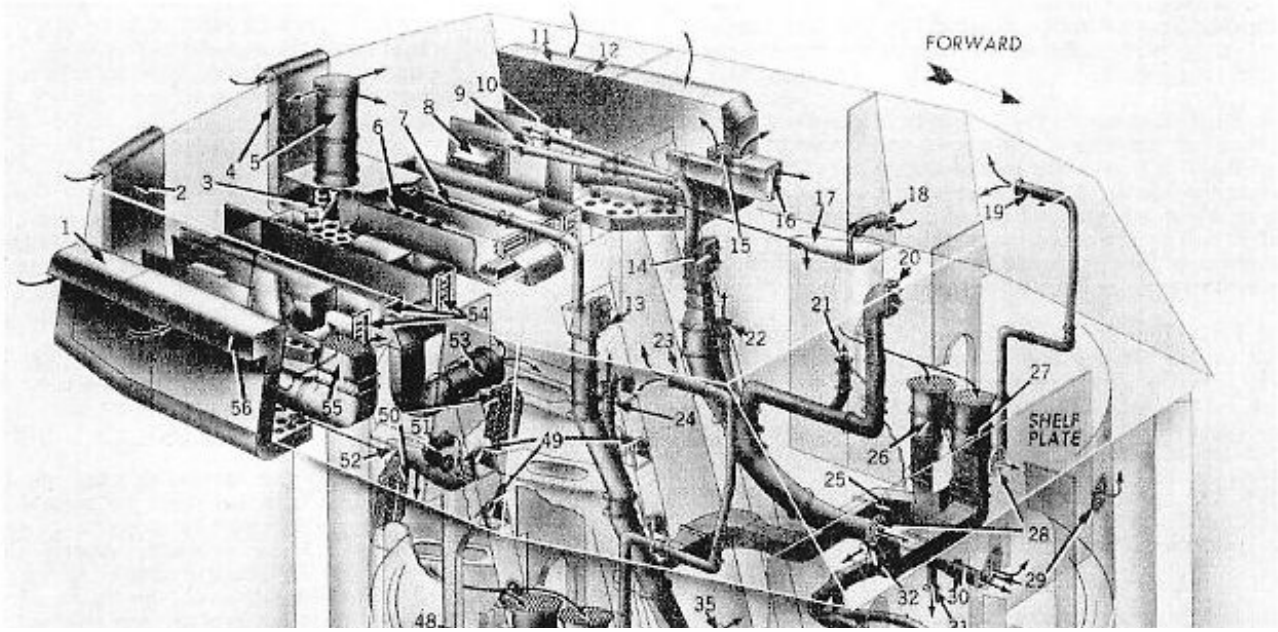
9. Air supply duct, center hoist operator's station
10. Air supply duct, left hoist operator's station
12. Intake and supply trunk
14. Automatic air supply shutter
16. Air supply duct, left and center powder hoist machinery space
17. Air passage opening
19. Air supply duct, left sight station
20. Automatic 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

the 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

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



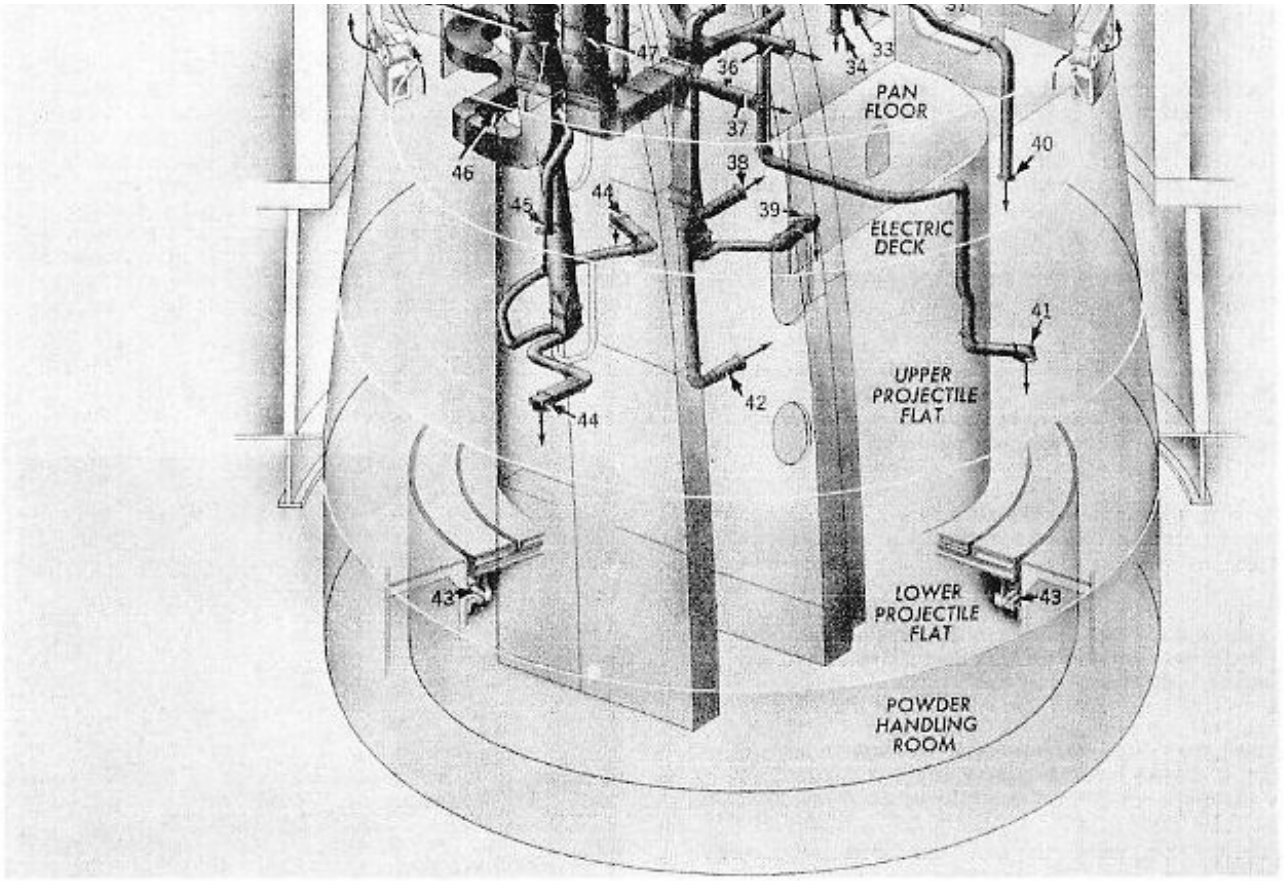


Figure 16-1. Turret Ventilating Systems. General Arrangement

16-3

Set 2 supplies air to the right 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 gunhouse (common with the intake and supply trunk for Set 1). The ON-OFF and speed selection pushbutton 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

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 pushbutton stations. Each pushbutton station is labeled with a designation of the system it operates.

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 gunhouse with a vertical air passage aft of the fan set. The ON-OFF and speed selection pushbutton 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 gunhouse (common with the intake and supply trunk for Set 3). The ON-OFF and speed selection pushbutton 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 (fig. 16-2) in the powder hoists and box girders prevent 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.

Sprinkling system

The turret sprinkling system shown in figures 16-3 and 16-4, provides a quick and efficient means of sprinkling all ammunition in the turret - whether in the ammunition hoists, in the loading trays, or ready for loading at the gun breech. It is an electrically and hydraulically operated system which permits selective or over-all control of sprinkling from both local and remote stations within the turret, as well as from a station outside the turret.

General arrangement. The sprinkling system includes a primary source of water from the ship's fire main, 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.

Turret firemain tubing. Water from the ship's fire main is led up to a pipe manifold (fig. 16-14) located in the non-rotating structure of the powder handling room. Connected to a globe valve at the top of the manifold, a 2.50-inch diameter fire hose connects fire main water to a 2.50-inch copper-nickel alloy tube in the turret rotating structure. This tube, fitted with a globe valve at its lower end (fig. 16-13), extends vertically upward adjacent to the right powder hoist trunk. The tube extends to the sprinkling tanks and to all sprinkling-head operating valves.

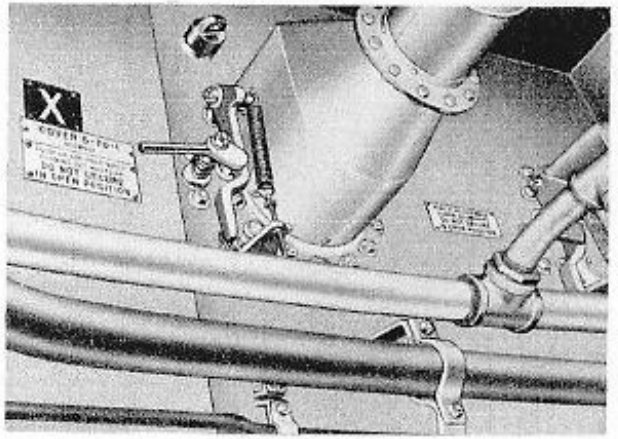
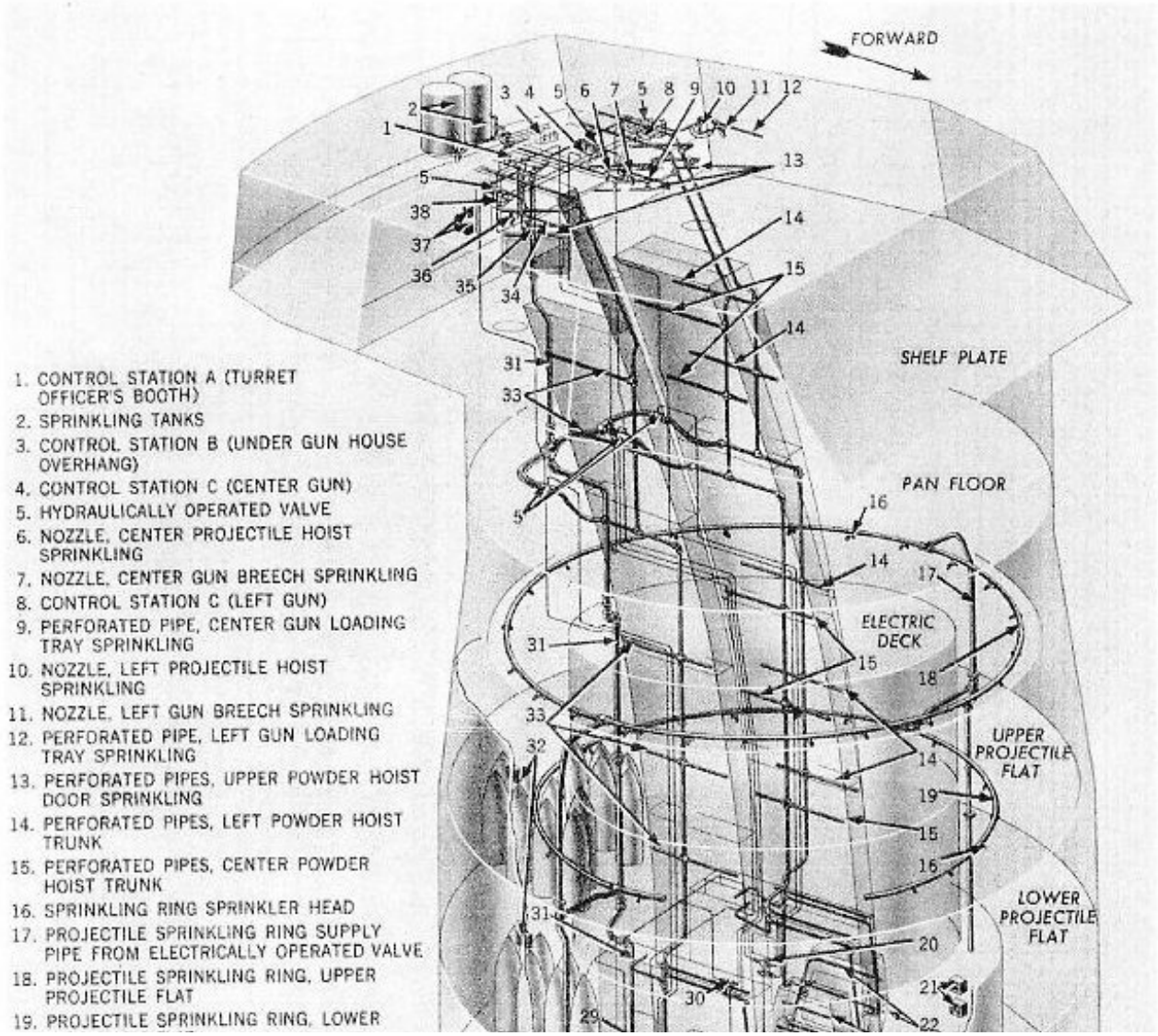
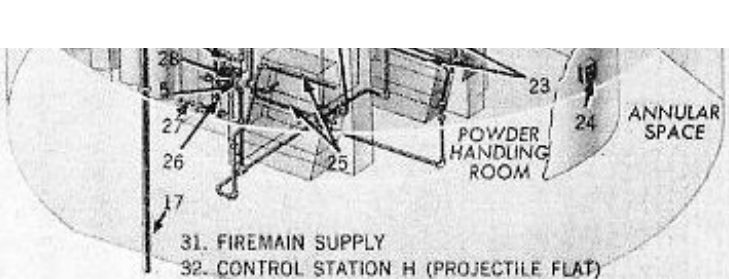


Figure 16-2. Ventilating System Air Exhaust Shutter, General Arrangement

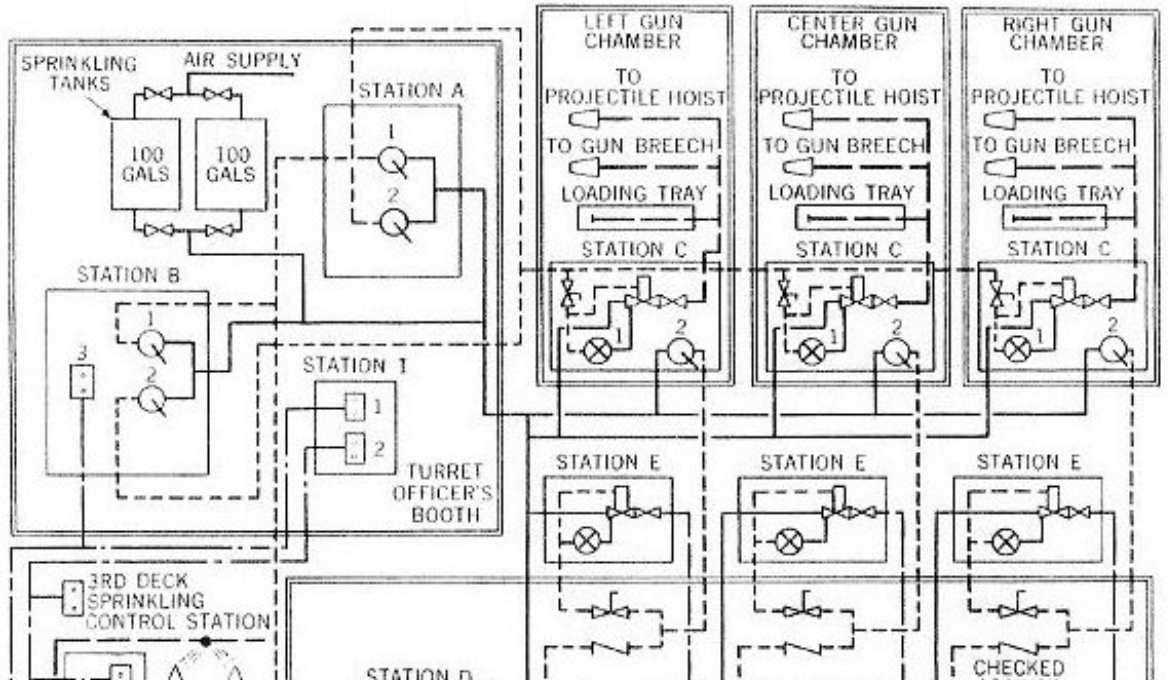

FORWARD
SHELF PLATE
PAN FLOOR
ELECTRIC DECK
UPPER PROJECTILE FLAT
LOWER PROJECTILE FLAT
1. CONTROL STATION A (TURRET OFFICER'S BOOTH)
2. SPRINKLING TANKS
3. CONTROL STATION B (UNDER GUN HOUSE OVERHANG)
4. CONTROL STATION C (CENTER GUN)
5. HYDRAULICALLY OPERATED VALVE
6. NOZZLE, CENTER PROJECTILE HOIST SPRINKLING
7. NOZZLE, CENTER GUN BREECH SPRINKLING
8. CONTROL STATION C (LEFT GUN)
9. PERFORATED PIPE, CENTER GUN LOADING TRAY SPRINKLING
10. NOZZLE, LEFT PROJECTILE HOIST SPRINKLING
11. NOZZLE, LEFT GUN BREECH SPRINKLING
12. PERFORATED PIPE, LEFT GUN LOADING TRAY SPRINKLING
13. PERFORATED PIPES, UPPER POWDER HOIST DOOR SPRINKLING
14. PERFORATED PIPES, LEFT POWDER HOIST TRUNK
15. PERFORATED PIPES, CENTER POWDER HOIST TRUNK
16. SPRINKLING RING SPRINKLER HEAD
17. PROJECTILE SPRINKLING RING SUPPLY PIPE FROM ELECTRICALLY OPERATED VALVE
18. PROJECTILE SPRINKLING RING, UPPER PROJECTILE FLAT
19. PROJECTILE SPRINKLING RING, LOWER

PROJECTILE FLAT
20. CONTROL STATION E (LEFT POWDER HOIST)
21. CONTROL STATION G (POWDER HANDLING ROOM)
22. PERFORATED PIPES, LEFT HOIST POWDER TRAYS
23. PERFORATED PIPES, CENTER HOIST POWDER TRAYS
24. CONTROL STATION F (ANNULAR SPACE)
25. PERFORATED PIPES, RIGHT HOIST POWDER TRAYS
26. GLOBE VALVE, FIREMAIN SUPPLY
27. HOSE CONNECTION, FIREMAIN SUPPLY
28. CONTROL STATION D (POWDER HANDLING ROOM)
29. CONTROL STATION E (RIGHT POWDER HOIST)
30. CONTROL STATION E (CENTER POWDER HOIST)



31. FIREMAIN SUPPLY
32. CONTROL STATION H (PROJECTILE FLAT)
33. PERFORATED PIPES, RIGHT POWDER HOIST TRUNK
34. PERFORATED PIPE, RIGHT GUN LOADING TRAY SPRINKLING
35. NOZZLE, RIGHT GUN BREECH SPRINKLING
36. NOZZLE, RIGHT PROJECTILE HOIST SPRINKLING
37. CONTROL STATION I (TURRET OFFICER'S BOOTH)
38. CONTROL STATION C (RIGHT GUN)

Figure 16-3. Turret Sprinkling System. General Arrangement



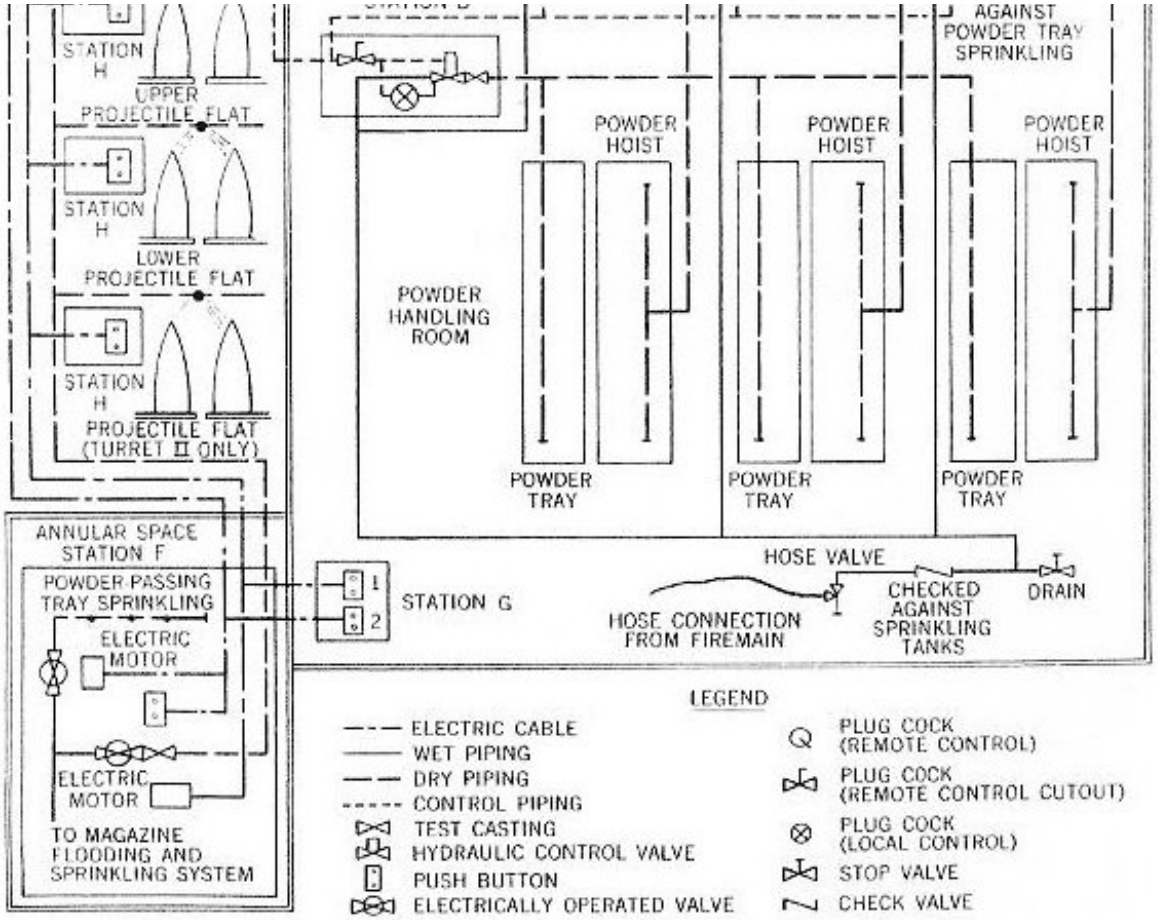


Figure 16-4. Turret Sprinkling System. Schematic Diagram

Sprinkling distribution system. The sprinkling system section described in the preceding paragraph is the wet sprinkling piping (fig. 16-4). During normal turret operation, this tubing contains water at all times. All wet sprinkling piping is copper-nickel alloy, seamless pipe and tubing. Fittings are flanged or socket-type, bronze, silver-soldered, and threaded bronze. Connected to this section is the dry sprinkling piping which leads to and sprinkles the various ammunition units. In normal turret operation this piping contains no water. Only when the complete system, or a portion thereof, is operated do these pipes contain water. All dry sprinkling pipes are brass seamless tubing with brass or bronze fittings, silver-soldered or threaded in position.

The dry sprinkling piping for the powder hoists is connected to the fire main through four hydrau-

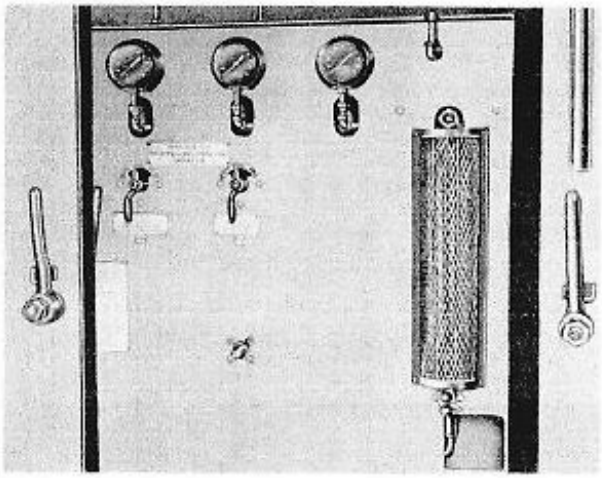


Figure 16-5. Magazine Sprinkling Control Station in Annular Space. General Arrangement

lically operated control valves located in the powder handling room. Piping leading from the valves is mounted on the exterior of the hoist trunks with 3/4-inch perforated sprinkling pipes extending into the trunks at five places (six places in turret II) from

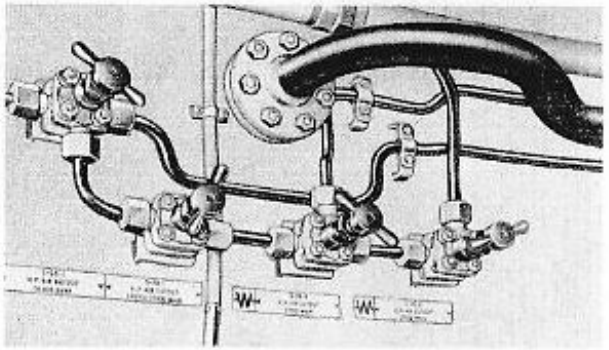
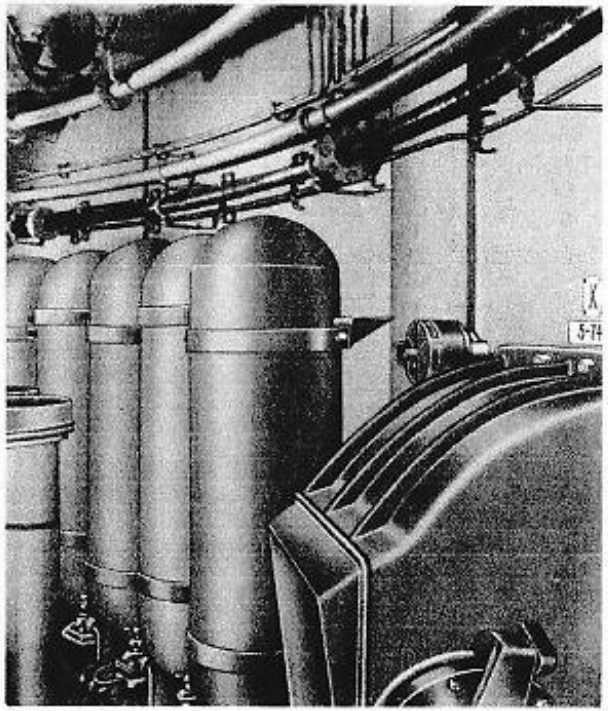


Figure 16-7. High Pressure Air System, Cutout Valves. Lower Projectile Flat, General Arrangement



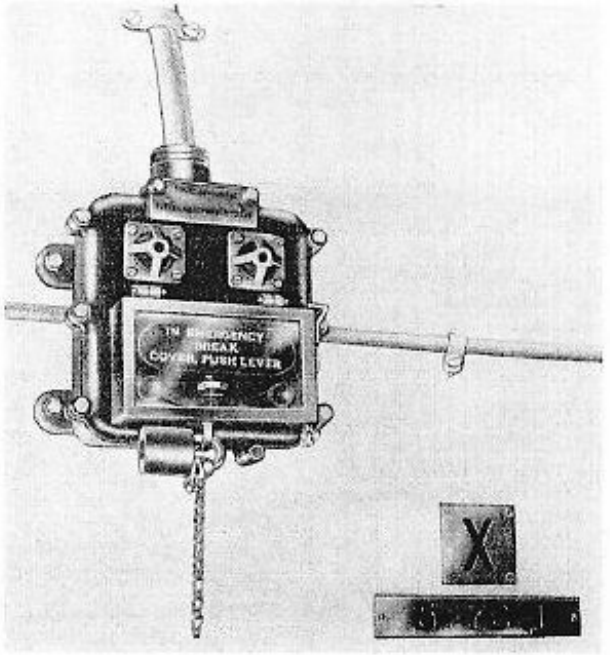


Figure 16-6. High Pressure Air Bottles in Annular Space. General Arrangement

Figure 16-8. Turret Sprinkling Control Station F

the lower end to the upper end of each. These perforations are 5/32-inch in diameter and are equally spaced in each pipe length. There are additional perforated sprinkling pipes at the powder trays and the upper trunk door. The arrangement is such that the powder tray or trunk and upper door of each hoist can be sprinkled individually.

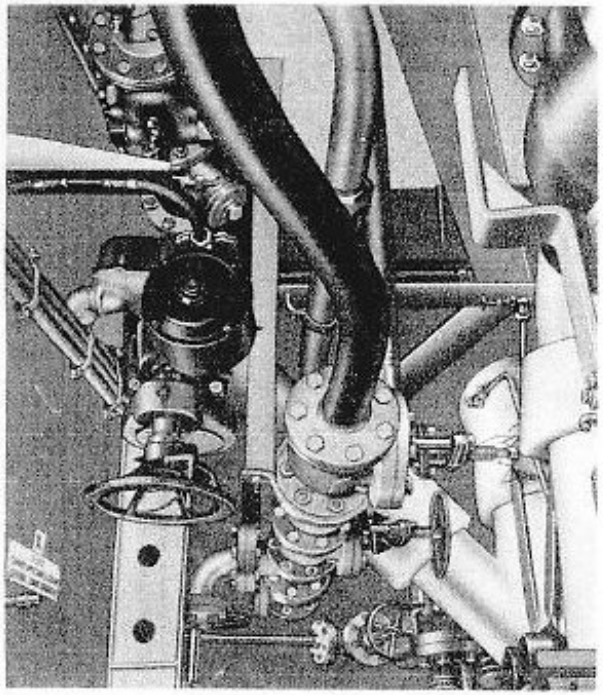


Figure 16-9. Sprinkling System Components in Annular Space

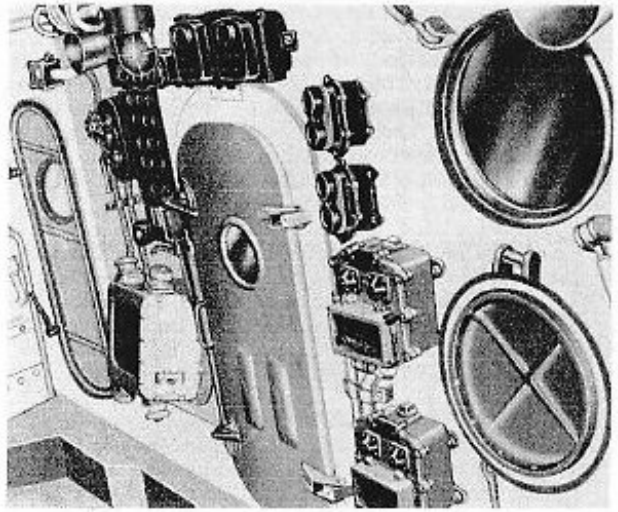


Figure 16-11. Turret Sprinkling Control Station I

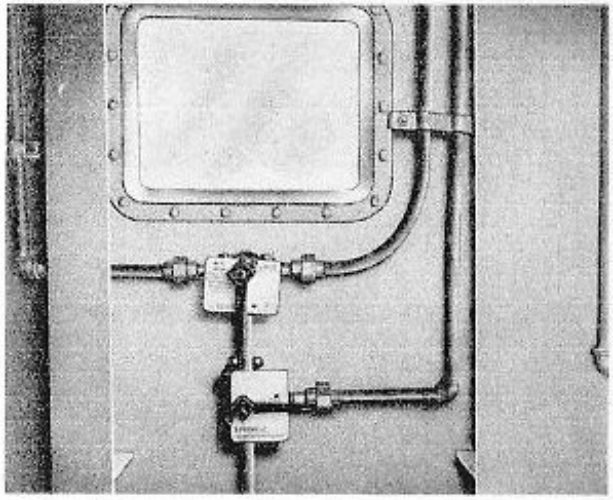


Figure 16-12. Turret Sprinkling Control Station E

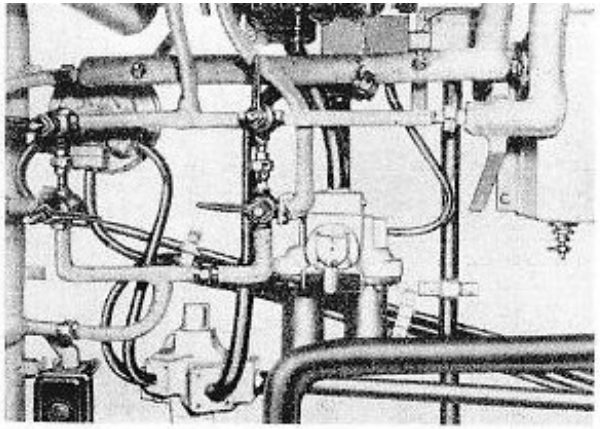


Figure 16-10. Sprinkling System Components on Electric Deck

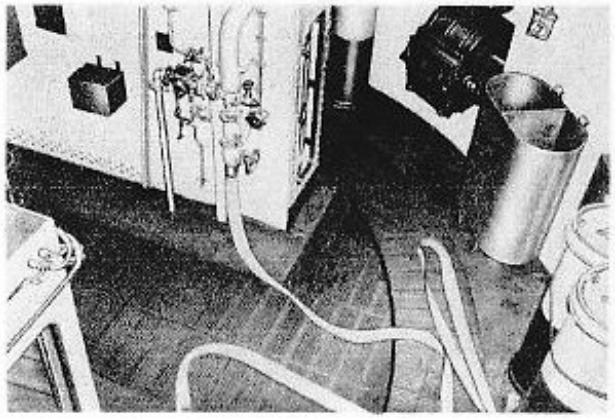
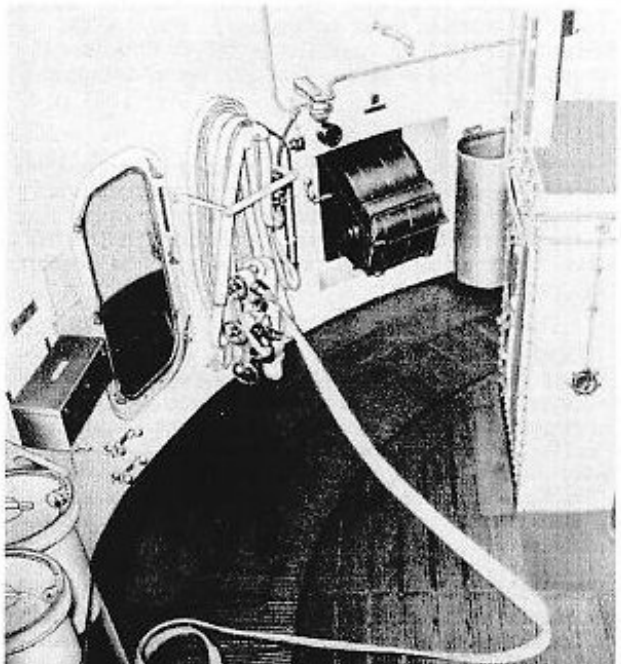


Figure 16-13. Firemain Connection in Rotating Structure

The dry sprinkling piping for the stowed projectiles is connected to the fire main through an electrically operated control valve located in the annular space outside the powder handling room (fig. 16-15). Piping leads from this valve up to the projectile flats, forming a sprinkling ring on each flat. Constructed of 2-inch pipe, the rings are mounted above and encircle the stowage areas of each flat. Each ring has 24 sprinkler heads which are equally spaced throughout 360 degrees to provide for sprinkling of every stowed projectile.

The dry sprinkling piping for the gun breeches is connected to the fire main through three hydraulically operated control valves, one located in each gun room. The installation comprises 1-1/4-inch perforated sprinkling pipes with 1-inch hose nozzles directed down the projectile hoist tubes and 1-1/4-inch hose nozzles aimed at the gun breech.



Vent and gage air piping system. A third piping system, essential to operation of the turret sprinkling system, is the vent and gage air piping system. This system uses air pressure, derived from the gas ejecting system main air supply, to maintain pressure on the water stored in the sprinkling tanks. The air supply take-off piping is fitted with a gate valve, a pressure reducing valve (dropping the pressure from175 to 100 pounds per square inch), and a relief valve (set at 105 pounds per square inch). The

piping that leads from the relief valve is fitted with a swing check valve, and with a gate valve and a three-way, two-port plug cock in the turret officer's compartment. From one port of the three-way valve, piping extends to both of the sprinkling tanks. Before entering each tank, the piping is fitted with a locked-open gate valve. From the second port of the three-way valve, piping leads to a tank vent and overboard overflow line.

The gate valve in the air supply take-off piping has a 1-1/4-inch line that leads into the turret officer's compartment and is connected to a system pressure gage. The sprinkling tanks have a 1/4-inch line that is connected to a system pressure gage.

Hydraulic control piping system. The fourth piping system within the turret sprinkling system is the hydraulic control piping system. This is an arrangement of hydraulically operated valves located to control sprinkling flow in parts of the dry pipe system. None of the sprinkling control cocks is located on the fire main. Instead, each control cock operates a hydraulically operated control valve which opens the system and permits water flow from the fire main into the dry sprinkling piping. The hydraulic control piping system utilizes water in the wet sprinkling piping, under pressure, as a control fluid.

Turret sprinkling control stations. Selective control of the turret sprinkling system is provided at both local and remote control stations (fig. 16-5). These are designated alphabetically, and consist of stations A to I inclusive.

CONTROL STATION A is located in the turret officer's compartment, left side just below the overhead. Mounted separately on the transverse bulkhead, the control station comprises 2 two-position valves, each being marked SPRINKLE and CLOSE. Valve 1 controls powder hoist sprinkling. Turning the handle to SPRINKLE permits water to flow into the three powder hoists. Valve 2 controls gun room sprinkling. Turning the handle to SPRINKLE permits water to flow into the projectile hoist, gun breech, and loading tray in each gun room.



Figure 16-14. Firemain Connection in Non-rotating Structure

CONTROL STATION B is located beneath the turret overhang, within a glass-faced lock box. It comprises 2 two-position valves, each being marked SPRINKLE and CLOSE. There is also a pushbutton station with the indicator and lever each marked OPEN and CLOSE. Valve 1 controls powder hoist sprinkling. Turning the handle to SPRINKLE permits water to flow into the three powder hoists. Valve 2 controls gun room compartment sprinkling. Turning the handle to SPRINKLE permits water to flow into the projectile hoist, gun breech, and loading tray in each gun room compartment. The pushbutton station electrically controls sprinkling in the annular space. Pressing the lever on the end marked OPEN causes the electrically operated valve in the annular space to permit water flow to sprinkle the powder passing trays.

CONTROL STATION C. There are three C control stations, one located in each gun room compartment adjacent to the rammer operator's station. The station comprises 2 two-position valves, each being marked SPRINKLE and CLOSE. Valve 1 controls (locally) gun room compartment sprinkling.

Turning the handle to SPRINKLE permits water to flow into the projectile hoist, gun breech, and loading tray in the local gun room compartment. Valve 2 controls powder hoist sprinkling. Turning the handle to SPRINKLE permits water to flow into the powder hoist that supplies that gun room compartment.

AIR SUPPLY. In filling the sprinkling tanks, before operation, the cock is set to VENT position. After water appears at the overflow, and as soon as both tanks are free of air, the cock is set to its normal AIR SUPPLY position. Should any sprinkling control valve be operated, water will be supplied from the sprinkling tanks or directly from the fire main, depending upon which is under higher pressure. Should air appear at the sprinkling noz-

CONTROL STATION D is located in the powder handling room. It comprises a two-position valve marked SPRINKLE and CLOSE which controls powder tray sprinkling. Turning the handle to SPRINKLE permits water to flow into both levels of the powder tray assemblies.

CONTROL STATION E. There are three E control stations (fig. 16-12), one located on each powder hoist trunk in the powder handling room. The station comprises a two-position valve marked SPRINKLE and CLOSE which controls powder hoist sprinkling. Turning any of the three handles to SPRINKLE permits water to flow into the powder hoist that the valve is mounted on.

CONTROL STATION F, located on the outer bulkhead in the annular space is a glass-faced lock box pushbutton station with the indicator and lever each marked OPEN and CLOSE (fig. 16-8). It electrically controls sprinkling in the annular space. Pressing the lever on the end marked OPEN causes the electrically operated valve in the annular space to permit water flow to sprinkle the powder passing trays.

CONTROL STATION G is located on the bulkhead in the powder handling room. It comprises two glass-faced lock box pushbutton stations with the indicator and lever of each marked OPEN and CLOSE Pushbutton station 1 controls projectile flat sprinkling Pressing the lever on the end marked OPEN causes the electrically operated valve in the annular space to permit water flow to sprinkle all projectile flats. Pushbutton station 2 controls sprinkling in the annular space and operated identically to the pushbutton at control station F.

CONTROL STATION H. There are three H control stations, one located on the outer bulkhead of each projectile flat. They are identical glass-faced lock box pushbutton stations with the indicator and lever each marked OPEN and CLOSE. Each station controls projectile flat sprinkling and operates identically to pushbutton station 1 at control station G.

CONTROL STATION I. There are two I control stations (fig. 16-11), both located on the transverse bulkhead in the right side of the turret officer's compartment. They are identical glass-faced lock box pushbutton stations with the indicator and lever each marked OPEN and CLOSE. Pushbutton station 1 controls sprinkling in the annular space (fig. 16-9) and operates identically to the pushbutton at control station F. Pushbutton station 2 controls projectile flat sprinkling and operates identically to pushbutton station 1 at control station G.

Air control plug cock. Adjacent to sprinkling control station A is the turret officer's three-way

zles, it indicates that the sprinkling tanks are empty. To continue sprinkling, it is necessary to close the gate valve (marked AIR TO SPRINKLING TANKS) fitted into the system piping before the three-way valve. This is necessary to relieve the air pressure within the system, which may build up greater pressure than firemain pressure, preventing filling or sprinkling. Sprinkling tanks are filled with water at all times, but air pressure is not added to the tanks until preparing for battle condition.

Testing system operation. A combination flush-out and test plug assembly is provided to test the operation of the hydraulically operated control valves. The test should be performed at least once a week on all hydraulically controlled valves. To test, the cover must be removed from the bottom of the valve, and the test plug assembly screwed in all the way, until solidly engaged. With the test plug assembly installed, any one of the sprinkling control cocks controlling the valve may be turned to SPRINKLE.

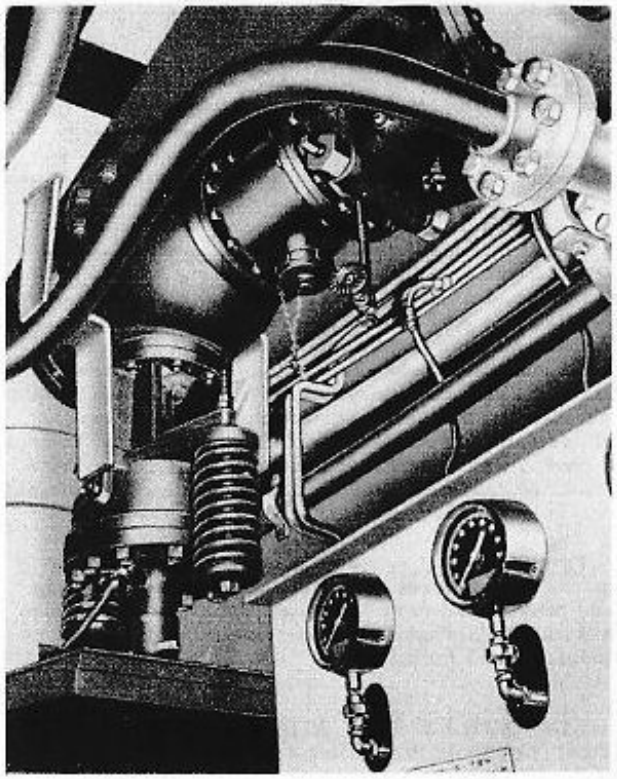


Figure 16-15. Electrically Operated Sprinkling

air control plug cock which is marked VENT and

Control Valve

CAUTION: Make sure that the proper control cock is operated. Should a control cock be turned which operates another hydraulically controlled valve, sprinkling will ensue.

After opening the control cock, open the pet cock at the bottom of the test plug assembly. If water flows, the valve is serviceable. If there is no water flow, replace the valve. To complete the test, it is necessary to reset the open sprinkling cock to CLOSE position, then remove the test plug assembly and install the bottom cover.

Counterrecoil air charging system

The counterrecoil air charging system provides a source of high pressure air (figs. 16-6 and 16-7) for the counterrecoil system. Air from the high pressure air bottles in the annular space flows through a portable pipe connection to a turret pipe system. The pipe system leads upward to a separator in the rear part of the center gun pocket. Refer to chapter 4 for detailed description of the counterrecoil system.

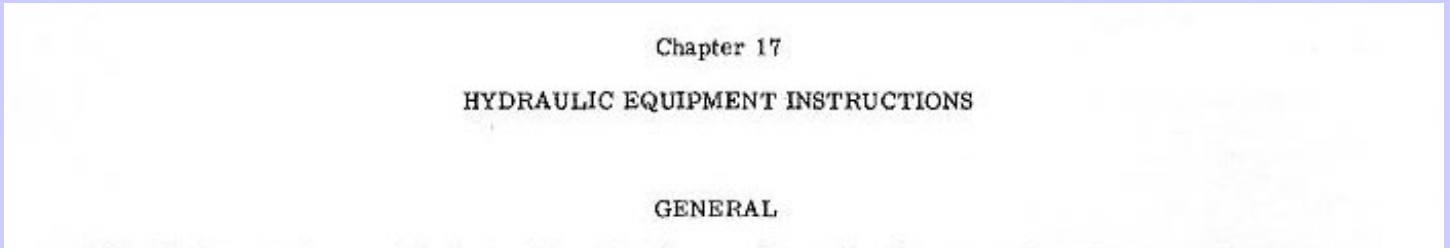
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CHAPTER 17 HYDRAULIC EQUIPMENT INSTRUCTIONS



Chapter 17

HYDRAULIC EQUIPMENT INSTRUCTIONS

GENERAL

This chapter contains specific instructions for the care and operation of hydraulic power equipment. In all hydraulic equipment, and particularly hydraulic regulator units, the fine clearances of valves, pistons, and plungers, and rotating vanes and other devices - necessitate great care when installing and servicing, in order to prevent fouling, etching, seizing and similar malfunctions. Cleanliness is of the utmost importance. Every possible effort must be exerted to keep foreign matter out of the system. More trouble and unnecessary delay are caused by foreign matter in systems than by any other source of trouble. Cleanliness at all times in the handling of hydraulic equipment cannot be overemphasized. Procedures for care and maintenance of all hydraulic gear are prescribed in the following paragraphs.

Purpose of instructions

The purpose of these instructions is to provide necessary information to install and maintain hydraulic equipment properly, so that maximum performance may be obtained from the units. Hydraulic drives of ordnance equipment are rugged, proven machines, of types that are manufactured, inspected, and tested with such care that, if properly handled, installed, and maintained, they will operate satisfactorily for an indefinite period of time. Satisfactory operation is designed performance of power output, speed, and control. These factors are essential to accurate gun laying and retention of the turrets designed rate of fire with good patterns.

Adherence to prescribed instructions will eliminate firing delays and repair work, and will prevent injury to personnel and equipment. A correctly installed hydraulic system, exercised daily and serviced with extreme care, will not only retain design characteristics of power, speed, and control, but will eliminate expensive dismantling and replacement cost. The turret installations do not require a general overhaul on each occasion of the ship's overhaul at navy yards if all instructions are observed and practiced. Thus the hydraulic drive instructions of preceding chapters and the installation and maintenance instructions below, are important to the turret crew and are vital to turret-gunnery efficiency.

INSTALLATION INSTRUCTIONS

Initial installation

When installing the various pipes, pumps, filters, and fittings of a hydraulic system, be sure that they are absolutely clean, free from scale and all kinds of foreign matter. A new hydraulic unit delivered from the Naval Gun Factory spares or from the manufacturer has all openings into the system closed with wooden or metal shipping covers or plugs. These must remain in place until immediately before connection into the system.

All dirty work in progress in the installation area must cease, and the air must be free of dust, fumes which may condense, or any other foreign matter which may foul freshly opened leads. All personnel in the turret should be cautioned against sweeping or using compressed air to clean the working area, while the unit is being installed. Clean, lint free cloth should be used for wiping hydraulic parts. The use of waste material is undesirable because it is rarely clean and shreds are easily snared inside hydraulic pipes and units. If temporary closures are necessary, plugs or caps of such size that close but cannot get into the pipes should be provided. Officers and supervisors in charge should keep the procedure under close observation at all times.

Overhauled installation

When an overhauled unit is installed in the turret, the same precautions should be observed as for installing a new unit. The overhauled unit should be flushed clean, air-dried, and all openings appropriately closed until immediately before connection into the system.

Special fitting, cleanliness

When installing a unit which requires special fitting of pipes or connections at an exposed, unsealed port, use extreme care to prevent entrance of metal slivers, fittings, or dust; thoroughly inspect the seat and the opening before closing the port. If it is necessary to bend the pipe to make a fit, the piping must be removed after bending and thoroughly cleaned. This is necessary to remove any scale that may have broken loose from the pipe while in the process of

bending. All such pipe, in addition to receiving the hot bath treatment (described on page 17-3), must be scrubbed internally with a frayed wire-rope pipe cleaner.

When drilling, welding, soldering, or other work is done on or near dismantled hydraulic equipment, keep all openings closed or covered. A thin metal covering of the same size as the port cover and with suitable bolt holes for the attaching bolts makes an excellent cover. As an alternative covering, grease-proof adhesive wrapping paper or fabric may be used. Such covers must never be removed until all metal chips, metal slivers, dirt, and other foreign matter have been removed from the area. Even a single metal chip or welding flake is enough to cause scoring of the internal parts and affect the accuracy and smoothness of operation.

Spare hydraulic equipment

Spare equipment, completely assembled but not connected for operation, cannot be stored indefinitely without deteriorating. This is particularly true of the elevation and train receiver-regulators. These units require a fill of hydraulic fluid and periodic exercise under operating pressure through full cycles of control action in each method of control selection. When such units are received for replacement installation, they should be installed with the least possible delay.

Partial installations

If the replacement schedule requires partial installation of the hydraulic equipment, the installed, hydraulic elements and all piping should be completely filled with hydraulic fluid and sealed. Hydraulic units that are not sealed accumulate considerable dirt and condensed moisture. Great care must be taken when operating a partially installed system to ensure proper lubrication of all moving parts. When the hydraulic units are completely installed and conditioned for operation under local control before the drives and automatic controls are installed or available, care should be taken that the auxiliary pumps which supply control and supercharge pressures are

sharp edges, inside and out, should be removed. If this is not done, the burr will obstruct the flow of fluid, and loose metal particles may get into the pipe line and damage the system.

Metal is removed when a pipe is threaded, thinning the pipe and exposing new and rough surfaces for chemical action. Corrosive agents work more quickly at such points than elsewhere. If pipes are assembled with no protective compound on the threads, corrosion sets in and the two sections stick together so that the threads seize when disassembly is attempted. The result is damaged or broken threads and pipes.

To prevent seizing, Permatex or some similar antiseize compound should be used on the threaded portion of the pipe after engaging the first three threads at the end. Antiseize compound should not be placed at the extreme end of the threading, because particles may enter the pipe line and damage the system. The compound should be used sparingly and on male fittings only.

Flanged pipe fitting

Flanges are used on most hydraulic pipe lines of the turret installations. They consist of a male and a female flange secured to the pipe ends with a seal placed between the joining flanges, which are then bolted together. If the flanges are designed to take a gasket, one of proper thickness must be used between the mating surfaces of the flanges in order to make a tighter connection. The gasket must be trimmed as described on page 17-4 , before installation. Flanges are occasionally screwed to a threaded section of the pipe and back-welded or brazed. The flanges are usually smooth bore-fitted units, silver-brazed on the end of the pipe. This method of assemblage eliminates any possibility of leakage between the flange and pipe.

Flanges must be squarely aligned when they are assembled together. The bolts diametrically opposite should be set up fairly tight, and the remaining bolts tightened an equal amount. Tighten each bolt an equal amount until on the last round all are equally tight.

not operated without lubrication. These pumps and the valve block units of the regulators are normally lubricated by fluid circulation in the control and supercharge systems.

Threading pipe

Pipe threads must be cut clean and smooth. The dies and pipe-cutting tools must be sharp so that they will not drag metal. Threads that are not clean and smooth will fit poorly; leakage will probably result, and slivers of the poorly cut threads may enter the system. Oil should be used liberally when cutting threads.

After pipe has been cut or threaded, the ends should be inspected for burrs. All projections and

Flared pipe fitting

To obtain a firm compression connection for flared tube fitting, the ends of tubes must be flared properly. The flare is made by slipping the tube nut over the end of the tube, inserting the ball-end of the flaring tool into the tube, and rolling the side of the tool over the end of the tube to flare the tube against the nut. The seat of a good flare is smooth and even, with the flared end projecting just beyond the end of the tube nut.

When the tube is properly flared and the tube nut tightened, the flare will seat firmly in the machined recess of the tube coupling. The tube will not turn when the nut is tightened and the flare will assume

the shape of any irregularities in the machined recess making a leakproof connection.

Cleaning pipe

Great care is required when hydraulic pipe is installed in the turret. A reconditioned pipe, or a pipe that has been removed for repair or servicing of an assembly, must be thoroughly cleaned before being installed. A pipe that has been removed and repaired, or to which any new connection, vent plug, gage plug, or other fitting has been added, requires the same cleaning as a new pipe. New pipe is shipped with metal discs or plug inserts to keep dirt out. It has been factory-inspected and, although presumably clean, must be recleaned before installation. All piping must be shaped to make a perfect fit to the various hydraulic units before final cleaning. Pipes should not be forced into place to make them fit, but should be removed and reshaped. If, at the time of installation, it is found necessary to reshape or to bend a pipe even slightly, remove the pipe and repeat the cleaning procedure described below. All piping should be cleaned after all other work is finished and just prior to installation. If, for any reason, the cleaned piping is not immediately installed in a closed system it must be recleaned before assembly. After cleaning, both ends of the pipe must be sealed

7. Immerse in sodium cyanide solution (four ounces to the gallon) for four minutes.
8. Rinse in warm, fresh water.
9. Dry by compressed air.
10. Brush
11. Blow out by compressed air.
12. Seal both ends until ready to install.

Steel Pipe.

1. Treat machined surfaces and threaded parts with hot paraffin wax.
2. Dip in acid-bath solution of one part sulphuric acid and 15 parts fresh water, remove immediately.
3. Wash in fresh, cold water.
4. Immerse for one minute in a neutralizing bath of 1-1/2 pounds of Magnus Number 2-1/2 per gallon of fresh water.
5. Soak in boiling water for 10 minutes.
6. Pass frayed wire rope through pipe (rope diameter to agree with size of pipe).
7. Wash internally with fresh, cold water at high pressure.
8. Dry thoroughly (do not use waste), do not leave threads or lint in the pipe.
9. Seal both ends until ready to install.
10. Oil to prevent rusting.

Alternatively, steel pipe may be cleaned as

until ready to install. To clean pipe proceed as follows:

Copper pipe.

1. Treat machined surfaces and threaded parts with hot paraffin wax.
2. Dip in acid-bath solution of two parts sulphuric acid, one part nitric acid, and four parts fresh water.
3. Wash in fresh, cold water.
4. Immerse for one minute in a neutralizing bath of 1-1/2 pounds of Magnus Number 2-1/2 per gallon of fresh water.
5. Soak in boiling water for 10 minutes.
6. Pass frayed wire rope through pipe (rope diameter to agree with size of pipe).
7. Wash internally with fresh, cold water at high pressure.
8. Dry thoroughly (do not use waste), do not leave threads or lint in the pipe.
9. Seal both ends until ready to install. Alternatively, copper pipe may be cleaned as follows:

Alternatively, copper pipe may be cleaned as follows:

1. Immerse in lye solution to remove grease and oil.
2. Rinse in warm, fresh water.
3. Immerse in 20 percent sulphuric acid solution for one-half hour. (When sand is used in bending copper tubing, immerse in a solution of 20 percent sulphuric acid and five percent hydrofluoric acid for one-half hour. This solution is prepared by adding hydrofluoric acid to the previously prepared 20 percent sulphuric acid solution.
4. Rinse in warm, fresh water.
5. Immerse in lye solution.
6. Rinse in warm, fresh water.

follows:

1. Immerse in hot lye solution to remove grease and oil.
2. Rinse in warm, fresh water.
3. Immerse for one-half hour in 30 percent hydrochloric acid at room temperature.
4. Rinse in warm, fresh water.
5. Immerse in lye solution.
6. Rinse in warm, fresh water.
7. Immerse in sodium cyanide solution (four ounces to the gallon) for two hours.
8. Rinse in warm, fresh water and brush until smut is removed.
9. Dry by compressed air.
10. Seal both ends until ready to install.

Making pipe connections

After cleaning and during installation, hydraulic equipment shall be opened only for as short a time as necessary for making connections, then connected as quickly as is consistent with good workmanship. The actual assembly of the hydraulic unit should be done when a minimum of other work is going on in the turret. Seals or plugs should be removed from pipe openings only when the joints are completed. Maximum care must be exercised to prevent foreign matter from entering the system. Joints must never be left open or unsealed when the mechanic in charge is absent from the job.

Cases may arise where the design of the hydraulic piping system is such that certain parts of the system must be welded, brazed or soldered in place and cannot be disassembled and removed to the shop for subsequent pickling and cleaning. Such piping should be fabricated away from the job, then cleaned before being

taken to the ship. Scale deposited by welding or other heat during installation should be removed. The pipe should then be blown clear with compressed air before the section is assembled in the system.

In fitting hydraulic pipe for the exact location of flanges, it is necessary to remove the airtight seals over the ports of the hydraulic units. During the fitting of the pipe, the interior of the units should be

the equipment and will result in leaks. Stress must be minimized throughout the system.

Filling hydraulic drive systems

When a new hydraulic drive system or a drained system which has been repaired or serviced, is filled with fluid, great care must be taken to insure

protected by a blank sheet-metal gasket of the same thickness as the gasket that will be used in the joint. The airtight seal must be replaced immediately after the fitting is made or the template taken.

When the final joint is made, the inner diameters of flat gaskets must be cut back slightly, so that the gasket material does not protrude into the system.

Sealing sleeves must be seated with careful initial alignment, with the connection drawn up evenly and without canting. A distorted or marred sleeve will leak and may produce a burr as it seats.

Pipe connection test

All piping, tubing, and fittings must be subjected to a hydrostatic test before installation into the system. These tests are to be performed on a suitable test stand provided for that purpose. Perform the following operation before and during the hydrostatic test:

1. Remove the rust-preventive compound on the interior surfaces of the tubing by washing with solvent Navy Specification P-S-661, before the hydrostatic tests.
2. Water used in the hydrostatic tests must contain 0.66 ounce of neutral CP sodium chromate to a gallon of water (to retard rust formation).
3. The pipe-testing rig should be filled with water and subjected to a test pressure of approximately 50 percent more than the maximum planned working pressure for each part.
4. After the test has been completed, drain the solution from the pipe, tube, or fitting and dry the interior with compressed air.
5. After the interiors of steel pipes have been dried, apply rust-preventive compound 52C18 (Grade 2) inside and out, if the pipe is not installed immediately.
6. Seal both ends of pipe until ready to install.

Shaping and securing pipes

Piping and tubing must be accurately bent and fitted so that it will not be necessary to force a section into place to make a satisfactory connection. Piping or tubing which has a length of greater than 50 diameters between fittings, and particularly pipe or tube sections which are subject to rapid variations of pressure, must have pipe clamps or brackets, or some other support near each bend. Vibration in such tubing will affect normally smooth operation of

that the fluid is not exposed to dust, fumes, or moisture. Fill the system with the prescribed fluid and proceed as follows:

1. Assemble full containers of an adequate supply of the hydraulic fluid required for the specific system.
2. Close all drain connections and, following specific instructions for the system to be filled, pour the fluid into a 200-mesh screened funnel (a 120-mesh screened funnel may be substituted if the system is being filled with 51F23 (Ord)). Cloth or rags must never be used to filter the fluid.
3. Vent the system according to specific instructions after it has been filled.
4. Replenish the system with additional fluid until the system fluid level is at the proper level.
5. Take test samples of fluid from principal units of the hydraulic system. Examine and test each sample for foreign matter, water, sludge, and acidity as described on page 17-5. If any test is positive, drain the fluid and flush the system until satisfactory samples are obtained.
6. When the system is clean, set the controls and operate the drive as described in the instructions given in the next paragraph.

Procedure for initial period of operation

Filling and flush-cleaning operations should be performed, wherever possible, without operating the power drive of the system that is being filled. If this is not practicable, operation of the drive should be at an absolute minimum until test samples establish that the system is clean. When a new or overhauled replacement unit has been installed, flushed clean, and refilled to the proper fluid level, the following operating plan should be followed:

Set all controls at neutral and start the electric motor of the hydraulic drive. Build up response pressure of main and auxiliary pump circuits, and for ten minutes permit such circulation to take place as will occur with the controls at neutral. This circulation will be small, comprising in most systems the oil leakage through valve block ports and past valve surfaces. However, it is an important operation to remove particles at or near contact surfaces which otherwise might produce scoring. It is essential that no valves or other parts having very fine clearances be moved even the slightest amount until the system is as clean as possible.

After this period of operation, examine the screens or filters (if any), in the system, and, if any evidence of foreign matter is found, drain all oil, flush, and refill the system

such tubing will affect normally smooth operation of flush, and refill the system.

When the filters remain clean, start moving the controls, creeping very slowly and gradually building up speed and power. During such operation, watch for symptoms of valve sticking, for evidence of binding of parts, and for leaks. At the first sign of such conditions, stop operations, diagnose the trouble and correct. Do not attempt to "work out" stiffness, lag, vibration, or any other malfunction. Always stop the machine, locate and correct the trouble.

MAINTENANCE INSTRUCTIONS

General

When installing the various pipes, tubes, and fittings of a hydraulic system, it is essential that the installation instructions in this chapter be followed carefully.

Cleanliness is as important when servicing a hydraulic system as during the initial installation. The maximum possible effort must be exerted to prevent the entrance of foreign matter into the system.

After a hydraulic system has been properly installed, has been thoroughly cleaned, has passed a dynamic test, and is filled with clean hydraulic fluid of the correct specification, it should perform satisfactorily for an indefinite period. Observe the following instructions to keep the system operating properly:

1. Keep all fluid clean, neutral, and free of residue. Filters should be examined frequently after the system has been put into use. Fluid should be checked monthly (daily for a new installation) for evidence of acidity, moisture, and sludge.
2. When ships return to their fitting-out yards after the shakedown cruise, and monthly thereafter, samples from each system should be drawn and checked.
3. All residue, metal particles, and other foreign matter found in filters must be identified in order to determine the source.
4. Fluid must be filtered by pouring it into a 200-mesh screened funnel (a 120-mesh screened funnel may be substituted if the system is being filled with 51F23 (Ord)) when filling the system. Never use cloth or rags to filter hydraulic fluid. See

of trouble by observing the quickness of response and the general performance at slow speeds. It facilitates locating and isolating troubles by observing under which control selection the troubles occur. During exercise operation, watch for symptoms of valve sticking, for evidence of binding, and for leaks. At the first sign of such conditions, stop the equipment, diagnose the trouble, and correct it. Do not continue to operate in an attempt to "work out" the malfunction.

Hydraulic fluid

The fluid specified for use in the turret elevating and training gears is a special hydraulic fluid compound designated by Bureau of Ordnance Specification Number 51F21 (Ord). Hydraulic fluid designated 51F23 (Ord) is used in all other turret hydraulic systems and may be used as a substitute for 51F21 in the elevating and training gears. Both hydraulic fluids described in chapter 18, will blend if a mixture is necessary or desirable.

Use of filters to maintain fluid purity. Filters in each system must be opened, examined, and cleaned at regular periods; not less than once weekly. Foreign matter in filters must be identified as to source, if possible. The parts producing such particles must be disassembled and corrected, and replaced if necessary. When such filter evidence is apparent, the systems must be drained and flushed clean. Make certain, when filling hydraulic units, that the fluid is free from sediment and water. Fluid should be tested as described in following paragraphs, and the system should be filled as described on page 17-4. Care must be taken to keep the fluid storage drums sealed

Never use cloth or rags to filter hydraulic fluid. See filling instructions on page 17-4.

5. Maintenance instructions for each system in other chapters - and the exercise, fluid purity, and other instructions in this chapter - must be observed at all times.

Daily exercise

All hydraulic mechanisms of the turret should be exercised daily. It is not necessary to train or elevate guns to their limits, nor to put other assemblies to the limits of their cycles. Response pressure should be built up, and parts moved relative to each other, in order to prevent residue from forming and causing sticking valves. When exercising hydraulic gear, take care to operate initially in HAND and AUTO at very slow (creeping) speeds. Such operation will enable personnel to recognize the first sign

must be taken to keep the fluid storage drums sealed and in a relatively cool location.

Test for water. If the hydraulic fluid develops a cloudy appearance, need for purification to remove water is indicated. Test for presence of water is made by using a microscope with a magnification of approximately 50 diameters. Place a few drops of the fluid on a slide which has been dusted with a light coating of very finely divided dry dye, such as neutral red, which is water-soluble but not oil-soluble. Examine the specimen for staining of the bubbles in the fluid. Bubbles of water will make red stain, bubbles of air will not.

Test for acidity. Hydraulic fluid should be renewed when its acidity increases to the point where the neutralization number becomes 0.50 or higher. This number is determined by the number of milligrams of potassium hydroxide required to neutralize one gram of fluid. To test the fluid for excess acidity,

prepare a mixture of 50 cubic centimeters of alcohol, 50 cubic centimeters of distilled water, and 20 grams of the fluid to be tested. Heat the mixture to the boiling point and agitate by swirling gently. Add one-tenth cubic centimeter of phenolphthalein indicator and sufficient N/10 potassium hydroxide to produce a definite pink color. The neutralization number of the fluid is determined by the number of milligrams of potassium hydroxide added to the test sample to give this color.

Test for sediment. Hydraulic fluid may be tested for sediment content by the following procedure which requires the use of two clean test tubes and medicine droppers, and filter paper. Fill one tube 2/3 full with a sample of fresh, filtered fluid of the same specification number as the fluid to be tested. Fill the second tube with an equal amount of the fluid to be tested. Shake both tubes vigorously for 1/2-minute and then fill the medicine droppers with samples from each tube. Place ten drops of each fluid on separate pieces of filter paper. If, after a comparison is made, the sample from the system shows an appreciable amount of sediment the system should be drained, flushed, and refilled with fresh fluid.

Special shut-off valve arrangements. The turret hydraulic systems are equipped with shut-off valves which are at all times locked in either the OPEN or CLOSED position, depending on the line in which they are installed.

Maintenance of valves. All valves must be handled carefully. If a valve is dropped, a part vital to its dependable operation may be broken or deformed. Valves should be located where they are not exposed to damage from blows. They should be accessible, and it should be possible to open or close them fully. Valves should not be installed where they must carry the weight, sag, or expansion of a line.

Valves should be in the closed position during installation. Operating parts are less likely to become twisted, and areas of closure are protected. The packing in a new valve should be tightened after it has been in use a short time, but it must not become tightly compressed.

Open and close valves slowly. Do not force the disc against the seat. If a valve refuses to seat properly, open it slightly so that sediment on the

Hydraulic system service maintenance

System installations for servicing. The turret hydraulic drives include service fittings for venting, for attaching pressure-test-gages, for opening and cutting off system lines, and for maintaining turret flame-seal of compartments and spaces. These fittings have different locations in the different systems and the schematic diagram for the hydraulic drive to be serviced should be referred to.

Venting of hydraulic systems. Hydraulic systems which are not self-venting must be vented periodically. Air in a system results in noise in pump, motor, or pressure pipe line, and causes irregular operation. To vent the system, operate the unit and open the air-vent valves (located at the system high points) until the escaping fluid ceases to have a frothy appearance. If the noise still continues it is an indication of mechanical trouble, and should be checked and corrected immediately.

Gage fittings. Gage fittings consist of a gage connection boss and a gage plug. On pipes of large diameter, the gage connection boss is positioned on the pipe and brazed in place. Gage fittings on small diameter pipes actually become part of the pipe in which they are installed. Connection lines are inserted into opposite ends of the gage boss and are brazed in place. A 1/4-inch gage plug is screwed into the boss at all times except when a gage is installed.

Drain-plug fittings in pipe lines. Drain-plug fittings, as installed in the pipes of the various systems, consist of a boss brazed to the underside of the pipe, and a plug threaded into the boss. The boss is undercut at the surface of contact with the pipe and permits flush brazing.

seat will be flushed away. If the valve still fails to seat, the system must be shut down and the valve disassembled to locate and correct the trouble. Valves that have been shut when the system is hot should be tested for closure when the system has cooled.

Inspect all valves regularly. Keep them locked in the position required. Never turn a valve knob or stem with a wrench. Valves should be tested four times a year.

In disassembling, be sure that the valve is open. Do not use a long-handled wrench to release the valve. A few light hammer taps on a short wrench are more effective, and will not twist the valve.

Use only the correct tools when reassembling and be sure that the valve is in the closed position during installation. Valve repair parts should be ordered by giving the manufacturer, serial number on the valve, its size and type, and the name (and number) of the part.

Successful operation of a hydraulic system depends upon the proper operation of the valves in that system. The operator should know what valves must be open, and what valves must be closed. Always check the valve to make sure it is in the correct open or closed position before starting the system.

Improper action of a hydraulic system can often be traced to faulty valve action. This is usually due to foreign matter in the valve seat, scoring or grooving of mating parts, or plugging of openings. As a result, the valve may stick, or may fail to close completely so that the system pressure is low, fluctuating, or non-existent.

The usual remedy for such conditions is to disassemble the valve, clean all parts thoroughly, replace damaged parts, and reassemble the valve.

Leakage through a valve may be due to foreign matter, to scoring of the valve, or to distortion of the valve seat because the valve is not strong enough for the system. Regrind the valve or install a new seat.

If the valve leaks through the stuffing box (around

pieces instead of two. Also, a support stool is not used. Mating surfaces of the flame seal are coated with red lead at assembly. All gaskets are tucked firmly into place before tightening the socket head screws.

For all fittings, after the socket head screws are

the packing gland), the gland must be set up by tightening the gland nut. Do not tighten too much or the stem will stick. It may be necessary to replace the packing to prevent leaking. If the stem does stick, the packing gland nut should be backed off slightly to release the packing. The stem may stick because it is rusty or dirty, and in need of a cleaning.

If the valve has been opened too far and allowed to jam, it may be necessary to use a wrench, which should be applied carefully so that the valve seat will not be damaged. If the stem threads are stripped or burred, replace the stem. Valve malfunction may be due to broken or weak springs. These should be replaced as soon as discovered.

Flame-seal and oil-stop fittings. Piping which extends from one level to another, or through a turret bulkhead, passes through flame-seal fittings which are designed to accommodate one or more pipes. When installing flame-seal fittings on the turret floor plate, first place a support stool in position on the plate and run a 1/8-inch fillet-weld around its base where it comes in contact with the plate. The flame seal proper comprises two castings, formed to the pipe contour, held together with socket head screws, nuts, and lockwashers. Each half of the casting is bolted to the support stool with socket head screws, nuts and lockwashers. Sheet gaskets 1/16-inch thick separate the flame seal from the top of the support stool and the outside of the pipe. Mating surfaces of the flame seal are coated with red lead at assembly.

Flame seals installed in turret bulkheads differ from the floor seals in that they consist of three

tightened, nuts are tack-welded in place.

Precautions for hydraulic system dismantling and servicing

Satisfactorily operating hydraulic systems. Do not open hydraulic systems which perform satisfactorily and which show no evidence of sludge, rust, or malfunction. Keep all cover nuts tightly secured to discourage removal without good reason.

Operating precautions - instructions for engineering assistance. Systems which are operating unsatisfactorily, and for which the trouble and correction cannot be ascertained, must not be operated, except in emergency, until replacement can be made or until a representative of the manufacturer can be secured to make correction. If it is deemed advisable to request a service engineer from the manufacturer, the request must be accompanied by a complete report about the abnormal characteristics. If parts are damaged, explain the phase of operation in which the casualty occurred. Such a report will facilitate restoring equipment to service.

Ordering replacement parts. When ordering replacement parts for hydraulic equipment, give the manufacturer, the manufacturer's piece number (from the piece), the ordnance number (from the drawing), and the name of the part and a description of it. Inspect mating or attached parts for evidence of damage. Order replacement parts, similarly, if they are required.

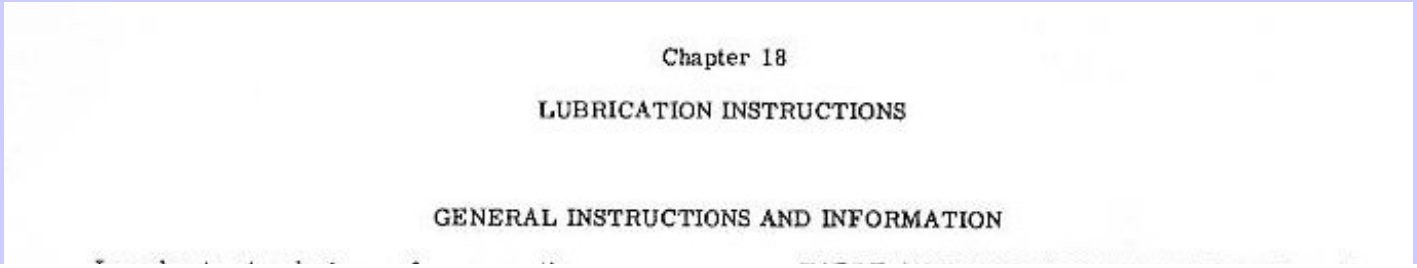
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TITLE AND FORWARD

CHAPTER 18 LUBRICATION INSTRUCTIONS



Chapter 18

LUBRICATION INSTRUCTIONS

GENERAL INSTRUCTIONS AND INFORMATION

In order to give design performance, the many types of ordnance equipment and mechanisms installed in the turret require regular application of appropriate lubricants. For proper lubrication of equipment ranging from heavy-duty instruments, several kinds of oil, grease, and compounds must be applied at different specified times or intervals. Every moving component of automatic equipment used in the turret must be regularly and properly lubricated to ensure efficient turret operation. Regardless of difficulty of access, all mechanisms must have proper lubrication at all times. It is vitally important that the instructions on the lubrication charts, in the preceding chapters, and in the following paragraphs be adhered to at all times.

Turret lubrication facilities

All bearing surfaces and moving parts of all turret assemblies have provision in the design for lubrication. The access facilities include pressure fittings, grease cups, cover plates, filling caps, and other devices, the positions of which are shown on the lubrication charts. Certain fixtures and mechanisms have sump or reservoir arrangements, and some are equipped with self-contained circulating systems. Moving parts within the hydraulic units are lubricated by the fluid which circulates within the systems. Special fluid is prescribed in each instance for such systems.

Selection of lubricants

The selection of lubricants for the various bearing surfaces is based on design and service use. The oils, greases, compounds, and fluids specified by the lubrication charts are tabulated below.

TABLE OF PRESCRIBED LUBRICANTS

LUBRICANT NAME		PRESCRIBED SYMBOL
MIL-L-15016	Lubricating Oil, General Purpose MS 3042, MS 3150	
MIL-O-6082	Oil, Lubricating, Aircraft Engine MS 1065	
51F21(Ord)	Fluid, Power Transmission	

TABLE OF PRESCRIBED LUBRICANTS (cont)

LUBRICANT NAME		PRESCRIBED SYMBOL
51F23(Ord)	Fluid, Hydraulic	
MIL-G-16908 (BuOrd)	Grease, Bearing	
MIL-L-3503	Lubricating Oil, Preservative, Light	
MIL-L-3572	Lubricant, Colloidal Graphite in Oil (Grade C - Heavy)	
NAVORD OS 1400	Lubricant, Worm Gear	
MIL-L-7866(Aer)	Lubricant, Molybdenum Disulfide	
MIL-L-16785(BuOrd)	Lubricating Oil, Breechblock	

Lubricant reference information. All materials of the above list are described and their limiting characteristics and purposes are defined, in "Lubrication of Ordnance Equipment, Ordnance Data 3000 Revision B." This publication is a reference book of general information prescribed for lubrication care of the 16-inch turrets.

Adulterants

Detection of harmful adulterants. For the purpose of sabotage, a wide variety of soluble, corrosive, gumming, and generally harmful agents may be added to lubricating oils and compounds. The detection of soluble adulterants in petroleum products requires tests that can be performed only by trained personnel with appropriate testing equipment. However, if there are indications of the presence of solid insoluble abrasives such as emery, carborundum, silica, pumice, etc., detection may be made by diluting a drain sample of the oil or grease with several volumes of gasoline (or solvent P-S-661) and filtering the mixture through chamois. If the presence of harmful agents in any lubricant is suspected, do not use it. Operate the equipment with an approved substitute of known purity. For the essential purity of hydraulic fluids, refer to chapter 17.

PRINCIPLES OF GOOD LUBRICATING PRACTICE

Effective and efficient lubrication maintenance depends on certain fundamental principles and practices indicated in the following paragraphs:

Function

The primary purpose of a lubricant, whether oil or grease, is to maintain an unbroken oil film between the surfaces of moving and stationary elements or moving parts. The oil film is intended to reduce friction and thus prevent excessive heat and rapid wear. Another function is to protect the surfaces from moisture, fumes, and acids -- thus preventing rust and corrosion. To apply and maintain the required oil film, various types of devices are incorporated in the turret mechanisms.

Frequency

The lubrication charts prescribe application of lubricants at regular periods. The periods are given as "Daily," "Weekly," and "Monthly," or with alternative "period of operation." In addition, other periods are designated on the charts or in the instructions of preceding chapters for certain parts or mechanisms as "Before operating," "Before firing," "Before assembly," "After firing," and "At overhaul." These prescribed intervals are essential to good operation and preservation.

Distribution

Unless the lubricants are properly distributed over the bearing surfaces, the parts may become galled or scored, and in some cases become seized or frozen. To ensure adequate distribution of lubricants, the equipment should be exercised during or immediately after lubrication. This obviously does not apply to elements which require the application of oils or compounds only after the gun is fired.

Lubricant distribution obtained by exercise is a design feature of the bearing, gear housing, oil bath sump, and pump supply system details of most by which it is to be applied. With antifriction bearings, the high unit pressure existing on the very small contact surfaces of the ball or roller tends to break the oil film and make the formation and maintenance of an unbroken oil film impracticable. The load is supported directly by the balls and rollers, and races which are in direct metal-to-metal contact with the moving elements of the equipment.

Because an unbroken oil film does not exist between contact surfaces of the balls or rollers and their races, the ability of these parts to support heavy loads is due to deformation or flexing action within the ball or roller. This continual flexing action generates heat which, if not dispelled by lubricants, would cause rapid wear and serious damage to the entire bearing assembly. To dispel this heat, the lubricant must be of a type and consistency to provide a proper lubricating film between the balls or rollers and the separators or cages. The lubricant must prevent rust or corrosion of the bearings and isolate them from dirt, water, and other foreign matter.

Any scratching, etching, or other destructive action, on the surfaces of the races, balls or rollers of antifriction bearings, rapidly destroys their load-carrying ability. Great care must be taken when cleaning, handling, packing, installing, and servicing all types of such bearings.

Oil used to lubricate antifriction bearings should be drained as soon as it becomes dirty, which indicates the presence of foreign matter. The bearings and related parts should be flushed with mineral oil and again drained before new, approved lubricant is applied. If the approved lubricant is grease which cakes or becomes dirty, flushing with mineral oil will not be sufficient to completely remove the grease. It will be necessary to remove the bearing, immerse it in solvent Navy Specification P-S-661, and rotate the balls or rollers until the old grease is completely removed. Cover the bearing assembly until ready to install. Apply a few drops of light mineral oil symbol 3042 to the moving parts of the bearing before packing it with grease. When packing the bearing at reassembly, apply absolutely clean lubricant to each ball or roller and use the fingers to force the grease

mechanisms. These design features comprise grease grooves in bearing surfaces, oil scoops or traps in gear housings, and pressure supply pump and pipe distribution.

Lubrication of antifriction bearings

The fundamentals of lubrication of antifriction-type bearings (ball and roller bearings) vary greatly from those involved in the lubrication of other bearing surfaces (sleeve and sliding types). In the latter type bearing, the journal load is supported by an oil film. The maintenance of this film under various speed, load, and temperature conditions influences the selection of the type of lubricant and the method

into and around each part. It is essential that all bearing parts receive a light coating of lubricant. It is not essential to completely fill all bearing cavities; most bearings operate cooler and last longer if not completely filled with grease. To pack the bearing properly, use only one-half to two-thirds of the amount it would take to fill all openings in the bearing assembly completely. This will permit lubricant expansion caused by the churning action of the parts. Unless provision is made to compensate for such expansion, the parts will overheat and oil seals will become distorted.

Caution must be used in the application of grease with the pressure gun because of the danger involved in overpacking the bearing assemblies.

There are exceptions to these general rules for grease lubrication of antifriction bearings: for example, deck lug bearings should be completely filled with grease at all times.

Excessive lubrication

Many lubricating points of the ordnance installation have limited capacity for lubricants. Sparing application is required, though in some instances the application must be frequent. Excessive lubrication can cause serious damage in addition to the exuding grease and oil. This is particularly true of turret electrical installations. Excess oil and grease destroy the insulation of power and communication leads, cause malfunction of switches and solenoids, and ruin motor armatures. All motors must be sparingly lubricated, and the excess lubricant accumulation in motor cases and at the grease retaining basins of main shaft bearings of some designs must be removed by opening the drains at least once a month.

Enclosed gear boxes with provision for oil-bath lubrication will overheat and may cause splash penetration into adjacent switch and motor units if the lubricant is added above design level. All such units are equipped with high- and low-level trycocks or plugs, or an oil gage. Units to which these instructions particularly apply are the motor base bearing

Preservation

Many of the parts of the gun, the slide, the power drives, and the control and securing devices of the turret installations are exposed finished-steel surfaces that cannot be preserved by painting. "Easy victims" for rust corrosion, they must be constantly observed and coated with prescribed lubricants of other preservatives. This lubrication principle applies particularly to "After firing" application of preservative coating to the bore and powder chamber, all bright work of the breech mechanism, and the exposed portion of the gun slide. It is not sufficient merely to apply the preservative coating. The surfaces must first be thoroughly cleaned, and all finger and hand impressions must be neutralized and wiped dry.

Substitution

The most important principle of good lubrication practice is consistent adherence to the lubricating plan. More damage can be done to ordnance equipment by mistaken judgment in selection of lubricants than will occur if the lubricant is omitted. Careless substitution can cause serious casualties and will result inevitably in poor performance. Substitution of a heavy lubricant (or one not proper for expected cold weather) in housed mechanisms that are lubricated by oil bath will groove the lubricant, resulting in damaged gear teeth and overheated

brackets of the parbuckling gear assemblies, the rammer reduction gear, and the projectile ring pinion drive speed reducers.

Cleanliness

When handling, applying, and storing lubricants, the importance of cleanliness cannot be overstressed. Because the lubricant comes into direct contact with the bearing surfaces of moving elements, the presence of foreign matter in the lubricant will quickly cause serious damage to the vital parts. To prevent such damage by contaminated lubricants, the following rules must be observed:

1. Always use clean, fresh lubricants when refilling oil or grease reservoirs and when applying greases or compounds to bearing surfaces.

2. Always make sure that the lubrication guns and equipment, as well as the hands, are free from dust, dirt, chemicals, moisture, or other foreign substances.

3. In the instance of disassembled grease-lubricating bearings, the old grease must be completely removed, and the bearings and housings must be washed thoroughly before the fresh grease is applied.

4. Always store unused lubricants in waterproof and dustproof containers with the cover securely seated.

resulting in damaged gear teeth and overheated, galled, and seized bearings. Similarly, substitution of grease for the light preservative oil in sight and gun attachment mechanisms will cause signal error in the shaft transmission system due to frictional-torque. Avoid trouble by always using the lubricants prescribed by the lubrication charts.

Temperature variations

The oils, greases, and compounds specified on the lubrication charts are for use under all normal operating conditions and temperatures. In extremely cold weather, some of the greases and oils may congeal to a point which precludes satisfactory application, distribution, and operation. When this occurs, the parts affected and the associated oil grooves, reservoirs, feeding channels and fittings should be thoroughly cleaned. Care must be taken to prevent trapping of appreciable quantities of any cleaning fluid in the operating mechanism. Where internal grooves cannot be reached for manual cleaning, light oil should be injected at the lubrication point. After application of the light oil, the equipment should be wiped dry and liberally coated with a light mineral oil to provide adequate lubrication. The oil should be one which will not congeal to a point where adverse operation effects may be encountered. Such application must be repeated more frequently than prescribed by the chart. Systematic inspection must be made at regular intervals to ensure that there will be no rusting of working parts. Immediately upon return to regions where operation temperatures are within the higher ranges, the original specified lubricants should be restored.

LUBRICATION CHARTS

Detailed lubrication instructions for all turret assemblies are given on the series of lubrication charts listed below. The charts are designed to ensure that no lubrication point will be missed, and that the frequency of lubrication will be adequate under all service conditions.

Lubrication Charts For

CAUTION: Neoprene gloves should be worn while handling the dry lubricant. Prolonged contact with the skin may cause dermatitis (inflammation of the skin).

Slide. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 4. There are numerous oil can lubrication points such as the plunger cover latches, and the differential indicator rod brackets.

16-Inch 3-Gun Turrets U.S.S. IOWA Class

Name of Assembly	Drawing Number
Breech mechanism	252446
Slide	252447
Deck lugs	252448
Elevating gears	252449
Training gear, above electric deck	252450
Training gear, above pan floor	252451
Rammer	252452
Projectile ring	252453
Parbuckling gear	252454
Projectile hoist	252455
Powder hoist, car, and hoist indicator	252456
Powder hoist, upper end of trunk	252457
Powder hoist, motor and speed gear	252458
Powder hoist, control stations and lower end of trunk	252459
Sight station	252460
Sight stations and shafting	252461
Rangefinder stand	252462

Detailed lubrication features

Lubrication features of all ordnance assemblies include pressure grease fittings, grease cups, and lubricant reservoirs in addition to lubricant circulating systems. Some assemblies have special fittings or features, described in the following paragraphs, for application of the prescribed lubricant.

Breech mechanism. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 3. The salvo latch mechanism, the breech plug forward and rear bearings, the gas ejector bearing pin, the rotation cam rollers, and other parts requiring daily lubrication are oil can lubrication points, some of which are equipped with ball-check fittings.

Gas check pads. Lubricate with molybdenum disulfide, MIL-L-7866 (Aer), as follows:

1. Remove all foreign matter from the surfaces of the pads with a clean dry cloth.

2. Sprinkle the molybdenum disulfide over all pad surfaces and rub it in thoroughly with a clean dry cloth coated with the dry lubricant.

3. Examine pads at periodic intervals and lubricate as noted above when required.

Deck lug. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 4. The trunnion radial and thrust bearings are lubricated through tubing connected to a manifold block mounted on the trunnion cover plate. This block is provided with four pressure grease fittings.

Elevating gear. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 5. There are numerous oil can lubrication points such as the handles on the control handwheels, the response gear coupling, and the roller and plunger of the danger zone cutout switch. The power drive flexible couplings are lubricated by removing two socket head plugs from the coupling and then filling the unit.

Training gear. Refer to the applicable lubrication charts and to the special lubrication instructions given in chapter 6.

Electric deck. Oil can lubrication points include the control handwheel handles, the neutral return hand pump handle, and the plunger and roller of the danger zone cutout switch.

Pan floor. Oil can lubrication points include the power-off brake linkage and shoe pins. The power drive flexible couplings and response gear upper bracket are lubricated by removing socket head plugs and then filling the unit.

Rammer. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 10. Oil can lubrication points are numerous and include the control lever pivot, control shaft bracket link, and linkage housing seal and clevises. The sprocket wheel roller bearings are lubricated through tubing connected to a manifold block located in the turret officer's compartment. This block is provided with pressure grease fittings.

Projectile ring. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 7. The auxiliary pump, response, and electric motor couplings are lubricated by removing socket head plugs and then filling the unit.

Parbuckling gear. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 8. The shaft bearing units are lubricated by removing plugs and then filling the units.

Projectile hoist. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 9. Oil can lubrication points are numerous and include the rack pawl shaft and plungers, tube pawl control mechanism, bell cranks, control handle bearing and solenoid plunger, and cradle latch operation shaft. The motor flexible coupling is lubricated by removing the socket head plug and then filling the unit.

Powder hoist. Refer to the applicable lubrication charts and to the special lubrication instructions given in chapter 11.

Powder car and indicator mechanism. Oil can lubrication points include the dumping trays handle latches and the lower switch lever.

Upper door, door locking mechanism sheave and safety latches. Oil can lubrication points are numerous and include the dog locking mechanism, selector lever and control lever brackets, safety latch brackets, and the locking dog operation linkage.

Motor and speed gear assembly. Oil can lubrication points are numerous and include the external cam links and speed gear control linkage, the servo selector linkage, and the valve control linkage and brackets. The motor and speed gear flexible coupling is lubricated by removing the socket head plugs and then filling the units.

Control stations and lower door. Oil can lubrication points are numerous and include the lower door sheaves, the lower door latch mechanism, the upper door dog operating mechanism, the starting lever, and the lower door limit switch levers.

Sight. Refer to the applicable lubrication charts and to the special lubrication instructions given in chapter 13. Oil can lubrication points include the pointers' and trainers' handwheel handles and seat pedestals, the telescope locking devices, and adjustable couplings.

Rangefinder stand. Refer to the applicable lubrication chart and to the special lubrication instructions given in chapter 14. Oil can lubrication points include the operators' seats, and the hood shutter-operating handwheel shaft bearings.

GENE SLOVERS
US NAVY PAGES

OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

HOME

IOWA CLASS BATTLESHIP PICTURES
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TITLE AND FORWARD

CHAPTER 19 TOOLS AND ACCESSORIES

Chapter 19

TOOLS AND ACCESSORIES

GENERAL DESCRIPTION

Turret equipment identified in this chapter comprises tools and accessories for servicing, adjusting, testing, and replacing parts of the ordnance installa- beams and sheaves, fixed whip hoists, monorail trolley-type conveyors and chain hoists, and other accessories and devices specially designed for serv-

tion. This equipment includes all devices required to secure and maintain alignments, verify positions, make repairs, replace parts, and perform "trouble shooting" tests. Included are items of special design and limited, specific use. All other items are standard, general-purpose tools of stock design and issue.

Special equipment

Wrenches, screw drivers, test outfits, gun tools, and other items designed to perform a particular operation or to hold or assemble, load, and test a single unit or class of equipment, are "special tools and accessories." They are identified and listed under that category in the listings of the following pages. Use of each item is limited to performing the operations for which it was designed.

Standard equipment

Hammers, pliers, grease guns, adjustable spanners, socket wrenches, and all similar stock items are "standard tools and accessories." They are intended for use in servicing any turret installation. All such items are identified in the following pages under the lists of "standard" tools.

Identities

Each tool is identified by an ordnance drawing part number (Navy Bureau of Ordnance), of Federal Standard Stock Catalog number, or an Item number of the Catalog of Navy Material. These identities are stamped or cast on the device or on an attached metal tag.

Types

16-Inch turret ordnance tools and accessories include various types of equipment, most of which are manually operated. Some equipment comprises engineering instruments and others are ordnance rigs for IOWA class turrets. All are classified in one of the following categories:

Ammunition handling equipment
Conditioning and preservation equipment
Servicing tools and accessories
Disassembly tools
Test and exercise apparatus

Ammunition handling equipment. Two groups of accessories are provided for handling powder and projectile units. These are Bureau of Ordnance items, identified in this chapter, and other items of Bureau of Ships cognizance. Bureau of Ships accessories include ammunition loading trunk fittings, portable ing ammunition to the turret magazine and projectile stowage.

Bureau of Ordnance equipment complements that of the Bureau of Ships. It comprises powder tank and projectile handling trucks, projectile carriers, powder tank carriers, and similar devices required for transporting ammunition when stowing.

Conditioning and preservation equipment. Principal tools and accessories for conditioning and preserving the ordnance installations are the gun maintenance items. These are the bristle sponges for cleaning the bore and powder chamber, the plug gage for locating constrictions in the bore, and the lapping head for removing such constrictions. They are supplemented by the tompion and muzzle cover which protect the gun interiors from weather.

Servicing tools and accessories. A large number of special and standard tools and accessories are provided for servicing the ordnance installation. This equipment comprises all items required for filling and charging the assemblies with liquid and air, all items for lubricating, and other devices for aligning and securing. A broad class of equipment, it is identified throughout the listings of the following pages.

The use of such items as the recoil and counterrecoil system pneumatic and fluid charging apparatus comprising the portable pipes, funnel, and pump (pages 19-11 and 19-12), and the wrenches and tools employed in charging and during performance of "running-in" operations.

Disassembly tools. Most of the standard tools and many of the special items are provided for purposes of dismantling and reassembling the ordnance installations when making adjustments, repairs, and replacements. This class of equipment includes hydraulic packing tools and socket wrenches, spanner wrenches, and other special devices for pulling and inserting the sealing elements of high pressure components.

Test and exercise apparatus. A group of important test and exercise accessories are identified in the following pages. This equipment includes hydraulic gage devices, fire control alignment and dial accuracy checking equipment, and other items. The use of equipment of this class is specified in applicable chapters.

INSTRUCTIONS

General

Special tools and all accessories are designed for specific applications and should not be used for other

purposes. Standard tools are for conventional use according to the instructions of the officer in charge. Use wrenches only when they fit the parts precisely, to avoid damaging the parts and wrenches. Do not abuse tools; proper fit of tool and engaged part minimizes wear and possibility of breakage. Improper fit may result in damage to both the tool and the engaged part. Also failure of an over-stressed tool may result in personal injury. Tools and accessories must be kept clean, properly lubricated, and in good working order. They should be cleaned and lubricated, and returned to the stowage box immediately after use. Storing instructions are given in the next column.

Operating precautions

When using any type of tool or accessory which has more than one application, be certain that the tool fits properly. Use of spanners and wrenches which are not exact fits will result in damage to the tool and to the part being worked on, and may result in injury to personnel. Use of pressure gages or other test apparatus of improper capacity may result in destruction of such apparatus. Improper fit of packing guides and oil seal leaders may result in damaged packings and oil seals. These tools must be handled with great care to prevent nicks and burrs which would damage a piston rod or cause a new packing or oil seal to leak. Before applying force to any rotating tool or wrench, examine the threads for the proper direction of rotation. Open-end wrenches must be applied with the direction of pull toward the short jaw. A steady, even application of force is preferable to a jerk or a sudden surge.

Paint or other protective coating on tools should be renewed whenever it wears thin or becomes broken. Unpainted or bright surfaces should be protected with medium preservation lubricating oil MIL-L-3150 at all times.

Service operations which require any type of rigging should be carefully planned in advance. All rigging must be adequate and secure to prevent breakage or slippage which might cause damage to tools or mechanisms, and injury to personnel. Tapped holes for eyebolts are provided for hoisting most heavy equipment. Where this provision is made, such equipment should be used in preference to blocking and cribbing.

Storing

Preservative materials must be applied over clean surfaces. All tools must be cleaned thoroughly before storing. Use a Navy-approved solvent and a wire brush to remove dirt from metal surfaces. Dry cleaning solvent, Navy (Federal) Specification P-S-661, stocked by Federal Standard Catalog No. 51-C-1326-75 in 50- to 55-gallon drums is recommended for general use in the cleaning of tools and accessories. Commercially available materials such as Stoddard Solvent and Varsol meet this specification.

After tools and accessories have been thoroughly cleaned, those which are subject to corrosion are not to be handled again with bare hands. Clean cotton or leather gloves should be worn to prevent contamination of the cleaned surfaces with perspiration.

Moisture must be removed from the surfaces that are to be coated or otherwise treated with preservative. The preferred methods of drying are:

1. Air-drying by compressed air
2. Oven drying
3. Wiping thoroughly

Choose the proper preservative material and application method for the tool being stored. The preferred methods of applying preservative are:

1. Dipping
2. Spraying
3. Brushing
4. Flowing the coating on
5. Flooding or immersion

The preservative material must be applied immediately after cleaning.

Place all instruments in waterproof cases provided for the purpose, or wrap them in waterproof material before storing.

Keep tools and accessories which have rubber elements out of direct sunlight and away from ex-

Threaded, hinged, sliding, and telescoping tools and accessories, as well as gages, should be exercised periodically to prevent rust formation, corrosion, and accumulation of dirt which might eventually make the assembly useless.

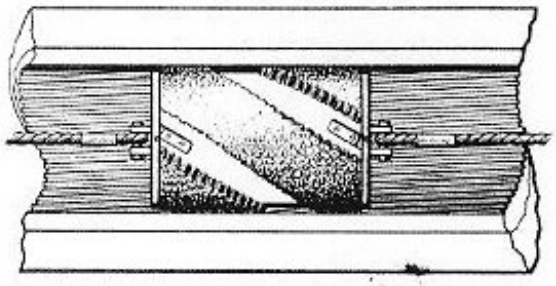
After tools have been used, return them to their designated position in the turret tool box, spare parts box, or storeroom as the case may be. Place pointed, edged, and fragile tools in racks of compartments so that they cannot be damaged by contact with other tools.

cessive heat. Do not permit oil or solvent to come into contact with rubber.

When preparing tools and accessories for indefinite storage, follow one of the recommended methods of preservation. The material applied must provide satisfactory protection over a long period of time, and be of a type which permits easy removal.

When tools are removed from storage, clean all preservative material from the tools and lubricate them with light oil.

TABLE 19-1. GUN TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Bristle sponge (bore)	8-Z-854	Clean the bore of the gun	

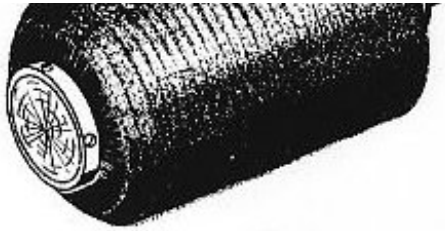
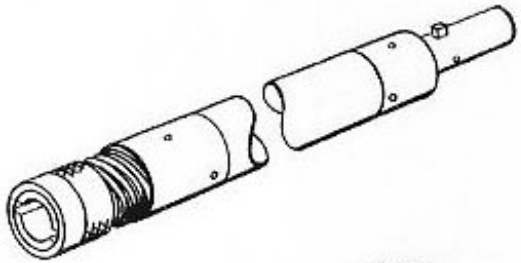
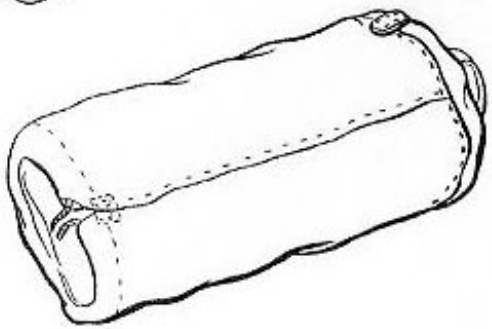
Bristle sponge (chamber)	8-Z-823	Clean the powder chamber	
Section handle	8-Z-825	With bore lapping head or similar accessories	
Bristle sponge canvas cap (bore)	8-Z-855	Protect bristle sponge (8-Z-854) when not in use	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Tompion	49830	To seal the muzzle end of the bore when	

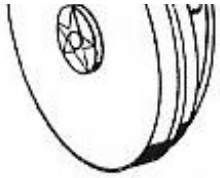
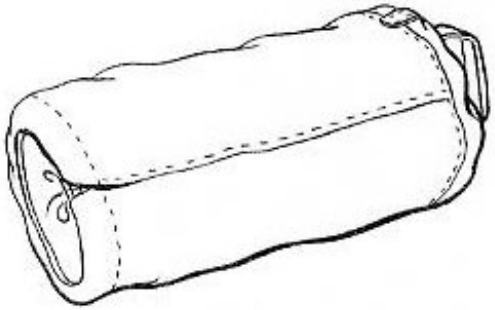
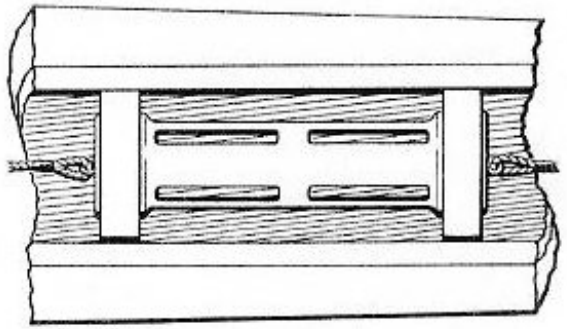
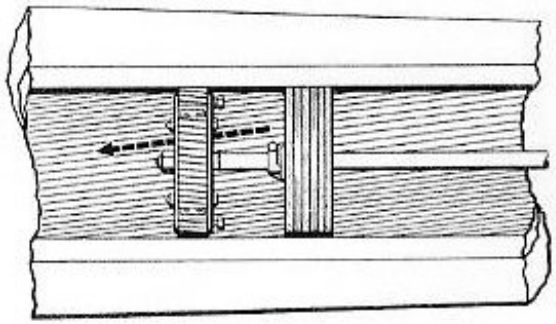
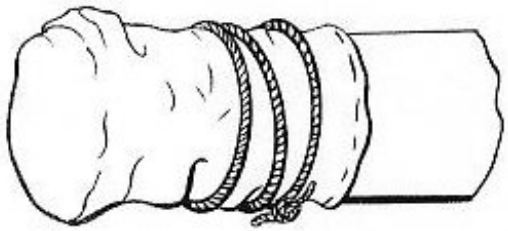
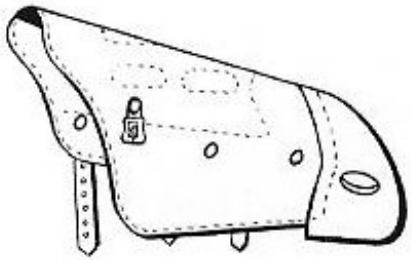
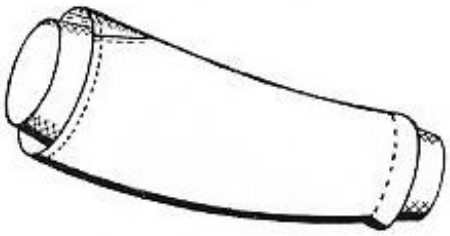
		the gun is not in use	
Bristle sponge canvas cap (chamber)	8-Z-849	Protect bristle sponge (8-Z-823) when not in use	
Bore plug gage	52120	Check gun bore for constrictions	
Bore lapping head	SK.12032	Clean bore and rifling of the gun	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Canvas cap	Fabricate locally	In addition to tompion to cover gun muzzle	
Gun captain's (base) sleeve	440598	To protect gun captain's arm when wiping mushroom after firing	
Gun captain's (cover) sleeve	440599	To protect gun captain's arm when wiping mushroom after firing	
Breech mechanism tools:			
Lifting bolt for Mason valve	50266-18	Removing the main valve	

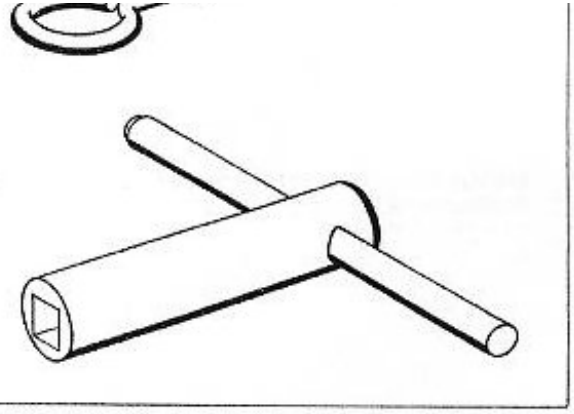
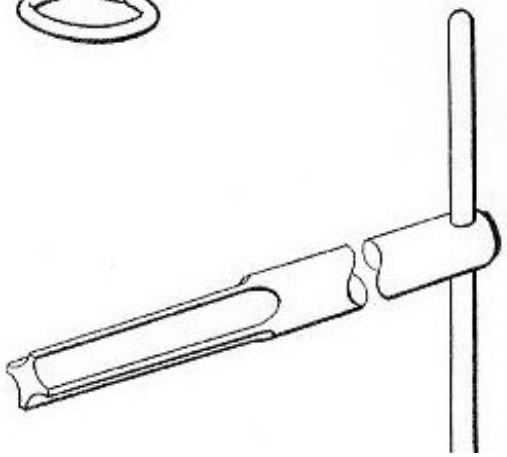
Socket wrench for Mason valve	50266-20	Adjusting the valve (air pressure)	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Vent cleaner and priming bit	8-Z-901-9	Cleaning the hole drilled through the mushroom and stem	
Primer seat cleaner	8-Z-901-10	Cleaning the primer seat (mushroom stem)	

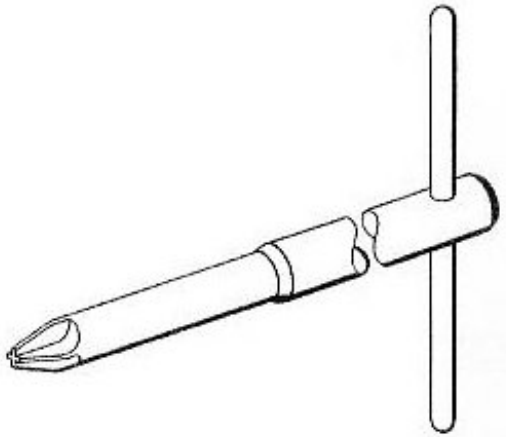
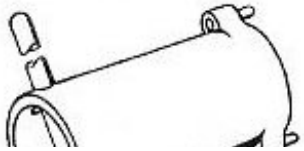
Primer vent cleaner	8-Z-901-12	Cleaning the mushroom vent hole	
Handle for primer seat and vent cleaners	8-Z-901-11	Turn primer seat and vent cleaners	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Wrench for mushroom nut	8-Z-905-2	Tighten and loosen nut on end of mushroom stem	

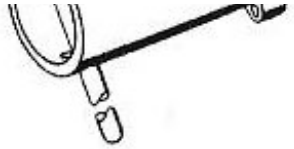
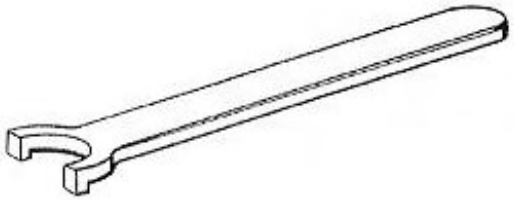
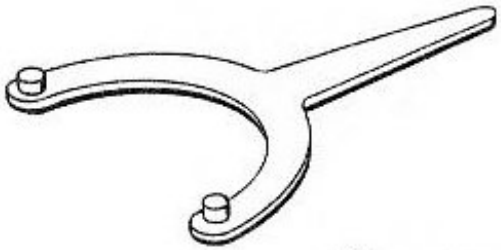
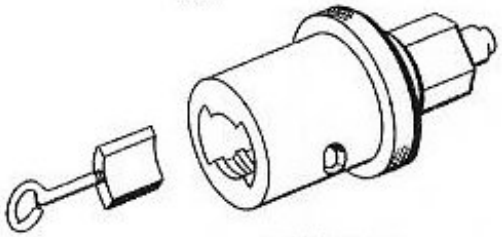
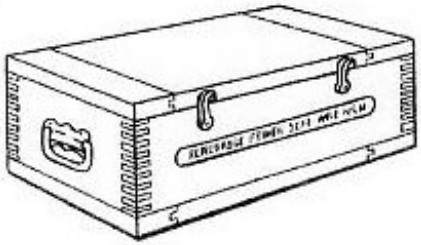
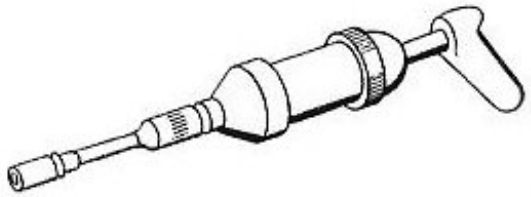
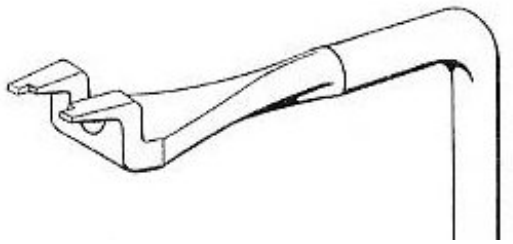
			
Spanner wrench, face type	8-Z-918-4		
Spanner wrench, face type	8-Z-918-5		
Removable primer seat wrench	8-Z-922	Removing and replacing mushroom primer seat	
Removable primer seat wrench box	8-Z-857	To hold the removable primer seat wrench when it is not in use	
Packing bolt and plug	8-Z-954	Sealing air duct in screw box liner	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Packing gun	8-Z 966	Sealing air duct in screw box liner	
Hydraulic grease gun	12-Z-339	Gun lubrication	
Mushroom stem protecting cap	26563-2	Protect mushroom stem when firing lock is removed	
Firing lock tools:			
Spanner wrench	8-Z-910-8	Removal of firing pin assembly	

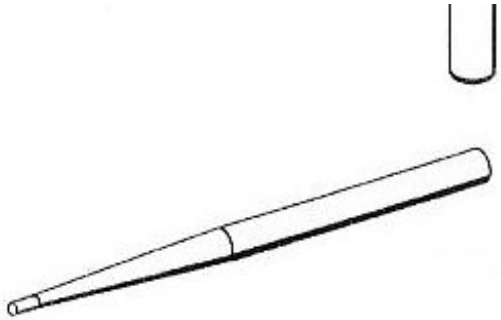
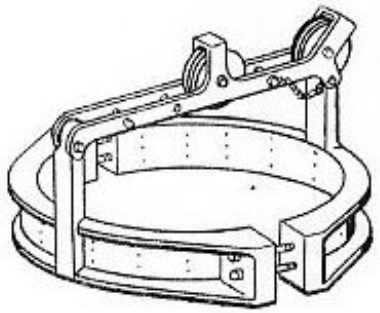
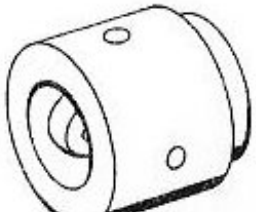
Pin	8-Z-911-4	Adjust cocking lever spring tension	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Exercise accessories:			
Muzzle sheave rig, backing out rammer	236161	Remove drill projectiles seated in the gun	
Backing out rammer	236162	Remove drill projectiles seated in the gun	

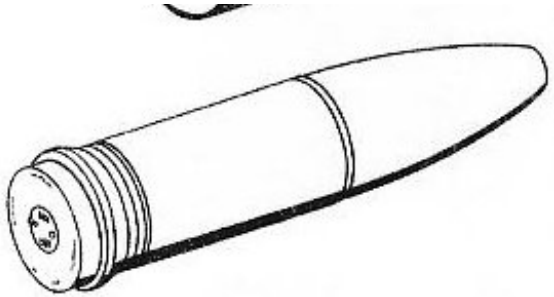
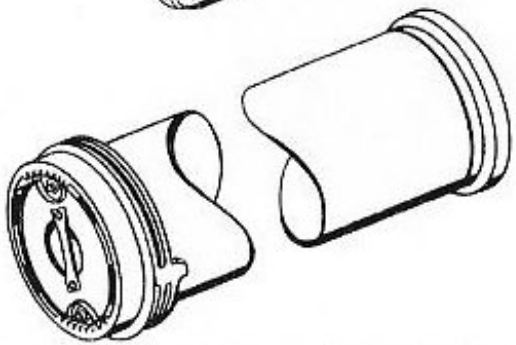
16-inch Drill Projectile Mk 2	267650	Turret practice	
Drill powder bag	245791	Turret practice	
Powder tank Mk 4 Mod 0 Mk 4 Mod 1 Mk 8 Mod 0	 227612 330100 562265	Container for drill or service powder bags	

TABLE 19-1. GUN TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION

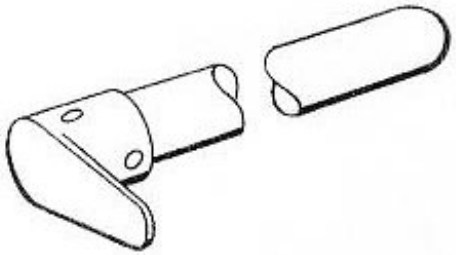
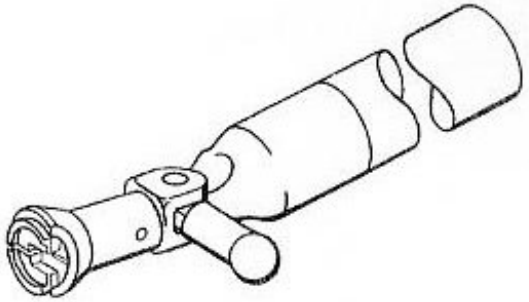
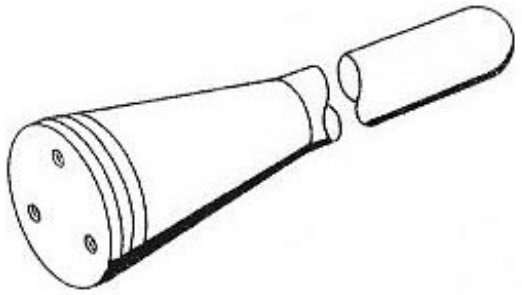
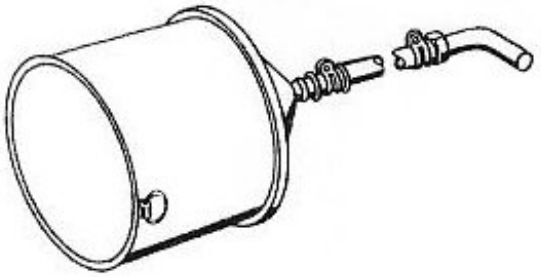
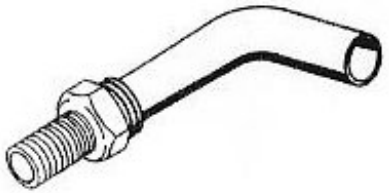
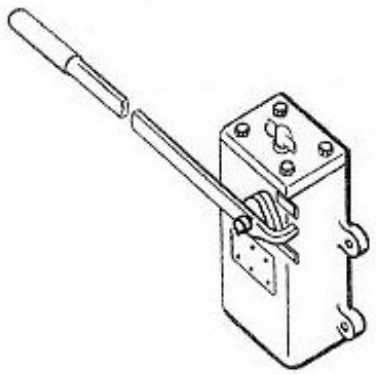
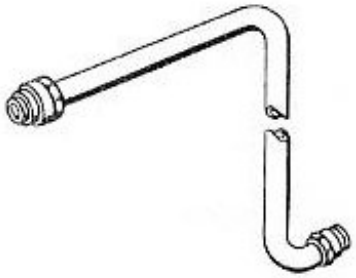
Powder unloading tool	49401	To remove powder bags from powder tanks or gun chamber	
Repriming	8-Z-931	Insert primers, live, or dummy, in firing lock	
Hand rammer	8-Z-883	Seat projectiles, live or dummy, in gun	
Shell eye bolt Mk 2	66346	Pulling projectiles, live or dummy, out of gun	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Recoil system charging tools:			
Funnel assembly	8-Z-801		
Funnel adapter	8-Z-801-3		
Liquid charging pump	118218	Charging counterrecoil liquid system	
Portable air pipes (123	232385-1	Charging counterrecoil	

inches long)		pneumatic system, right and center guns	
Portable air pipes (123 inches long)	232385-2	Charging counter-recoil pneumatic system, left gun	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Portable liquid pipes (93.50 inches long)	232384-1	Charging counterrecoil liquid system	
Liquid pump gage assembly	164698	Liquid pressure gage for charging pump	

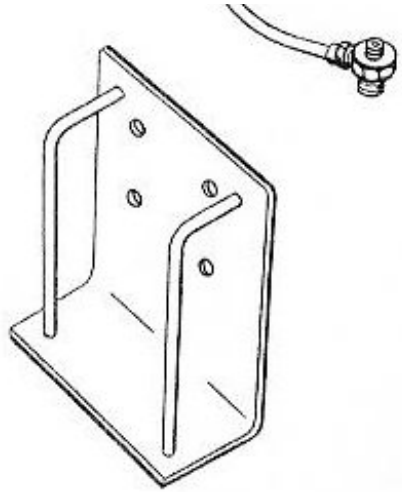
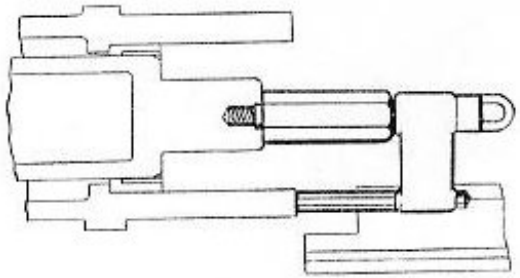
Liquid pump stand	118768	Stand for liquid charging pump	
Slide servicing tools:			
Counterrecoil plunger support and stop	236064	When removing counterrecoil plunger packing	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Special spanner	8-Z-900	Counterrecoil	

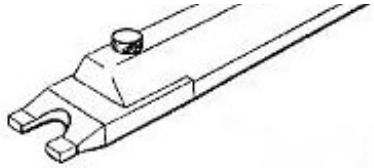
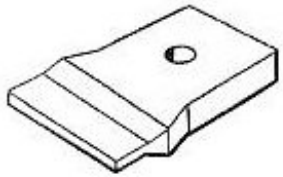
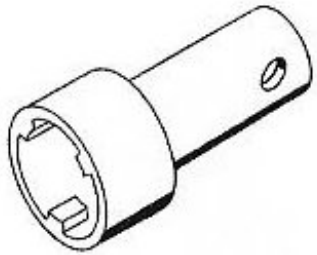
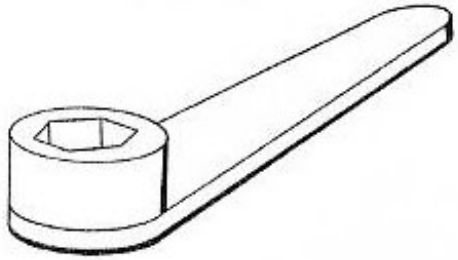
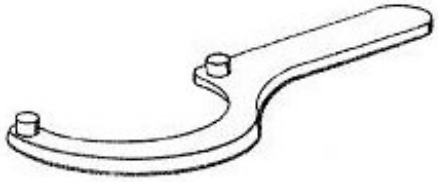
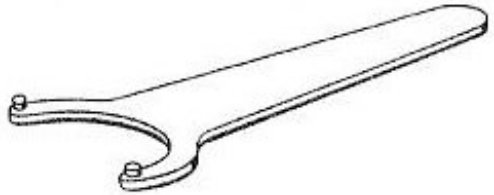
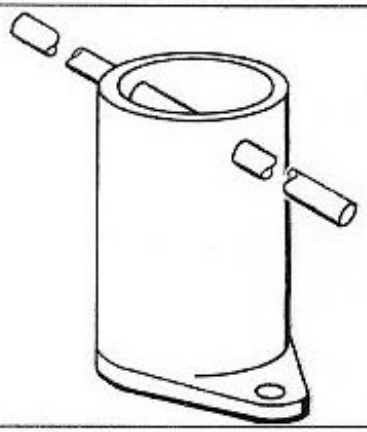
Special screw driver assembly	8-Z-909-5, 7, 8	General maintenance and repair work	
Screw driver blade (1.50 inches wide)	8-Z-909-9	Used with handle of screw driver assembly	
Socket spanner wrench	8-Z-948-1	Tighten or loosen counterrecoil valve assembly gland	
Diaphragm guide	8-Z-949-2	Assembling differential cylinder diaphragm in safety gage plate	
Socket wrench, handle type	8-Z-955-1	Tighten or loosen recoil cylinder strap bolts	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Spanner wrench, hook type (7.375 inches radius)	8-Z-955-2	Tighten or loosen recoil cylinder piston rod nut	
Spanner wrench, hook type (8.375 inches radius)	8-Z-955-3	Tighten or loosen recoil cylinder head nut	
Face spanner wrench	8-Z-955-6	Tighten or loosen depression buffer piston packing gland	
Face spanner wrench (5.75 inches diameter)	8-Z-960-1	Tighten and loosen yoke rod nuts	
Face spanner wrench (8.25 inches diameter)	8-Z-960-2	Tighten and loosen depression buffer gland nut	

Face spanner wrench (3.50 inches diameter)	8-Z-960-3	Tighten and loosen elevation buffer gland nut	

TABLE 19-2. SLIDE TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Face spanner wrench, barrel type	8-Z-960-4	Tighten and loosen slide securing pin adapter	

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Adjustable angle wrench	12-Z-706-9		

Pin spanner wrench (6.0 in. diameter)	12-Z-713-0114		
Face spanner wrench	12-Z-714-0137		
Engineer's single head wrench (open end, 1-7/8 in.)	12-Z-721-14		
Engineer's single head wrench (open end, 3 in.)	12-Z-721-17		
Engineer's double head wrench (open end, 1-7/16 and 1-5/8 in.)	12-Z-721-37		
Engineer's double head wrench (open end, 1-13/16 and 2 in.)	12-Z-721-39		
Engineer's double head wrench (open end, 2-1/4 and 2-5/8 in.)	12-Z-721-40		
Cap screw wrench (5/8 in.)	12-Z-723-9		

TABLE 19-3. ELEVATING GEAR TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			

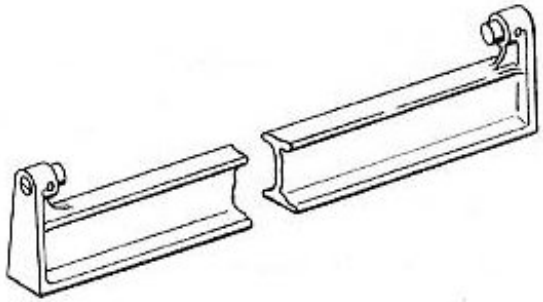
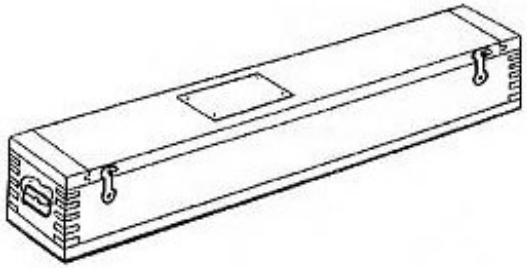
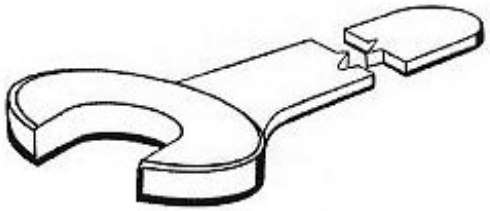
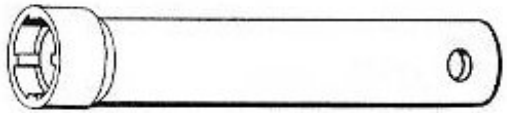
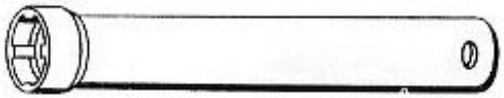
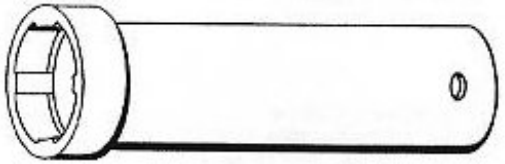
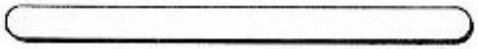
Tram	8-Z-934	To locate precisely the gun position in train and elevation	
Tram test gage	8-Z-935	To check the tram	
Tram and test gage box	8-Z-1215	To hold the tram and test gages when they are not in use	
Maintenance tools:			
Engineer's single head wrench (5.0 inches opening)	8-Z-919-2	Tighten or loosen elevating screw pivot pin	

TABLE 19-3. ELEVATING GEAR TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Socket wrench (for ball bearing locknuts 1-3/4 inches)	8-Z-943-7	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts 3-5/8 inches)	8-Z-943-15	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts 5-7/16 inches)	8-Z-943-24	Tighten or loosen ball bearing locknuts	
Handle for socket wrench	8-Z-943-22	Turn socket wrenches	
Handle for socket wrench	8-Z-943-23	Turn socket wrenches	

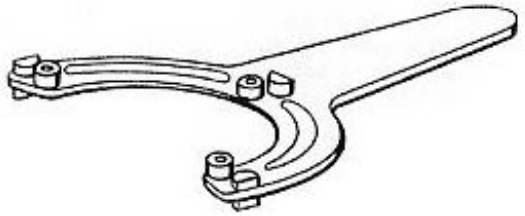
Face spanner wrench	8-Z-958-6	Tighten or loosen oscillating bearing adjusting nuts	

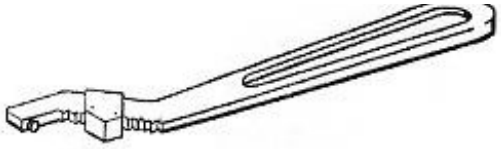
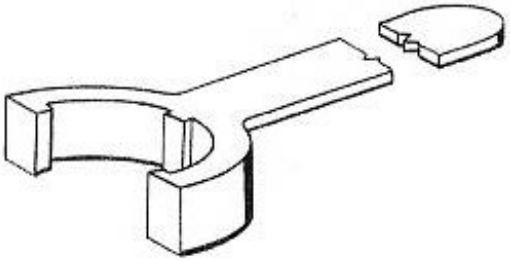
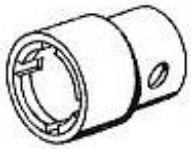
TABLE 19-3. ELEVATING GEAR TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Engineer's single head wrench (open end, 3/8 in.)	12-Z-721-1		
Engineer's double head wrench (open end, 7/16 and 1/2 in.)	12-Z-721-25		
Engineer's double head wrench (open end, 9/16 and 5/8 in.)	12-Z-721-26		
Engineer's double	12-Z-721-27		

head wrench (open end, 3/4 and 13/16 in.)			
Engineer's double head wrench (open end, 7/8 and 15/16 in.)	12-Z-721-28		
Engineer's double head wrench (open end, 1 and 1-1/8 in.)	12-Z-721-34		
Engineer's double head wrench (open end, 1-1/16 and 1-1/4 in.)	12-Z-721-35		
Engineer's double head wrench (open end, 1-5/16 and 1-1/2 in.)	12-Z-721-36		

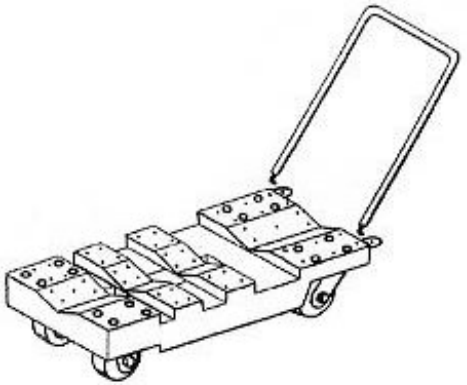
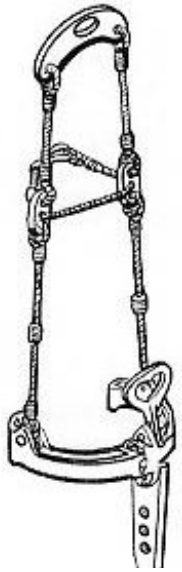
TABLE 19-4. TRAINING GEAR TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			

Spanner wrench (adjustable pin type)	8-Z-936-3	General use in tightening and loosening packing nuts	
Spanner wrench	8-Z-958-1		
Socket wrench	8-Z-958-2		

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Socket wrench, offset handle offset handle (7/16 in.)	12-Z-720-2		

TABLE 19-5. PROJECTILE HOIST TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Projectile handling equipment:			
Projectile truck	SK 140109	Handling projectiles	
Projectile Carrier Mk 3 Mod 1	242653	For projectile stowage handling	

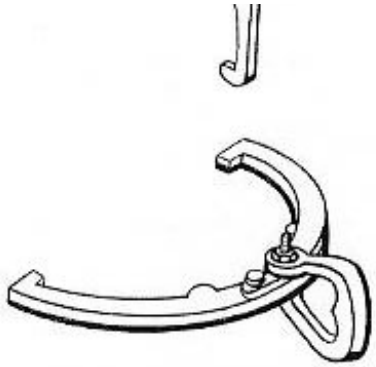
Handling tongs	242657	Handling projectiles in passageways (use with 16-inch Projectile Carrier Mk 3, Mods 1 and 4	

TABLE 19-5. PROJECTILE HOIST TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Screw driver (standard, 12 in.)	12-Z 705-5		
Monkey wrench (adjustable to 1-3/4 in.)	12-Z-706-7		
Single end wrench (open, 11/16 in. U.S. standard nuts)	12-Z-707-05		
Single end wrench (open, 25/32 in. U.S. standard nuts)	12-Z-707-06		
Single end wrench	12-Z-707-010		

(open, 1-1/4 in. U.S. standard nuts)			
Single end wrench (open, 2 in. U.S. standard nuts)	12-Z-709-014		
Spanner wrench (pin-type, 3 in. dia. circles)	12-Z-713-0110		
Spanner wrench (adjustable-type, 2 to 4 in. circles)	12-Z-715-0119		

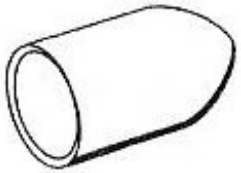
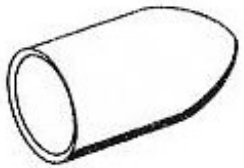
TABLE 19-6. RAMMER TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Spanner wrench,	8-Z-921-2		

pin-type			

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Screw driver (standard, 6 in.)	12-Z-705-5		
Monkey wrench (adjustable from 2-1/8 in.)	12-Z-706-3		
Double end wrench (open, 11/16 and 7/8 in. U.S. standard nuts)	12-Z-711-059		
Double end wrench (open, 1-1/16 and 1-1/4 in. U. S. standard nuts)	12-Z-711-066		
Spanner wrench (pin-type, 3 in. dia. circles)	12-Z-713-0108		
Socket wrench, off-set handle (1-1/8 in.)	12-Z-720-11		

TABLE 19-7. POWDER HOIST TOOLS AND ACCESSORIES

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Oil seal leader	274347-4	To protect the oil seal, when reassembling the the piston in the brake cylinder	
Oil seal leader	274349-2	To protect the oil seals when reassembling the safety car stop release valve and the latch and vent valve	
Oil seal leader	274349-4	To protect the oil seal when reassembling the piston rod in the safety car stop device cylinder and lever assembly	
Oil seal leader	274349-3	To protect the oil seal when reassembling the piston rod in the dashpot cylinder assembly	

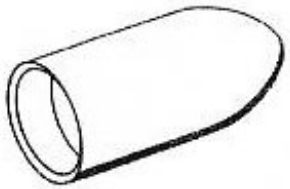
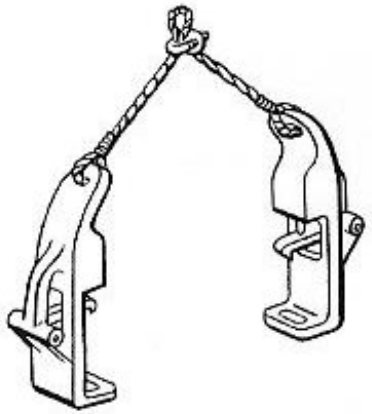
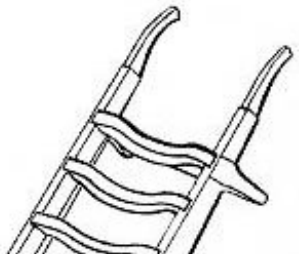
Oil seal leader	274350-2	To protect the oil seal when reassembling the control pump gear case assembly	

TABLE 19-7. POWDER HOIST TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Powder handling equipment:			
Powder Tank Carrier Mk 2 Mod 0	SK 140116	For powder stowage handling	
Powder Tank Truck Mk 1 Mod 0	SK 84701	Handling powder tanks	

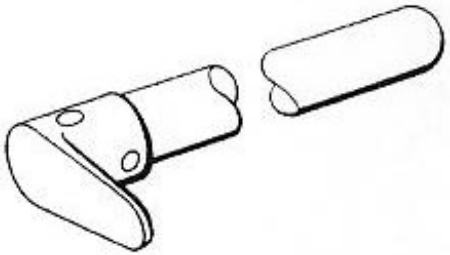
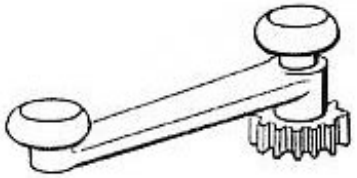
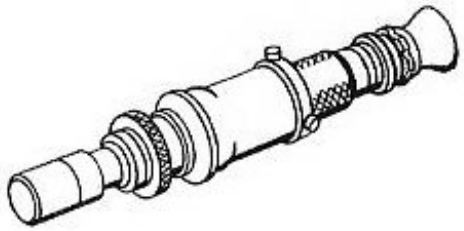
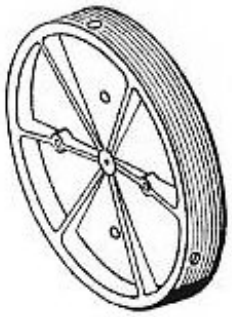
			
Powder unloading tool	49401	To remove powder bags from powder tanks	
Powder tank opening tool	204245	To open powder tanks	

TABLE 19-7. POWDER HOIST TOOLS AND ACCESSORIES (cont)

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Socket wrench (1/4 in.)	12-Z-700-0156	Spanner wrench (face-type, 1-3/4 in. center-to-center of pins)	12-Z-714-0128
Socket wrench (3/8 in.)	12-Z-700-0158		

(5/8 in.)	
Socket wrench (1/2 in.)	12-Z-700-0160
Socket wrench (5/8 in.)	12-Z-700-0162
Socket wrench (3/4 in.)	12-Z-700-0163
Socket wrench (7/8 in.)	12-Z-700-0164
Single end wrench (open, 1/2 in. U.S. standard nuts)	12-Z-707-03
Single end wrench (open 19/32 in. U.S. standard nuts)	12-Z-707-04
Single end wrench (open 7/8 in. U. S. standard nuts)	12-Z-707-07
Single end wrench (open 1-1/16 in. U.S. standard nuts)	12-Z-707-09
Spanner wrench (face-type, 1 in. center-to-center of pins)	12-Z-714-0125
Spanner wrench (face-type, 1-1/4 in. center-to-center of pins)	12-Z-714-0126
Spanner wrench (face-type, 1-1/2 in. center-to-center of pins)	12-Z-714-0127
Spanner wrench (face-type, 2-1/4 in. center-to-center of pins)	12-Z-714-0130
Spanner wrench (face-type, 2-1/2 in. center-to-center of pins)	12-Z-714-0131
Spanner wrench (face-type, 2-3/4 in. center-to-center of pins)	12-Z-714-0132
Spanner wrench (face-type, 3 in. center-to-center of pins)	12-Z-714-0133
Spanner wrench (face-type, 3-1/4 in. center-to-center of pins)	12-Z-714-0134
Spanner wrench (face-type, 3-1/2 in. center-to-center of pins)	12-Z-714-0135
Spanner wrench (face-type, 3-3/4 in. center-to-center of pins)	12-Z-714-0136
Spanner wrench (adjustable-type, 2 in. to 4 in. circles)	12-Z-715-0118
Pressure gage (hydraulic)	12-Z-323

TABLE 19-8. TOOLS AND ACCESSORIES FOR SIGHTS AND GUN ATTACHMENTS

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
SPECIAL TOOLS AND ACCESSORIES			
Testing accessories:			
Telescope (bore sight assembly, breech end)	233261	Ensure the maintenance of correct alignment of the lines-of-sight of the telescopes with respect to the bore axis	
Telescope holder (bore sight assembly, breech end)	54613-1	Ensure the maintenance of correct alignment of the lines-of-sight of the telescopes with respect to the bore axis	
Muzzle disc (bore sight assembly, muzzle end)	54613-3	Ensure the maintenance of correct alignment of the lines-of-sight of the telescopes with respect to the bore axis	

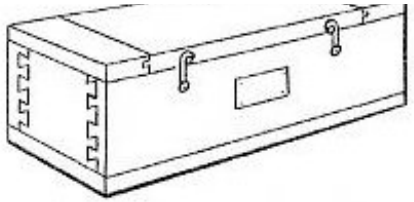
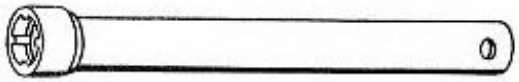
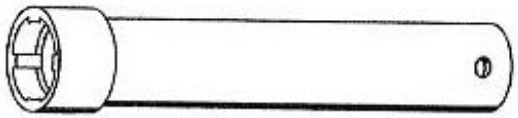
Bore sight box	236090	Stow bore sight telescope	

TABLE 19-8. TOOLS AND ACCESSORIES FOR SIGHTS AND GUN ATTACHMENTS (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Maintenance tools:			
Socket wrench (for ball bearing locknuts, 3/4 inch)	8-Z-943-1	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 7/8 inch)	8-Z 943-2	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 1 inch)	8-Z-943-3	Tighten or loosen ball bearing locknuts	

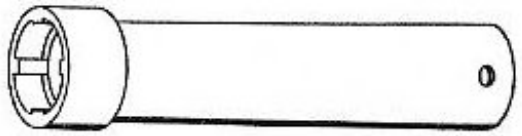
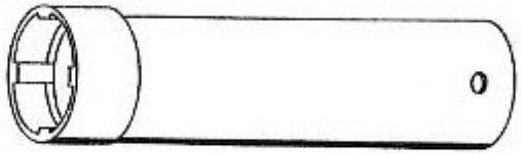
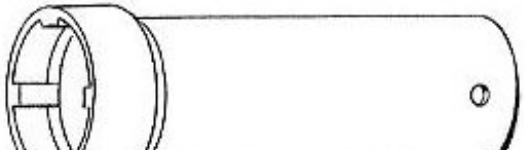
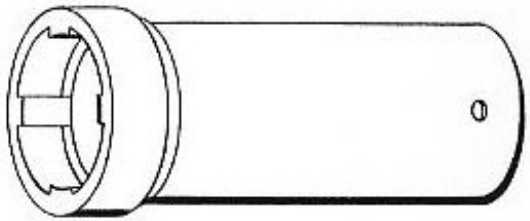
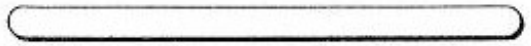
Socket wrench (for ball bearing locknuts, 1-1/8 inches)	8-Z-943-4	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 1-3/8 inches)	8-Z-943-5	Tighten or loosen ball bearing locknuts	
Socket wrench (for ball bearing locknuts, 1-1/2 inches)	8-Z-943-6	Tighten or loosen ball bearing locknuts	

TABLE 19-8. TOOLS AND ACCESSORIES FOR SIGHTS AND GUN ATTACHMENTS (cont)

TOOL NAME	DESIGN IDENTITY	USE	ILLUSTRATION
Socket wrench (for ball bearing locknuts, 2- inches)	8-Z-943-8	Tighten or loosen ball bearing locknuts	

			
Socket wrench (for ball bearing locknuts, 2-1/4-inches)	8-Z-943-9	Tighten or loosen ball bearing locknuts	
Handle for socket wrench	8-Z-943-22	Turn socket wrenches	

TOOL NAME	DESIGN IDENTITY	TOOL NAME	DESIGN IDENTITY
Standard tools			
Screw driver (standard, 8 in.)	12-Z-705-4		
Monkey wrench (adjustable from 1-1/4 in.)	12-Z-706-4		

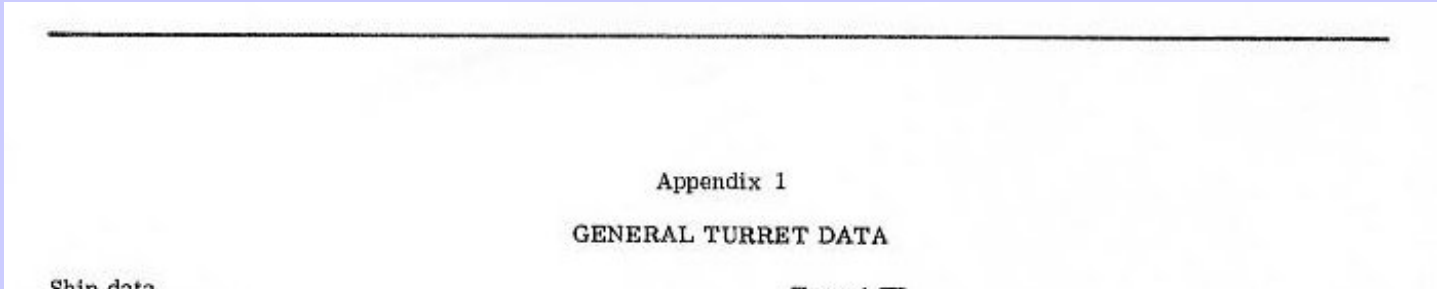
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IOWA CLASS BATTLESHIP PICTURES
NAVAL ORDNANCE PAMPHLET OP 769
TITLE AND FORWARD

APPENDIX 1 GENERAL TURRET DATA



Appendix 1

GENERAL TURRET DATA

Ship data

Ship data

Displacement (standard), tons	45,000
Length, feet	888
Beam, feet	108
Amplitude of roll, degrees	
Period of roll, seconds	
Amplitude of pitch, degrees	
Period of pitch, seconds	

Main battery positions

Turret I	
From bow, *feet	224
Above waterline, **feet	26.15
Turret II	
From bow, *feet	296
Above waterline, **feet	34.65
Turret III	
From bow, *feet	642
Above waterline, **feet	28.40

Main battery director positions

Forward director	
From bow, *feet	401
Above waterline, ***feet and inches	151-0
Aft director	
From bow, *feet	570
Above waterline, ***feet and inches	97-6
Control station	
From bow, *feet	343
Above waterline, ***feet and inches	98-9
Reference point	
From bow, *feet	343
Above waterline, ***feet and inches	69-3

* Vertical axis from forward perpendicular at 34.6-foot waterline.
** Trunnion axis above 34.6-foot waterline.
***Line-of-sight above 34.6-foot waterline.

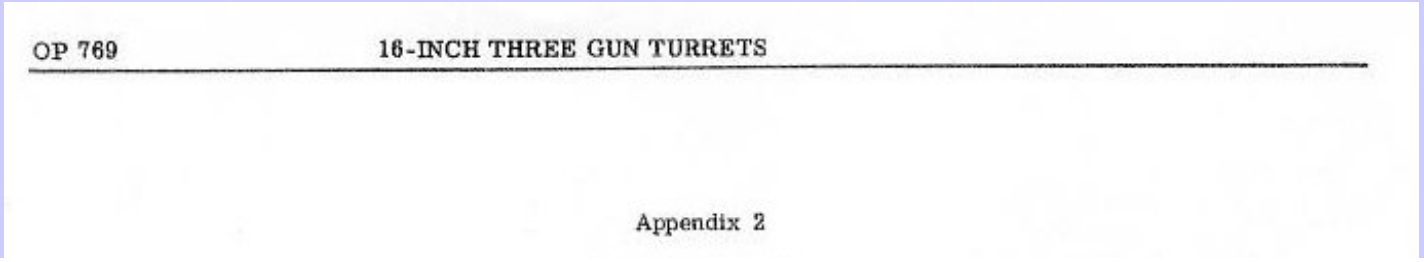
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TITLE AND FORWARD

APPENDIX 2 ORDNANCE DATA


OP 769 16-INCH THREE GUN TURRETS

Appendix 2

ORDNANCE DATA

- Internal ballistics
  - Length of gun, inches 816.0
  - Bore diameter, inches 16.0
  - Bore length, inches 800.0
  - Projectile travel, inches 689.67
  - Powder chamber length, inches 105.82
  - Powder chamber volume, cubic inches . 27,000.0
  - Powder chamber pressure (service charge), pounds per square inch 35,000.0
  - Number of grooves 96
  - Length of grooves, inches 682.46
  - Depth of grooves, inches 0.15
  - Twist . . . . Uniform, right hand, one turn in 25 cals.
- External ballistics
  - Muzzle velocity, AP Projectile (service charge), feet per second 2425
  - Muzzle velocity, HC Projectile (service charge), feet per second 2690
  - Range, AP Projectile (service charge), yards 40,185
  - Range, HC Projectile (service charge), yards 41,622
- Range tables
  - Armor-piercing 16-inch projectile . . . . OP 1457
  - High-capacity 16-inch projectile . . . . . OP 1100
- Weight pounds, each turret
  - Turret roller path load 4,030,000
  - Total ordnance installation 1,540,000
  - Gun assemblies, right, center, left, each:
    - Gun, with screw box liner 239,156
    - Gun, with recoiling parts. 292,000
    - Yoke 38,500
  - Elevating gear, right, center, left, each:
    - Electric motor (including speed reducer) 1880
    - Electric motor controller 165
    - Receiver-regulator 240
  - Training gear:
    - Electric motor 4500
    - Electric motor controller 1800
    - Reduction gear 3100
    - Receiver-regulator 320
  - Projectile ring, upper or lower:
    - Electric motor 1200
    - Electric motor controller
      - First design 130
      - Second design 150
  - Parbuckling gear, upper or lower:
    - Electric motor 650
    - Electric motor controller 110
  - Projectile hoist, each:
    - Electric motor 1900
    - Electric motor controller 235
    - Speed reducer 375
    - Electric motor controller 165
  - Powder hoist, each:
    - Electric motor. 2550
    - Electric motor controller 235
    - Powder car (empty) 2050
  - Train limits, all turrets
    - Right train, degrees. 150
    - Left train, degrees 150
  - Elevating limits, each gun
    - Elevation, degrees 45
    - Depression, degrees. . . . . -2
    - Depression, (turret II), degrees 0
- Ammunition data
  - Armor-piercing projectile, 16-inch:
    - Designation . . . . . Mk 8 Mod 0
    - Weight, pounds 2700
    - Length, inches. 72
    - Radius of ogive, inches 144
  - High-capacity projectile, 16-inch:
    - Designation . . . . . Mk 13 Mod 0
    - Weight, pounds 1900
    - Length, inches 64
    - Radius of ogive, inches 144
  - Powder charge, 16-inch:
    - Number of bags (service charge) 6
    - Total weight (service charge), pounds . . 650
- Projectile stowage
  - Service projectiles:
    - Turret I
      - Upper projectile flat, outer ring. . . . 120
      - Lower projectile flat, outer ring . . . 126
      - Each inner ring 72
      - Total stowage 390
    - Turret II
      - Upper projectile flat, outer ring. . . . 70
      - Lower projectile flat, outer ring . . . 125
      - Each inner ring 72
      - Fixed stowage, third level 121
      - Total stowage 460
    - Turret III
      - Upper projectile flat, outer ring. . . . 100
      - Lower projectile flat, outer ring . . . 126
      - Each inner ring 72
      - Total stowage 370
  - Drill projectiles:
    - Turret I 9
    - Turret II 9
    - Turret III 9
- Gun data
  - Center of gravity, from breech, inches . . . 280.6
  - Distance of recoil, design length, inches . . 47
  - Distance of recoil, maximum, inches . . . 48
  - Gun oscillating weight, pounds 387,900

Cradle	755
Spanning tray	184
Rammer, each:	
Electric motor (including speed reducer)	1750
Gun laying speeds:	
Maximum training gear rate, degrees per second	4
Max.elevating gear rate, deg. per second	12

Appendix 2 - cont'd.

Gun firing order	L,R,C
Firing delay period, second	0.06
Firing load, trunnion pressure, gun at 45 degrees elevation, pounds, each gun	1,677,648
Gun brake load, pounds	1,380,782
Recoil system pressure, 42 degrees elevation (service charge), psi	2900
Counterrecoil buffing pressure, 0 degrees elevation psi	7200
Counterrecoil system air pressure, psi	1550
Counterrecoil pressure, full recoil, psi	2153
Counterrecoil force, full recoil, pounds	372,857
Recoil period, 15 degrees elevation, second	0.43
Counterrecoil period, 15 degrees elevation, second	0.90
Gun spacing, centerline of center gun to centerline right and left guns, inches	122
Lines-of-sight data:	
Depression of line-of-sight (includes 20 degrees of roll), degrees	50
Elevation of line-of-sight (for 20 degrees of roll) degrees	20
Deflection movement (left), mils	100
Deflection movement (right), mils	175

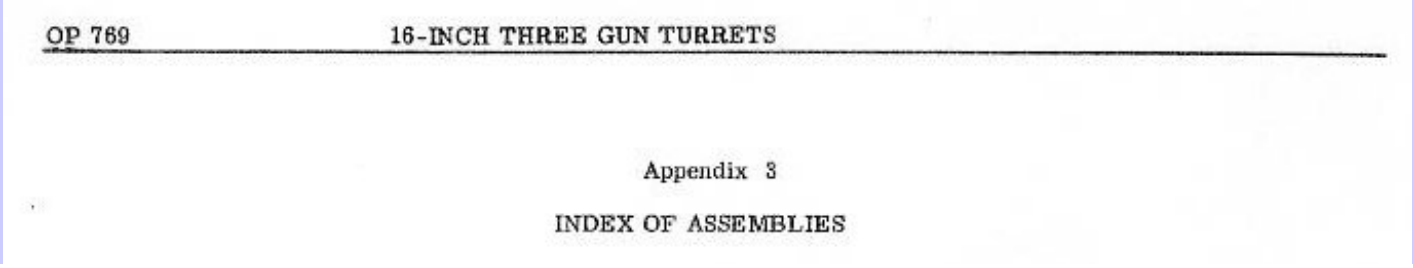
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APPENDIX 3 INDEX OF ASSEMBLIES



OP 769 16-INCH THREE GUN TURRETS

Appendix 3

INDEX OF ASSEMBLIES

16-INCH TURRET ASSEMBLY NO. 84

TURRET I - USS IOWA

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-0	9-1	9-2
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equip ment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-4	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-5	--
Periscope	29-0	--	29-0
Periscope Mount	5-10	--	5-10
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62268, 62560.

16-INCH TURRET ASSEMBLY NO. 85

TURRET II - USS IOWA

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-3	9-4	9-5
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun El evation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-5	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-2	10-0	10-0
Train Receiver-Regulator	--	18-6	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62269, 62560.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 86

TURRET III - USS IOWA

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-6	9-7	9-8
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-6	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-6	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regula-			

16-INCH TURRET ASSEMBLY NO. 87

TURRET I - USS NEW JERSEY

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-0	9-1	9-2
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-4	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regula-			

[illegible]	--	18-7	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62270, 62560.

tor	--	18-5	--
Periscope	29-0	--	29-0
Periscope Mount	5-10	--	5-10
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.
** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62271, 62560.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 88

TURRET II - USS NEW JERSEY

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-3	9-4	9-5
Sight	4-2	--	4-3
Training Gear	--	2-0	--

16-INCH TURRET ASSEMBLY NO. 89

TURRET III - USS NEW JERSEY

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-6	9-7	9-8
Sight	4-2	--	4-3
Training Gear	--	2-0	--

Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-5	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-6	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

**One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62272, 62560.

Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-5	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-6	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-2	--	3-3
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-7	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

**One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 62273, 62560.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 90

TURRET I - USS MISSOURI

16-INCH TURRET ASSEMBLY NO. 91

TURRET II - USS MISSOURI

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-0	9-1	9-2
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	11-2	--
Auxiliary Computer	--	3-2	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-4	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-5	--
Periscope	29-0	--	29-0
Periscope Mount	5-10	--	5-10
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92469, 107912.

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-3	9-4	9-5
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	11-2	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-5	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-6	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92470, 107912.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 92

TURRET III - USS MISSOURI

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-6	9-7	9-8
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-9	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-6	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-7	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

16-INCH TURRET ASSEMBLY NO. 93

TURRET I - USS WISCONSIN

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-0	9-1	9-2
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	11-2	--
Auxiliary Computer	--	3-2	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-4	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-5	--
Periscope	29-0	--	29-0
Periscope Mount	5-10	--	5-10
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92471, 107912.

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92472, 107912.

Appendix 3 - cont'd.

16-INCH TURRET ASSEMBLY NO. 94

TURRET II - USS WISCONSIN

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-3	9-4	9-5
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit			

16-INCH TURRET ASSEMBLY NO. 95

TURRET III - USS WISCONSIN

Ordnance Assembly	Mark and Mod Right	Center	Left
Gun	7-0	7-0	7-0
Breech Mechanism	4-0	4-0	4-0
Firing Lock	14-5	14-5	14-5
Gas Ejector	5-0	5-0	5-0
Yoke	5-0	5-0	5-0
Slide	6-0	6-0	6-0
Deck Lug	7-0	7-0	7-0
Elevating Gear	5-0	5-1	5-2
Rammer	5-0	5-1	5-2
Projectile Hoist	8-0	8-1	8-2
Powder Hoist	9-6	9-7	9-8
Sight	4-2	--	4-3
Training Gear	--	2-0	--
Rangefinder Stand	--	52-0	--
Parbuckling Gear	--	1-0*	--
Projectile Ring	--	2-0**	--
Firing Circuit	--	3-0	--
Lighting Circuit			

Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	11-2	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-5	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-6	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92473, 107912.

Lighting Circuit	--	3-0	--
Fire Control Equipment:			
Multiple Turret Train Indicator	--	12-9	--
Auxiliary Computer	--	3-2	--
Rangefinder Stabilizer	--	4-1	--
Gun Elevation Indicator	33-3	33-3	33-4
Turret Train Indicator and Transmitter	--	37-6	--
Gun Elevation Order Transmitter	2-0	--	2-1
Sight Setter's Indicator	3-4	--	3-5
Elevation Receiver-Regulator	10-0	10-0	10-0
Train Receiver-Regulator	--	18-7	--
Periscope	28-0	--	28-0
Periscope Mount	5-11	--	5-11
Rangefinder	--	52-0	--
Telescopes, Pointers' and Trainers'	66-0	--	66-0

* One assembly comprises two separate parbuckling gears, one on each flat.

** One assembly comprises two separate drives, one each for the inner ring of each flat.

NOTE: This index derived from Sketch Nos. 92474, 107912.

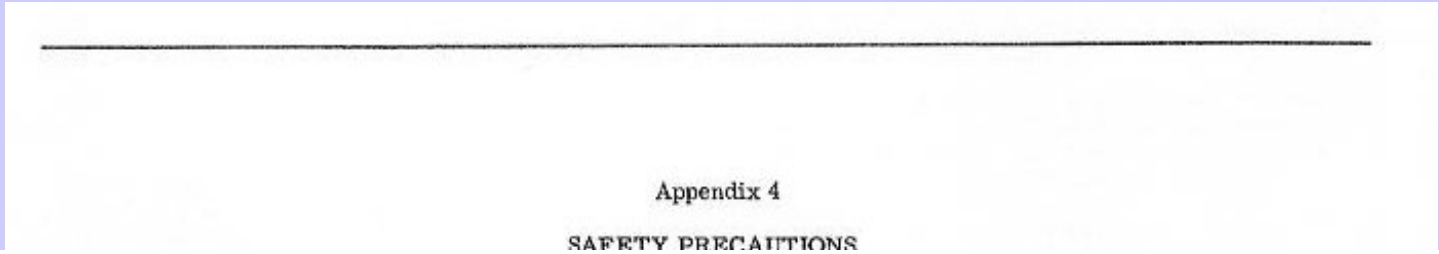
GENE SLOVERS
US NAVY PAGES

OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

HOME

IOWA CLASS BATTLESHIP PICTURES
NAVAL ORDNANCE PAMPHLET OP 769
TITLE AND FORWARD

APPENDIX 4 SAFTY PRECAUTIONS



Appendix 4

SAFETY PRECAUTIONS

Appendix 4 consists of warnings and safety measures for operation of the turret. It is a recapitulation of the operating precautions of all chapters of Ordnance Pamphlet 769 (First Revision), together with extracts from NavOrd Instructions 5100.1.

This precautionary material is of first importance to the turret organization; every member of the crew should be thoroughly familiar with every warning and the significance or reason for each.

EXTRACTS FROM NAVORD INSTRUCTIONS 5100.1

General

1. To avoid danger of casualties, the observance of the following safety precautions is mandatory. The Bureau of Ordnance shall be informed of any circumstances which conflict with these safety precautions or which for any other reason require changes in, or additions to, them.

2. When in doubt as to the exact meaning of a safety precaution, an interpretation shall be requested from the Bureau of Ordnance. Conditions not covered by these safety precautions may arise which in the opinion of the commanding officer, may render further operation of the equipment unsafe. Under these conditions, nothing in these safety precautions shall be construed as authorizing such further operation.

3. Safety devices provided shall always be used as designated to prevent possibility of accident, and shall be kept in good order and operative at all times. All instructions promulgated by competent authority to insure safe operation or handling of equipment shall be strictly observed.

4. Whenever any motion of a power-driven unit is capable of inflicting injury on personnel or material not continuously visible to the person controlling such motion, the officer or petty officer who authorizes the unit to be moved by power shall, except at general quarters, insure that a safety watch is maintained in areas where such injury is possible both outside and inside the unit, and shall have telephone or other effective voice communication established and maintained between the station controlling the unit and the safety watch. These precautions are applicable to turrets, gun mounts, guns, directors, rangefinders, searchlights, torpedo tubes, rocket launchers, and similar units. Under the conditions stated above, the station controlling shall obtain a report "all clear" from each safety watch before starting the unit. Each safety watch shall keep his assigned area clear and if unable to do so shall immediately report his unit

5. In turrets and enclosed mounts, a warning signal shall be installed outside the turret or mount; and whenever power train is used, except at general quarters, the officer or petty officer in charge of the turret or mount shall cause warning signals to be sounded before using power and at intervals during its use.

6. Changes, modifications in, or additions to ordnance material, or other material used in connection therewith, shall not be made without explicit authority from the bureaus concerned.

7. No ammunition or explosive assembly shall be used in any gun or appliance for which it is not designated.

8. No other than drill ammunition shall be used for drill.

9. On guns equipped with hydropneumatic counterrecoil systems, the safety link, locking the gun to the slide, shall be connected at all times except when firing or when testing and overhauling the counterrecoil systems or when a battery is in a condition of readiness for action.

10. Except in action or when specifically authorized, antiaircraft guns shall not be fired at elevations greater than, or fuse settings less than, those prescribed in the current orders for Gunnery Exercises. When firing antiaircraft guns as such, all personnel not required to be exposed shall be kept under cover.

Ammunition Handling and Stowage

1. As familiarity with any work, no matter how dangerous, is apt to lead to carelessness, all persons who may supervise or perform work in connection with the inspection, care, preparation, use, or handling of ammunition or explosives --

(a) Shall exercise the utmost care that all regulations and instructions are rigidly observed.

(b) Shall carefully supervise those under them and frequently warn them of the necessity of using the utmost precaution in the performance of their work.

No relaxation of vigilance shall ever be permitted.

2. Except in case of emergency, ammunition shall not be transferred during fueling operations.

fouled, and the controlling station shall promptly stop the unit until it is again reported clear.

3. All ammunition, explosives, and powder shall be protected from abnormally high temperature. If

so exposed, they shall be handled in accordance with current instructions of the Bureau of Ordnance. Permissible maximum storage temperatures shall be prescribed by the Bureau of Ordnance.

4. Smokeless powder which has been wet from any cause whatever must be regarded as dangerous for dry storage. Such powder shall be handled in accordance with current instructions of the Bureau of Ordnance.

5. Smokeless powder which shows unmistakable signs of advanced decomposition shall be disposed of in accordance with current instructions of the Bureau of Ordnance.

6. To minimize the risk of fire, explosion, and damage to ammunition and its containers from accidental causes, ammunition shall be handled as little as practicable. As the action of denting thin-cased high-explosive ammunition is known to have caused detonation of the explosive in some instances, special care shall be exercised to insure that such ammunition is never struck, dropped, or bumped.

7. Defective bomb type and thin case ammunition shall be disposed of in accordance with current instructions of the Bureau of Ordnance.

8. A fused projectile, whether in a container or not, if dropped from a height exceeding five feet shall be dumped overboard in a manner conforming with regulations for dumping ammunition at sea except when practicable to turn the projectile into a Naval Ammunition Depot. Such ammunition shall be handled with the greatest care.

9. Care must be used to avoid tapping or otherwise striking fused projectiles. This precaution is particularly applicable to attempts to loosen such a projectile in the cartridge case by repeated light blows of a mallet, unloading such a projectile wedged in the bore of a gun, and the striking of a projectile by the recoil of a gun or an ejected case.

moved to safe storage until normal conditions have been restored.

14. Black powder is one of the most dangerous of explosives and shall always be kept by itself. Only such quantities as will meet immediate needs shall be taken from the magazines. A container of black powder shall never be opened in a magazine nor in the vicinity of a container in which there is any explosive.

15. Ammunition shall not be altered, nor shall fuses or any other parts be removed or disassembled without explicit instructions from the Bureau of Ordnance.

Service of guns, including ammunition supply

1. Live ammunition shall be loaded into guns for firing purposes only. Test or inspection of ammunition by fitting it into guns is prohibited, except when authorized by specific instructions of the Bureau of Ordnance.

2. During firing no other ammunition than that immediately required shall be permitted to remain outside of the magazine.

3. During gunnery exercises, charges in excess of the amount required to be available for one run shall not be assembled in the vicinity of guns mounted outside of turrets. No charge for a bag gun shall be removed from its tank, nor shall the tops of tanks be removed or so loosened that the bags may be exposed to flame until immediately before the charge is required for loading.

4. When either cartridges or bag charges are outside the magazines, each flame-proof compartment or space which forms a stage of the ammunition train, including the magazines and gun compartments (in or out of turrets), shall, wherever practicable be kept closed from all other compartments or spaces except when the actual passage of ammunition requires it to be open. Where practicable,

10. The covers of switches, circuit breakers, etc., shall be kept securely closed while powder is exposed in the vicinity.

11. Magazines shall be kept scrupulously clean and dry at all times. Nothing shall be stored in magazines except explosives, containers, and authorized magazine equipment. Particular attention shall be paid that no oily rags, waste, or other foreign materials susceptible to spontaneous combustion are stored in them.

12. Naked lights, matches, or other flame-producing apparatus shall never be taken into magazines or other spaces used primarily as magazines while these compartments contain explosives.

13. Before performing any work which may cause either an abnormally high temperature or an intense local heat in a magazine or other compartment used primarily as a magazine, all explosives shall be re-

no flame-proof stage of the ammunition train shall be open to both the preceding and the following stages at the same time.

5. If flame seals be damaged during firing, except in action, so that they can not fulfill their purpose, the gun or guns concerned shall cease firing until the flame seals are again effective.

6. (a) In a magazine or handling room in which powder is removed from tanks to be sent to the guns in bags, not more than one charge per gun, for the guns being served by that magazine or handling room, shall be exposed by removal of tank tops, or by so loosening the tank tops that the bags may be exposed to flame.

(b) In each subsequent flame-proof stage of the ammunition train, not more than one charge per gun, for the guns being supplied through that stage, shall be allowed to accumulate. For this purpose,

the spaces or handling rooms at the tops and bottoms of continuous-chain powder hoists will be considered separate stages (whether or not separated from the hoists by flame-proof doors, flaps or shutters).

(c) In addition to the above, continuous-chain powder hoists may be kept filled; or if hand passing is used, there may be one bag of powder at the station of each man in the train.

(d) It is the intent of this article to permit sufficient powder to be exposed to provide an adequate supply for the guns being served. The maximum amount specified above should be exposed only if a smaller amount will not assure an adequate supply.

7. As there is an inflammable gas present in the chamber of a gun after firing which, under certain conditions, may constitute a danger by igniting the powder charge which is to be used for the next round, and as smoldering remnants of powder bag may also be present, the following precautions shall always be observed:

(a) Bag guns shall not be loaded until a member of the crew has assured himself that the bore is clear of powder gases and remnants and has announced

projectiles may cause abnormally high pressure. In bag guns, projectiles shall not be rammed by interposing one or more sections of a powder charge between the head of the rammer and base of the projectile.

11. The mushroom of every bag gun shall be wiped after each shot with a sponge or cloth dampened with fresh water.

12. As soon as a gun is loaded the breech shall be closed without delay.

13. When priming a lock of the sliding-wedge type, care shall be taken to insure the primer being pushed in beyond the primer catch to prevent the primer coming out or being crushed by the operation of the wedge in closing.

14. In loading a bag gun, neither the gun ready light switch nor the gun firing cut-out switch (which are combined in some installations) shall be in the closed position until the breech is fully closed and all personnel are clear of the recoil.

15. To guard against blowing out primers which may fire at the instant of closure, care shall be taken

"bore clear" either by voice or by approved signal, such as a hand, whistle, gong, or horn, except that, when the gas ejector system does not readily clear the bore, the combined sponge and rammer (where provided) may be used. The sponge shall be dipped in water for each load.

(b) Until the "bore clear" signal above described is given, or the projectile is rammed home with the wet combined sponge and rammer, powder shall not be exposed closer than four feet to a gun not mounted in a turret.

(c) In turrets fitted with ammunition cars, the car and the center of an open breech shall not be allowed within six feet of one another until the "bore clear" signal has been given. In turrets fitted with continuous-chain powder hoists, or for hand passing, the powder shall not be exposed in the turret chamber, nor shall the flame seal, shutter, or flap between the turret chamber and the next stage in the powder train, be opened or unlocked until the "bore clear" signal is given.

8. If a powder bag is broken to the extent of allowing powder to fall out, the command "Silence" shall be given and the loose powder shall be gathered up. If it is impracticable to utilize this section of the charge satisfactorily in loading, it shall be secured in a flameproof container or immersed in water.

9. In turrets not fitted with bulkheads between guns, the "bore clear" signal to the turret crew shall not be given until the guns which have been fired and whose breech plugs have been opened are reported clear, at which time one signal to the entire turret crew shall be given.

10. Care should be exercised to prevent projectiles from slipping back from their seats, as unseated whenever the breech of a bag gun with a live primer in the lock is being closed, that the operating lever is followed through during the last part of its travel, to prevent any opening of the lock due to rebound.

16. The breech plug of a bag gun shall never be unlocked or opened while there is a live primer in the lock.

17. A firing lock into which a live primer has been inserted shall never be opened, either independently or by operation of the breech mechanism, unless the firing circuit is broken externally by the lock or breech mechanism (for example, at local pointer's key or gun captain's ready switch), except when it is known that the loaded gun has fired. This applies to the firing of primers at drill, to the operation of loaded guns, and the examination of primers.

18. The limiting position of the breech of the gun or recoil shall be indicated and the gun crew shall be instructed to keep clear.

19. While a gun is being loaded, all personnel not required for the unloading operation shall be kept at a safe distance from the gun.

23. Effective measures shall be taken to guard against prematurely opening the breech of a loaded gun, whether or not the gun is fitted with a salvo latch.

24. If a gun is loaded at the order "cease firing"

(a) The gun shall be kept pointed and trained in a safe direction.

(b) The breech mechanism shall be kept fully closed.

(c) The gun shall normally be cleared by firing as soon as practicable.

25. A loaded and fused projectile, seated in the bore of a gun that is shot from previous firing, presents a hazard, since detonation of the projectile is possible as a result of being heated. Whenever practicable, such projectile should be disposed of promptly by firing the round. Whether a gun is hot or

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

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

27. Ships shall cease the firing of [illegible]

cold, the risks attendant upon removing a loaded and fused projectile seated in the bore, by backing out, are considered unwarranted except in the case of guns for which existing instructions specifically prescribe this procedure.

26. (a) 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.

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

(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.

(c) 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 or 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.

27. Ships shall cease the firing of any gun whose line of fire is endangering any objects other than the designated target. These objects include friendly ships and aircraft and own ship's structure together with the mounts and launchers and their barrels, fixed or moving. This stipulation applies to objects in the vicinity of the firing point, throughout the trajectory and in the vicinity of the target. Turrets, mounts, guns and launchers which are not firing, while others are firing, shall be trained and elevated if manned, or secured if unmanned, in a manner that will provide the greatest amount of safety from the firing. This position of greatest amount of safety of the unmanned mounts will generally be that position which the firing cut-out mechanism cams of the firing mounts were cut to clear.

TURRET GENERAL PRECAUTIONS

DANGER. Live 440-volt leads are exposed whenever covers of the bus transfer panel, equipment panels, controllers, motor terminal boxes, and many of the control panels and connection boxes are open.

DANGER. Never enter the cable trunk at the foot of the central column or the wiring recess at the top until the 440-volt supply switches are open at NORMAL and ALTERNATE switchboards.

Always open the 440-volt supply switch at the equipment panel as well as the controller concerned when preparing to work on any power driven assembly.

Never position the automatic control circuit transfer switches of the elevating drives at AUTO until all personnel have been cleared from the gun pits.

DANGER. Never fire the guns with personnel in the gun pits.

DANGER. Always close and secure the gun room, sight station, pan floor, and projectile flat batches, and the circular foundation doors before firing the gun.

DANGER. Always start the ventilating systems before firing the guns.

ORDNANCE EQUIPMENT PRECAUTIONS

Personnel Danger

Never fire the guns without first checking the recuperator air pressure and differential fluid.

Never put hands, feet, or head into a hoist way or path of a cradle, spanning tray, slide, or housing when power is on.

DANGER. Never climb through the inner compartment archways of the projectile flats when the projectile ring power drives are operating; always stop the power drive electric motor.

Never parbuckle projectiles directly from the fixed stowage space to the hoist except in an emergency, such as failure of the projectile ring drive.

Never use more than three turns of snubbing rope around a gypsy head when parbuckling; two turns are usually sufficient.

Never start the snubbing action with a jerky, sudden movement when parbuckling; "ease" the projectile into motion.

Never hold the projectile hoist shutters open by hand when parbuckling out of the hoist; latch the shutters open before unloading the hoist.

DANGER. Never perform gun sliding-out exercise without setting the slide securing pin in its 20-degree elevation socket.

Never enter the gun pits except when the slide securing device is engaged.

Never start the elevating gear until the gun pits re cleared of all personnel.

Always operate the elevating gear slowly in HAND control when operating the slide securing device.

Always lash all projectiles carefully, inspecting all toggle links, before going to sea.

Do not unscrew hydraulic adjustments excessively. There is danger of injury to personnel and equipment because of the hydraulic pressure.

WARNING. Always observe all cautions listed under "Turret general precautions."

Equipment Casualty

Gun equipment precautions

ing lock action by operating the breech through two opening and closing cycles.

FIRING PRECAUTIONS

Before loading live ammunition in the gun verify that the salvo latch locking pin is not in the hole designated B to prevent opening the breech when a misfire or hangfire goes unnoticed in salvo fire.

After each round has been fired, verify that the gun has returned to battery by observing the indicator marks on the yoke and counterrecoil cylinders; the service of the gun shall be stopped should the gun fail to return to battery.

MISFIRE PRECAUTIONS

Position the READY switch at SAFE immediately. Unload or fire the gun, observing NAVORD INSTRUCTIONS 5100.1.

STOWING PRECAUTIONS

Secure the gun locking device immediately after "Cease fire."

Always seat the slide securing pin.

Always install tompions or canvas covers on gun muzzles.

MISCELLANEOUS PRECAUTIONS

Use utmost care to avoid damaging the breech mechanism when removing a drill projectile from the gun chamber by means of the backing-out rammer. If possible, have guns trained fore and aft to minimize the effect of the roll of the ship. Observe "backing-out precautions," page 101.

Use only clean, soft cloth to wipe the counterrecoil plungers. Scratches will cause loss of air charge. No rust-protection oil film is required.

Never use an organic or heavy oil or grease to

PREPARATION PRECAUTIONS

Check recuperator air pressure and differential fluid.

Check recoil cylinder fluid level.

Check the fluid level of the breech opening and operating lever buffers, and the elevating and depression buffers.

Remove the muzzle covers and tompions.

Disengage and stow the gun locking device.

Release the slide securing pin.

Verify breech action, gas ejector supply, and firing equipment precautions.

coat the gun bore, chamber, or gun and slide bright work, or to lubricate the firing lock. Use authorized lubricant only.

Never use abrasives or detergent or caustic solutions to remove discoloration or smoke rings from the gun bore; use an oil-soaked cloth.

Never use kerosene, gasoline, carbon tetrachloride, caustic or soda solutions to clean the firing lock; use alcohol.

Ammunition handling equipment precautions.

Before hoisting projectiles, operate the empty hoist, the cradle, the function control and shut-off valve, and the shutters, to verify normal operation of all indicator and interlock actions.

When hoisting projectiles always hold the hoist

control handle in HOIST position until the TOP OF STROKE indicator is illuminated.

While the first four projectiles are being loaded into a hoist, check the brake action. Verify the solenoid brake release movement and that the brake drum is clean and oil-free.

When operating the first cradle lowering movement with projectile, check the cradle buffer for normal action.

Before lowering projectiles, the cradle operator must verify that the function control and shut-off valve is operating properly.

When lowering projectiles the cradle operator must not move back the cradle projectile latch until the rack is at the top of stroke.

When handling powder between the magazine scuttles and hoist loading trays avoid rough treatment that may cause a powder bag to tear.

Transfer projectiles from the rotating ring to the hoist when loading the hoists, and from the hoist to the rotating ring when unloading. Never use a handle

Always inspect the projectile ring for loose tools or other obstructions before starting operations.

When reversing the direction of projectile ring rotation, permit the ring to come to a full stop before reversing hand lever movement.

Keep projectiles secured in the projectile ring until rotation stops; then unclamp only the projectiles which are to be parbuckled. In rough weather, unclamp the projectiles one by one as needed for parbuckling.

Refer to the "Personnel danger precautions" on page 587.

Gun laying equipment precautions.

Before attempting to start the power drive electric motor, make sure that the tilting box is at neutral, the control selector lever is at HAND, the gun pits are clear, and operating personnel are in safe positions.

Before shifting to AUTO control, make sure that the synchro receivers are energized and that gun po-

the rotating ring when unloading. Never parbuckle projectiles directly from the outer ring to the hoist except in an emergency, such as failure of the projectile ring drive.

Turn the snubbing rope twice around the gypsy head for normal parbuckling. Never use more than three turns.

Replenish the rotating ring as it is depleted by parbuckling from fixed stowage to the rotating ring; projectiles must be lashed when in position.

Loop the snubbing rope under the copper rotating band, never above it.

It is preferable to load projectile hoists from the upper flat first; this procedure is not compulsory.

Before parbuckling, make sure that the projectile hoist shutters swing freely.

Make certain that the loading door in the hoist is lowered before parbuckling on the upper flat. Before parbuckling on the lower flat, make certain that the hoist loading door on the upper flat is raised and secured.

Never use the parbuckling gear to snub auxiliary whip hoists; this procedure is not compulsory.

Always stow projectile rings with both centering pins of each securely seated.

Always lash all projectiles carefully, inspecting all toggle links, before going to sea.

Never attempt to load or unload a projectile ring when it is in motion.

sition is in close agreement with gun order.

The gun layer must remain at his station whenever the equipment is in operation. He must be prepared to stop the equipment immediately if any emergency arises.

Always shift the control selector lever to HAND before stopping the power drive.

Protect the elevating gear drive from vibration and settling by setting the slide securing pin at the zero degree secured position whenever the drive is not operating.

WARNING. It is possible to adjust some transfer acceleration limiting valves so that the Hand control line is completely cut off. Every possible precaution must be taken to prevent this condition because neither the handwheels nor the hand stops will have any effect.

Never attempt to improve the operation of an elevation receiver-regulator if the performance is satisfactory.

Training gear equipment precautions.

Always retract both centering pins before starting the training gear drive.

Before attempting to start the power drive electric motor, make sure that the tilting box is at neutral, the control selector lever is at HAND, and operating personnel are in safe positions.

Before shifting to AUTO, make sure that the synchro receivers are energized, and that turret position is in approximate agreement with turret train order.

The train operator must remain at his station whenever the power drive is in operation; he must be prepared to stop the power drive if an emergency arises.

Always shift the control selector lever to HAND before stopping the power drive.

as the turret officer's transfer switchboard.

Never adjust sights and gun attachments without cause, and then only in the prescribed order. Adjustments made out of order will upset other adjustments.

Never attempt to improve the operation of fire

Operate the drive slowly in HAND when locating centering pin positions.

Protect the train drive from backlash and the roller path from deformation by setting both centering pins tight whenever the drive is not operating.

Never attempt to improve the operation of an elevation receiver-regulator if performance is satisfactory.

Fire control equipment precautions.

Never attempt to set the sights when any appreciable effort is required to turn the sight setter's hand cranks. Stop and investigate. Find and remove the cause of the abnormal load before resuming operation.

Exercise the sights and gun attachments periodically and frequently through full range of movements.

Dry out and ventilate sight hoods daily. Clean and dry telescope objectives.

Always keep the sight hood shutters closed when the sights are not in use.

Never make internal adjustments or open any fire control instrument without cause.

When securing fire control equipment after operations, open all transmission, communication, and lighting circuits at the instrument controls as well

control equipment if performance is satisfactory.

Whenever trouble occurs, test the equipment in all types of control, to isolate the cause, before resorting to disassembly or adjustment.

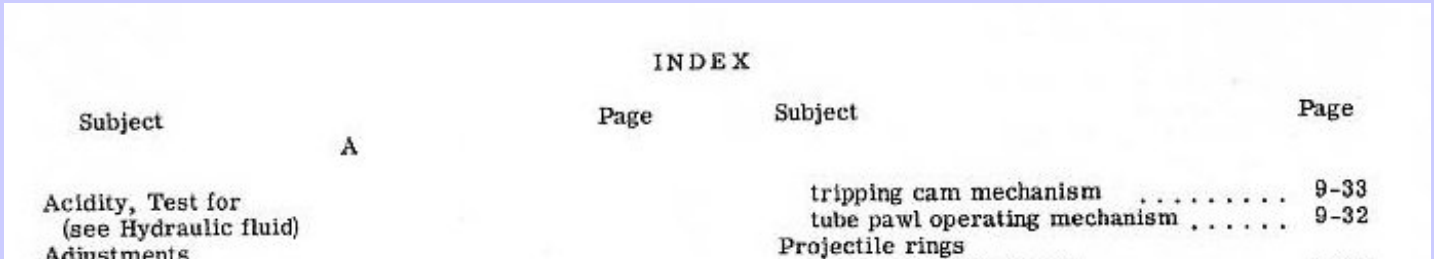
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OP 769 CONFIGURATION OF THE THREE GUN TURRETS USS NEW JERSEY 30 APRIL 1968 REACTIVATION

HOME

IOWA CLASS BATTLESHIP PICTURES
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TITLE AND FORWARD

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