

PRELIMINARY HANDBOOK OF INSTRUCTIONS

FOR THE

SPERRY MACHINE GUN TURRETS (.50 Calibre)

MANUFACTURED BY

SPERRY GYROSCOPE CO., INC.

BROOKLYN, N. Y.

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SPERRY
.50 CALIBRE MACHINE GUN TURRETS
UPPER LOCAL
LOWER REMOTE
LOWER BALL

INSTRUCTION NO. 14-230
JANUARY 1942

F O R E W O R D

FOREWORD

This book has been prepared and divided into three major parts to facilitate an understanding of the following turrets:

- PART 1 - SPERRY UPPER LOCAL TURRET
- PART 2 - SPERRY LOWER REMOTE TURRET
- PART 3 - SPERRY BALL TURRET

The material herein relates specifically to DESCRIPTION, OPERATION, MAINTENANCE and INSTALLATION of the turrets. Complete overhaul information and replaceable parts lists will be provided in Sperry Instructions 14-231 for the turrets. Appendix A included in this book provides an incomplete replaceable parts list for temporary use only and should be removed from the book when the Overhaul Manual becomes available.

The turrets are designed for mounting in an airplane and house all necessary equipment for accurately directing the fire of two .50 calibre machine guns. The turrets and guns are moved in azimuth and elevation by electrically driven hydraulic units which provide smooth and easily controlled power for the "tracking" operations.

A Sperry .50 Calibre Automatic Computing Sight is used with each of the turrets to provide automatic calculation of the prediction and ballistic deflections so that the projectile will be accurately directed to strike a fast moving target. The reader is referred to Instructions 14-225 for complete description of the computing sights.

The three parts of this book are arranged and indexed to facilitate the location of any particular information relating to the different turrets. A complete CONTENTS and LIST OF ILLUSTRATIONS page will be found at the beginning of each part of the book.

RESTRICTED

T. O. No. 11-45C-1

PART - 1

SPERRY UPPER LOCAL TURRET

U P P E R L O C A L T U R R E T

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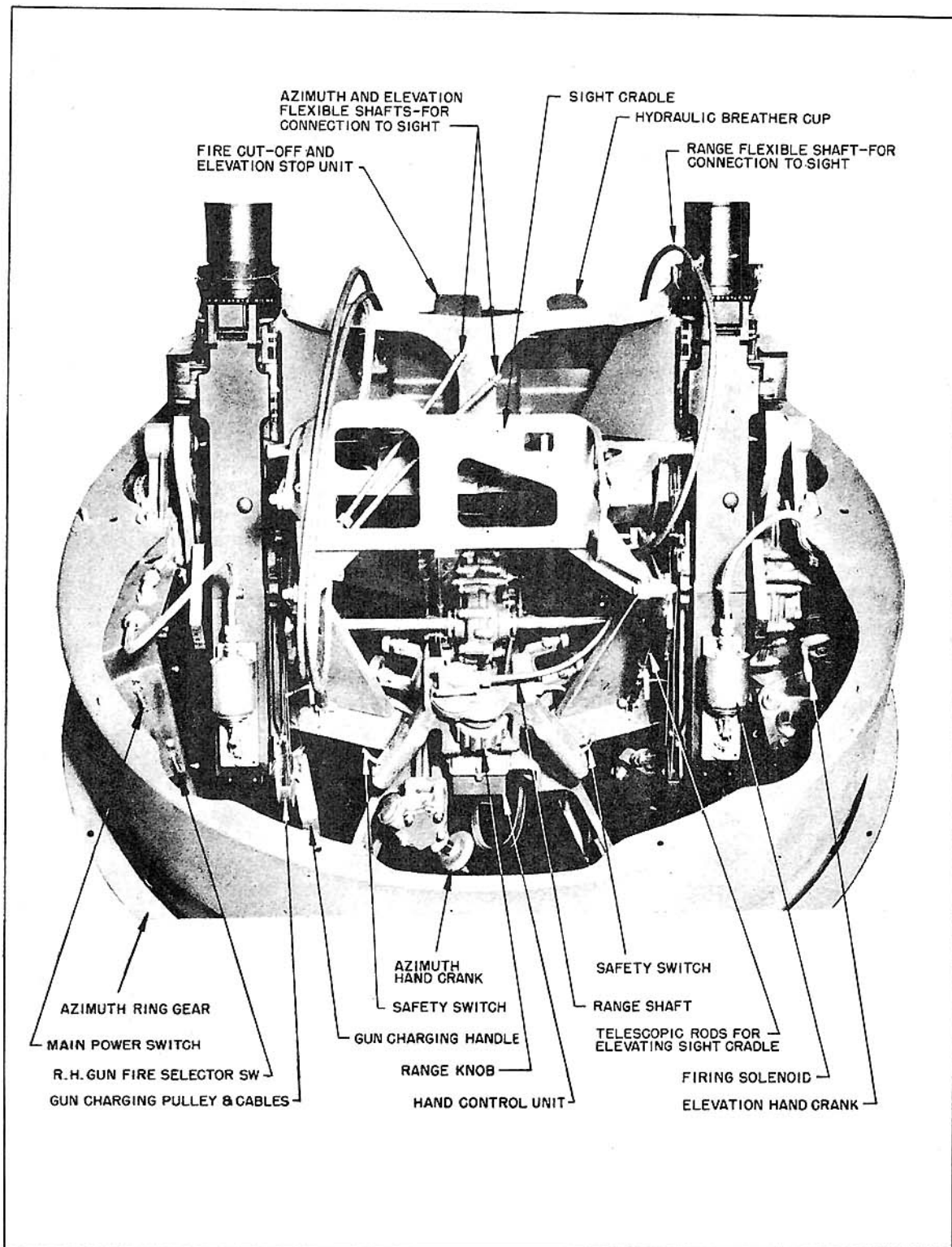
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UPPER LOCAL TURRET



FRONTISPIECE
UPPER LOCAL CONTROLLED TURRET
(TOP VIEW WITH DOME AND COMPUTING SIGHT REMOVED)

I N T R O D U C T I O N

INTRODUCTION

1. The Sperry Upper Local Turret described in this book is designed for mounting in an airplane and houses the necessary equipment for accurately directing the fire of two .50 calibre machine guns. This equipment consists essentially of:

- (a) Hydraulic power unit and associated mechanisms for controlling the turret and guns.
- (b) .50 Calibre Automatic Computing Sight K-3 (refer to Instructions 14-225 for detailed description of this unit.

2. All units of equipment, including the guns and computing sight are mounted within the turret structure, which, in turn, is supported in the airplane by a centrally located thrust bearing at the base of the turret and by an azimuth ring gear near the top of the turret. The computing sight is mounted on a cradle which is mounted between the guns.

3. Arrangement of the various units is such that the entire turret can be rotated through 6400 mils azimuth, but the guns and sight are limited in their vertical movements from 0 to +1511 mils. (0 to 85°)

4. The hydraulic unit provides the power for moving the turret in azimuth and the guns in elevation. Control of the hydraulic power rests in conveniently located hand grips which are manipulated by the gunner in the turret.

5. The computing sight is used by the gunner to locate the target; the target is then "tracked" in azimuth and elevation by means of the hydraulic power unit which moves the turret and guns. When the reticles of the computing sight frame the target during tracking, the gunner operates the key to fire the guns. As described in detail in Instructions 14-225 for the .50 Calibre Automatic Computing Sight, the necessary corrections are automatically introduced into the system and the final gun positions are such that the projectile will be properly directed to strike the moving target.

U P P E R L O C A L T U R R E T

SECTION IDESCRIPTIONA - GENERAL

1. The Upper Local Turret is a metal structure designed for mounting in the upper portion of the fuselage of an airplane. The main unit inside the turret is an electrically driven hydraulic power unit which is used to move the turret in azimuth and the two .50 calibre guns in elevation. Several other minor accessory units are also enclosed in the turret structure. Figure 1 is a schematic representation of the various mechanical units and their general relation to the complete mechanism of the turret.

2. In order to simplify the description, each of the following will be treated separately:

- (a) Hydraulic Power Unit
- (b) Hand Control Unit
- (c) Fire Cut-Off and Elevation Limit Unit
- (d) Switch and Junction Box
- (e) Terminal Box
- (f) Collector Ring Assembly
- (g) Electrical System

B - DETAIL DESCRIPTIONHYDRAULIC POWER UNIT

3. This unit is used to furnish the mechanical power for driving the turret in azimuth and the guns in elevation. The entire unit is mounted within the turret structure. The unit consists of three separate assemblies:

- (1) The azimuth hydraulic system;
- (2) The elevation hydraulic system; and
- (3) An electric motor, common to both systems

The operation of both systems is identical.

4. The hydraulic system consists of:

- (a) A constant speed - variable displacement hydraulic pump.
- (b) A variable speed - fixed displacement hydraulic motor.
- (c) A control and replenishing pump.
- (d) Associated pipe lines, valves, shafts etc.

5. Figure 4 is a schematic cross sectional view of the hydraulic system. Reference should be made to this figure for a clear understanding of the following description of operation of the system.

DESCRIPTION

6. The pump side of the unit, driven by the electric motor shaft, is referred to as the "A" end; the hydraulic motor side, which has the shaft for driving the turret or guns, is referred to as the "B" end. The "A" end shaft is coupled to one end of an electric motor which has the other end of its shaft coupled to the second hydraulic unit. The speed of the electric motor and thus the "A" end shaft, is approximately 4000 r.p.m.

7. The hydraulic pump is provided with inlet and outlet flow pipes. The direction and amount of flow in these pipes is controlled by a movable yoke. The yoke is displaced to one side or the other by a linkage between it and the "booster" piston. The position of the "booster" piston is determined by the control shaft which, in turn, is positioned by the gunner's hand control unit. With this arrangement, a small torque applied to the control shaft is sufficient to actuate the "booster" piston and through it to displace the yoke.

8. If the pump is rotating at approximately 4000 r.p.m. and the yoke is in its normal position, the pistons do not change their positions in the cylinders as the pump rotates. However, if the yoke is displaced in either direction, the pistons will move in and out as the pump rotates off-center. Movement of the pistons in the cylinders creates a hydraulic flow through the pipes to the hydraulic motor. The amount and direction of yoke displacement thus controls the speed, and direction of rotation of the hydraulic motor. The hydraulic motor causes the "B" end shaft to rotate and this motion is transferred by proper gearing to the azimuth or elevation mechanisms of the turret or guns.

9. The control and replenishing pump is also driven by the constant speed electric motor. Replenishing valves are so designed and situated that when the pressure in the system falls below a certain limit, additional hydraulic fluid will be introduced into the system without interfering with its normal operation. Relief valves are provided so that any abnormal pressure developed in the system will be released before damaging the hydraulic system.

10. The hydraulic system thus provides the means for the gunner to obtain smooth operation of the turret and guns as they are moved in azimuth and elevation to "track" the target.

CONTROL UNIT

11. This unit as shown in Figure 2 is used by the gunner to control the azimuth and elevation hydraulic systems. A pair of offset hand grips are mounted on it in such a manner that they can be turned in azimuth and elevation to control the turret and gun movements in the same planes. A "range" knob is mounted centrally at the upper end of the unit, so that it can be turned by either thumb.

12. A gun firing switch is mounted to the rear and at the upper end of each grip. The two firing switches are connected in parallel so that either switch can be used to fire the guns. A power or "safety" switch is provided on each grip; these switches are also connected in parallel so that the gunner can operate the turret when either hand rests on a grip. This type of switch is provided so that in event of mishap to the operator, causing his hands to fall off the grips, it will open the power circuits of the turret and stop all turret motion and firing of guns.

13. The range mechanism gear box is mounted on top of the control unit and is connected by means of a flexible shaft to the range input of the computing sight. The con-

UPPER LOCAL TURRET

nections between the control unit and the hydraulic systems are made by means of shafts and associated gear trains through the fire cut-off and elevation limit unit as shown schematically in Figure 2.

FIRE CUT-OFF AND ELEVATION LIMIT UNIT

14. The Fire Cut-Off and Elevation Limit Unit is provided to:

- (a) Open the firing circuit when the guns are pointed at any portion of the airplane in which the turret is mounted, and
- (b) Remove the hydraulic power driving the guns when they reach the elevation limits (which are imposed by the structures of the airplane and the turret).

15. A schematic diagram of the unit is shown in the upper left corner of Figure 2, in which the important items of assembly have been numbered to simplify an understanding of the mechanism. The azimuth control shaft 31 passes into the unit and through a gear train drives shaft 35 which controls the output of the azimuth hydraulic unit. The elevation control shaft 32 passes into the unit and through a gear train drives: (a) shaft 37 to control the output of the elevation hydraulic unit, and (b) a flat plate 38 which carries a "keg" projection on one side of the plate. When the guns are moving in elevation, shaft 36 which connects to the elevation gear train of the turret, is rotated by that gearing. As shaft 36 rotates, it drives worm wheel 40 through worm 39, which is secured to the shaft. The worm wheel carries a projection similar in size and shape to the one on plate 38. The point at which these projections meet is adjusted so that when the guns are moving downward (toward zero E_g), the meeting of the projections on 40 and 38 causes shaft 32 to rotate in the direction to close the valve of the hydraulic unit through shaft 37 and thus stopping the guns in their movement so that they will not strike the aircraft structure.

16. Shaft 36 is also connected through a second worm wheel and worm to a rack and pinion gear device which carries a cam pin 41. The associated cam 42 is mounted on a gear which is rotated by shaft 33 which, in turn, is driven by the azimuth gear train of the turret. The rack, which forms a part of the plate carrying cam pin 41, is pivoted at points 43 and 44 so that as the cam pin moves over a high spot on the cam 42, the plate is "lifted" and raises the switch pin 45 to open the firing circuit. The cam "lifts" are designed to prevent firing of the guns when they are pointed at any portion of the airplane structure, such as, wings, motors, propellers, tail, etc. This safety feature, permits the gunner to track and fire on a rapidly moving target, without any attention being given to the position of the guns with respect to his own plane.

SWITCH AND JUNCTION BOX

17. This unit is a metal box housing the switches, fuses and the power relay for controlling the electrical circuits of the turret. Terminals are provided in the box for power, inter-connection between various units in the turret and telephone connections for intership communication. The cover of the box may be removed by loosening two screws and sliding the cover out. Spare fuses are mounted on the inside of the cover.

18. Three switches are provided in the box. A single pole single throw toggle type switch designated as the "power" switch, operates the coil of the main switch relay and from its contacts furnishes the power to all circuits in the turret. Two single pole single throw switches are provided to control the firing solenoids of the guns. These

DESCRIPTION

switches can be set independently so that the guns may be fired individually or in salvo as desired by the gunner.

19. The telephone and microphone jacks are customer installed and should be of the open circuit type. All connections, between the switch and junction box and the various units of equipment in the turret are made by means of flexible conduits as shown in Figure 3.

TERMINAL BOX

20. A terminal box is provided as a means for making all connections from the turret to the airplane's power supply and inter-communicating circuits. The box is located adjacent to the thrust bearing mounting flange at the base of the turret. Figure 6 shows the box in outline form and Figure 3 shows the electrical terminals in the box.

COLLECTOR RING ASSEMBLY

21. This assembly is provided so that the turret can rotate continuously without the electrical connections between the turret and airplane being twisted or strained. The assembly consists of two parts:

(1) The fixed section, containing the collector rings, which mounts to the aircraft structure at the base of the turret.

(2) The revolving section containing the brushes, which rotates in azimuth with the turret.

The fixed section contains eight rings, six of which are cabled to the airplane's D.C. power and to the inter-communication circuits. One ring acts as a common ground return for the entire electrical system. Two spare rings are provided as shown in the electrical system diagram, Figure 3. The telephone "push-to-talk" switch is mounted on the revolving section of the assembly in such a position that it can be operated by the gunner's foot.

ELECTRICAL SYSTEM

22. The electrical system is shown on the schematic wiring diagram, Figure 3. Explanation of the switches and inter-unit connections has already been made in the descriptions of the hand control unit, the switch and junction box and the collector ring assembly. All leads in the turret electrical wiring are letter coded at each end for ease in circuit tracing. The plugs and receptacles are keyed to prevent improper connections being made.

23. All electrical power for the turret is obtained from the airplane's supply. The voltage used is 27.0 volts D.C. Reference should be made to Section IV, Installation, for complete information pertaining to the method of making the external connections from the turret to the airplane.

C - MECHANISM FUNCTIONING

24. The functioning of the azimuth and elevation mechanisms of the turret is described in the following paragraphs. Reference should be made to Figure 2 in which the various parts have been numbered to facilitate an understanding of their functions.

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25. Displacement of the guns in elevation is controlled by lifting or depressing the hand control grips 7 and 8. The direction of such displacement (increasing or decreasing E_g) corresponds to the direction of the hand grip motion about the horizontal axis 10.

26. Rotation of the turret is obtained by turning the hand grips about the vertical axis 9. The range knob 11 is mounted conveniently between the hand grips, so that the gunner rests both thumbs on this knob while holding the grips in the palms of his hands. When tracking the target, this knob 11 is rotated to set range in the computing sight 3 by means of flexible shaft 12.

27. Movement of the hand grips represents rate control of the turret in azimuth and the guns in elevation. The hand grips are mechanically connected through - (a) a centralizing and safety spring device, (b) a set of variable pitch gears and (c) the fire cut-off and elevation limit unit, to the azimuth and elevation hydraulic systems 20 and 21. The centralizing spring devices 15, 16, serve to return the hand grips to their zero rate position when the grips are released by the gunner. The variable pitch gear assembly in the azimuth and elevation control mechanisms are provided to convert linear motion of the hand grips into non-linear motion of the control valves of the respective hydraulic units in order to produce non-linear rate of motion of the turret and guns. The purpose of this device is to spread the slow rates for "tracking" over a larger part of the hand grip movement, while the high rates for "slewing" are spread over the remaining smaller part.

28. This non-linear conversion is accomplished by feeding the hand grip movement to one of a pair of spur gears 27 and 28, with the axis of 27 off the true center of the gear, and with the meshing gear 28 mounted on its true axis. As the offset axis of 27 rotates, the true center will rotate about the offset axis. In this way, linear rotation of the offset axis will cause non-linear rotation of the meshing gear, due to the fact that the ratio of the radius of 27 in mesh with the radius of 28 varies with the rotation of the offset axis.

29. The input to the elevation hydraulic power unit serves to displace the yoke on the variable stroke hydraulic pump as described in paragraphs 3 to 10. The resultant operation of the hydraulic unit rotates the output shaft, which through a suitable gear train 26, the auxiliary elevation axle 52, and the two sector gears 51, is connected to the main elevation axis of the guns. An elevation hand crank 48 is located on the right side of the turret in order to provide manual elevation of the guns during testing or when the power has failed.

30. A flexible shaft 36 is connected to the left hand elevation gear train 50 through a pair of bevel gears at the left hand side of the turret. The other end of this flexible shaft terminates in the fire cut-off and elevation limit unit as previously described. By means of a pair of bevel gears, rotation of this shaft 46 produces rotation of the flexible shaft input (E_g) to the sight. A fixed coupling and an adjustable coupling are provided on the elevation axle 52 to permit proper adjustment upon installation.

31. Rotation of the azimuth control shaft 31 is carried through a gear train and a shaft 35 directly into the azimuth hydraulic power unit where it serves to displace the yoke on the variable stroke pump as explained in paragraphs 3 to 10. The resultant operation of the hydraulic motor rotates the output shaft which through a train of spur gears 25, an intermediate driving gear shaft and pinion 5, is connected to the azimuth fixed internal

DESCRIPTION

ring gear and thus serves to position the turret in azimuth. The lower end of the intermediate driving gear shaft is provided with an azimuth hand crank so that the turret can be moved manually during testing or in case of power failure.

32. The upper end of the shaft is connected: (a) through spur gears to the Ag input to the sight through a flexible shaft, and (b) to the firing cut-off cam to rotate it in accordance with the azimuth position of the turret. In this manner the azimuth and elevation displacements are used to restrict the line of fire within certain prescribed limits as described in paragraphs 15 and 16.

U P P E R L O C A L T U R R E T

SECTION IIOPERATIONGENERAL

1. The following procedure applies only to actual operation of the turret mechanism in conjunction with the Automatic Computing Sight. Reference should be made to Section I for detailed description of the functioning of the turret mechanisms and to Instructions 14-225 for a complete description of the operating features of the Computing Sight.

A - PRE-FLIGHT OPERATION

2. The following pre-flight procedure is recommended to insure satisfactory operation of the turret during actual combat.

- (1) Clean plexiglass panels in dome
- (2) Check alignment of sight and guns by boresighting
- (3) See that hydraulic breather cups are one quarter full of oil
- (4) Be sure that power clutches are engaged
- (5) Check to see that hand cranks are disengaged (do not disengage until after power clutches have been engaged)
- (6) Load ammunition boxes and feed ammunition just up to guns
- (7) Move main switch lever to "ON" position
- (8) Move sight switch lever to "ON" position
- (9) Close safety switches on hand control unit
- (10) Allow hydraulic units and sight to "WARM" up at least 5 minutes before take-off
- (11) Check response of azimuth and elevation mechanisms by manipulating the hand control unit
- (12) Turn range knob and observe that reticles move in response
- (13) Adjust reticle light to desired brilliance (approximate)

B - IN-FLIGHT OPERATION

- (1) Charge guns twice
- (2) When target is sighted, set in target dimension on sight
- (3) Turn on fire selector switches
- (4) Turn hand controls so that reticles stay on target ("tracking" the target)
- (5) Adjust range knob until reticles frame the target
- (6) Close either firing switch
- (7) After ammunition is used up, charge guns at least twice to clear out live shells
- (8) Move turret to 3200 mils azimuth and guns to 0 elevation when not in use

O P E R A T I O N

3. In event of power failure, the turret may be controlled by the handcranks. It is not possible to track a target when the handcranks are used, since the movement of the guns and turret would be too irregular for accurate sighting even if the gunner could manipulate all the controls at one time. The handcranks may be used, however, for positioning the turret and guns so that they point to the approximate position of the target.

4. When it is necessary to use the handcranks, the procedure shown below should be followed exactly as shown.

- (a) Engage azimuth and elevation handcranks
- (b) Disengage power clutches
- (c) Move turret and guns in desired directions
- (d) When finished re-engage power clutches
- (e) Be sure to disengage handcranks before operating power motor again

UPPER LOCAL TURRET

SECTION IIIMAINTENANCEA - ADJUSTMENTS AND TESTSGENERAL

1. The instructions given herein cover the necessary adjustments and tests on the turret mechanisms. Specific information covers the following in the order named:

- (a) Eccentric gears
- (b) Centralizing springs
- (c) Control handles
- (d) Hydraulic power drive
- (e) Elevation stops
- (f) Fire cut-off

2. ECCENTRIC GEARS:- The eccentric gears which control hydraulic power for azimuth and elevation movement of the turret should be adjusted in the following manner:

- (a) Remove covers on control unit and fire cut-off unit.
- (b) Turn on power to turret and turn azimuth and elevation rate shafts in fire cut-off unit until rates from both hydraulic units are zero.
- (c) Loosen locknuts on front ends of pinion shafts in control unit and set both eccentric gears so that their slots are horizontal.
- (d) Tighten locknuts.
- (e) Replace covers on units.

3. CENTRALIZING SPRINGS:- The centralizing springs control the forces from the hand control unit to the eccentric gears. They should be adjusted in the following manner:

- (a) Turn on power to the turret.
- (b) Set rate to zero on both azimuth and elevation hydraulic units.
- (c) Adjust joints on vertical rods so that centralizing springs are in their center position.

4. CONTROL HANDLES:- The control handles are the medium by which the gunner controls the movement of the turret and guns in azimuth and elevation. The rods from the control handles pass the manual force to the centralizing spring. The following adjustment between the rods and springs should be made:

- (a) Set centralizing springs at zero rate position for elevation and azimuth.
- (b) Adjust the rods to the control handles so that the handles are vertical and are centered for azimuth.

5. HYDRAULIC POWER DRIVE:- With the sight and turret switches "ON" and with the turret being operated by the control handles, smooth operation should be obtained when the turret moves in azimuth and the guns in elevation. The turret should rotate at rates from

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5 mils/sec to 800 mils/sec, and the guns should move in elevation at rates from 5 mils/sec to 500 mils/sec. If smooth operation is not obtained, the hydraulic unit should be carefully inspected for leaks and foreign matter, particularly in the valves. The torque of the hydraulic unit should be approximately 377 pounds and 707 pounds respectively in the azimuth and elevation movements (both measured at the outer end of the guns).

6. When the control handles are released, the "dead man" switches should open and stop the turret. The turret should be operable from the switch on either control handle. A check should be made to assure that the brushes on the collector rings make good contact during complete revolution of the turret. CARE SHOULD BE TAKEN TO AVOID OPERATING THE TURRET WITH THE SIGHT SWITCH "OFF".

7. ELEVATION STOPS:- The elevation stops should be checked by raising and lowering the guns slowly under power to both extremes in elevation. The movement of the guns should cease automatically as they reach 0° or 85° elevation (1511.1 mils on the dial).

8. If operation of the elevation stops is not satisfactory, it will be necessary to realign the mechanism in the following manner:

- (a) Remove cover of fire cut-off unit
- (b) Run guns slowly to zero elevation
- (c) Loosen the three retainer screws on the large spiral gear on the elevation rate shaft, also loosen the three screws on the gear from the elevation flexible shaft to the elevation fire cut-off rack.
- (d) Turn elevation rate shaft until hydraulic unit just begins to move gun upward.
- (e) Turn stop lug until it prevents any greater downward rate, due to its contact with the other lug
- (f) Tighten retainer screws
- (g) Move guns slowly and check 0° and 85° limits
- (h) Reset fire cut-off unit in accordance with paragraph 9
- (i) Replace cover of unit

9. FIRE CUT-OFF UNIT:- The fire cut-off unit should be checked by aiming the guns (by boresighting) at all parts of the airplane structure, or its accessories, which come within the field of fire. It should not be possible to operate the firing solenoid of either gun while the guns are pointed at any of these various cut-off areas. A convenient method of checking operation of the firing solenoids is to connect an ohmmeter across the DCP terminal of the fuse block in the switch box (remove the 20 ampere fuse during this test) and the FK terminal on the fire selector switches. When the firing key is operated, the ohmmeter will show a closed circuit if the fire cut-off switch is closed.

10. If the firing solenoid can be operated when either of the guns is pointed at any portion of the airplane or its accessories, it will be necessary to make adjustments in the following order:

UPPER LOCAL TURRET

- (a) Remove cover of fire cut-off unit and remove switch bracket assembly of unit and lay bracket aside.
- (b) Set turret at zero azimuth. Set guns at 9° elevation (160 mils). This should be done by first running guns to zero position, i.e., where the scribe marks on the elevation cross shaft and the elevation gear housing line up. Then move the guns up by turning the cross shaft exactly 3 revolutions and then back 1 revolution.
- (c) Loosen the three clamp screws in center of the cam (for azimuth) and the three ring retainer screws on the elevation worm gear (for elevation).
- (d) Place setting fixture (#177126) in the hole in the cam.
- (e) Place cam pin in detent of fixture by revolving cam in azimuth and by sliding cam pin in elevation. Test for detent with light finger pressure.
- (f) Tighten the clamp screws and recheck the setting.
- (g) Tighten the ring retainer screws and again check the setting.
- (h) Using the handcranks, move the turret in azimuth and the guns in elevation until the cam pin reaches the top of the slope (11°) on the fixture.
- (i) Adjust height of cam pin by means of locknut so that it opens the fire cut-off switch as near the top of the slope as is possible. Check opening of the switch with an ohmmeter and not by "click" of the switch.
- (j) Switch must open before cam pin reaches flat surface of the fixture.
- (k) CAUTION: DO NOT PUSH SWITCH DIAPHRAGM TOO FAR EITHER BY HAND OR BY THE CAM PIN - THIS MAY DAMAGE THE SWITCH AND ENDANGER IMPORTANT SAFEGUARDS.
- (l) Remove setting fixture from cam and disengage handcranks.
- (m) Replace switch bracket assembly and fasten cover to unit.

B - ROUTINE MAINTENANCE

- 11. CLEANING:- Every precaution should be used to prevent dust, dirt or other foreign matter from entering the turret. Keep all cover plates in place and perform the servicing operations in as dust-free surroundings as is possible.
- 12. All switches, terminal blocks, slip rings etc., should be cleaned regularly with a clean cloth and carbon tetrachloride. Be sure that excess grease or oil is removed after the servicing operations.
- 13. Particular care should be used to prevent small particles of foreign matter getting under the valve seats of the hydraulic units; the most common cause of sluggish hydraulic operation is due to disregard of this precaution.
- 14. OILING:- While oiling is a necessary and important part of the maintenance of the turret, it should be kept in mind constantly that excess oil or grease in the mechanisms is to be guarded against.
- 15. All points of friction should be given a few drops of Univis #40 oil (be careful not to over-oil). Using a hypodermic needle, put one drop of oil in each bearing of the fire cut-off unit. Andok C grease should be used when lubrication of the gear trains is required.

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16. The breather cups of the azimuth and elevation hydraulic units should be inspected regularly and filled to one-third of their capacity with Univis #40 oil.

17. 50 HOUR INSPECTION ROUTINE:- After each 50 hours of actual service, the following routine is recommended to insure efficient operation of the turret:

(1) Check power gears and bearings for wear and excess backlash. Seven mils may be considered the safe limit. This represents 1/4" movement of ends of guns in elevation or azimuth.

(2) Clean fire cut-off unit and put one drop of #40 Univis oil in each bearing.

(3) Clean dome panels.

(4) Empty clips and cases from ammunition bag.

(5) Clean slip rings (replace brushes if necessary).

(6) Make approximate check of torque of hydraulic units (377 lbs. at end of guns, azimuth; 707 lbs. elevation).

(7) Check operation of fire cut-off cam and sealed switch.

(8) Check for binds in gear trains, bearings and ring gear. Clean and adjust if necessary.

(9) Check cannon plugs for loose connections.

(10) Boresight turret.

(11) Have guns serviced.

(12) Check to see that guns have not loosened in their mounts.

(13) Check grease in gear boxes, add Andok C grease when necessary.

(14) Clean relay points with crocus cloth.

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SECTION IVINSTALLATIONA - GENERAL

1. The instructions given herein cover the installation of the turret proper in the airplane, and the subsequent installation of certain units inside the turret. Specific information covers the following in the order named:

- (1) Installation of turret in airplane
- (2) Electrical connections to the turret
- (3) Installation and alignment of guns
- (4) Installation of gun accessories
- (5) Installation of oxygen bottle and regulator
- (6) Installation of Computing Sight K-3
- (7) Double power unit (minor assembly)
- (8) Replacing turret dome
- (9) Boresighting

B - INSTALLATION OF TURRET IN AIRPLANE

2. Installation of the turret in the airplane should proceed in the manner described in the following paragraphs, using the installation and outline drawing, Figure 6, for reference.

(a) The turret is supported in its shipping crate by the outer flange of the azimuth ring gear and suitable bolts. Remove the top of the crate.

(b) Lift off the dome by taking out the nuts on the studs in the mounting flange and separating the two halves of the gun slot covers.

(c) Removal of the dome provides access to two hoisting lugs on the turret structure. These lugs are arranged so that their center lifting point is approximately at the center of gravity of the turret assembly. Lift the turret out of its crate and remove the azimuth ring gear assembly.

(d) A sectional outer flange constructed in six segments is mounted to the ring gear proper. Because the opening in the airplane is not large enough to pass the assembled flange, it is necessary to remove two opposite flanges of the ring before sliding the ring gear through the turret opening in the plane. With the ring gear in the airplane, replace the flanges and mount the ring gear in its supporting structure, shimming as necessary to level the gear with respect to the airplane. Orient the ring gear so that the zero azimuth point (marked $A_g = 0$) is on the center line of the plane and forward $\pm 1^\circ$. This point should be marked on the supporting structure.

(e) Lower the turret through the ring gear into the airplane, carefully meshing the azimuth drive pinion with the ring gear. When the turret is properly installed as described in this and the following paragraph, the Fire Cut-Off Unit should be synchronized as described in paragraph 10 of Section III.

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(f) A 5/16" space has been provided between the floor mounting plate and the thrust bearing mounting flange. While holding the turret with the slings, the thrust bearing mounting flange shall be shimmed up until the lower surface of the azimuth drive pinion is 1/8" below the ring gear. (See Figure 6). In shimming the thrust bearing mounting plate, care should be used to assure that the plate is perpendicular to the vertical axis of the turret. This may be done by checking the vertical position of the azimuth drive pinion with respect to the ring gear at several points on the ring. When the check has been made, bolt the mounting flange (through the shims) to the floor with six 3/8" bolts.

C - ELECTRICAL CONNECTIONS TO TURRET

3. Terminals are provided in the switch and junction box (left side of turret) for connecting two jack cords. These jack cords are terminated in two jacks, one for the telephone head set and one for the microphone. The jacks should be mounted in the side of the box and wired as shown on Figure 3, Schematic Wiring Diagram.

4. Connect the positive pole of D.C. (27.0 volts) from the ship's power supply to the 5/16" screw marked DCG in the terminal box at the bottom of the turret. Connect the ground wire to the 5/16" screw which is located on the thrust bearing housing at the bottom of the turret; see Detail "B" in Figure 6. Connect the telephone and microphone leads from the ship to the proper terminals in the terminal box at the base of the turret.

D - INSTALLING AND ALIGNING THE GUNS IN TURRET

5. Remove the front trunnion and charge slide assemblies. The Edgewater recoil adapter cartridges should be screwed in place and the guns put in place as shown in Figure 5. Bolt the rear trunnion in place with the bolt, nut, and cotter key supplied for the purpose.

6. Align the guns in the following manner (plane must be level sidewise) so that they will be laterally parallel as well as perpendicular to the horizontal cross axis of the turret.

(a) Adjusting screws which bear on a sliding block are provided on the rear trunnion for making lateral adjustments. Bolts with locknuts are provided in the same location for making vertical adjustments. Always make the lateral adjustment first since it is necessary to loosen the locknuts on the vertical bolts before the lateral adjustment screws can be moved. To make the lateral adjustment, raise the guns to approximately 85° and loosen the locknuts on the vertical bolts. Adjust the guns laterally until a spirit level placed against the side plates of the guns shows the guns to be in parallel vertical planes. When the guns are in parallel vertical planes they must be laterally parallel and perpendicular to the horizontal cross axis of the turret. When this adjustment has been completed, both lateral adjusting screws and their respective locknuts should be tightened.

(b) To make the guns vertically parallel, the gun yoke should be set at zero elevation. This can be done by running the guns down until the sight mounting pin is level; aligning the zero mark on the flange of the elevation cross shaft (just to right of central gear housing) with the zero mark on the housing. Adjust the guns vertically by means of the locknuts on the vertical bolts at the rear trunnions so that a spirit level when placed on the cover plates, shows the guns to be level; then tighten the locknuts. Make adjustments with guns pointing to rear of airplane.

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E - INSTALLATION OF GUN ACCESSORIESGENERAL

7. The following gun accessories are installed before the gun has been mounted in the turret: (1) Firing solenoid adapters, (2) Firing solenoids, (3) Link ejection chutes and (4) set of hand charger parts (for modifying the standard hand charger of each gun). Figure 5 should be referred to in connection with the following installation instructions.

FIRING SOLENOID ADAPTERS

8. The firing solenoid adapters are mounted at the tops of the gun receivers and are held in place by three hexagon head machine screws. To install the adapters, the receiver top covers shall first be removed by taking out the three flat head retaining screws. The adapters shall then be placed at the tops of the receivers with their cover plates removed and the interconnecting linkage to the gun trigger bars connected as shown in Figure 5. The adapter cover plates shall then be replaced and the three retaining screws (with the lockwashers on them) inserted in the mounting holes.

FIRING SOLENOIDS

9. The firing solenoids are mounted at the tops of the firing solenoid adapters with the electrical connections forward and are held by mounting bolts at the forward ends and the mounting lugs at the rear. They should be installed by removing the nuts and cotter keys from the forward mounting bolts and inserting the mounting lugs and bolts in the slots which are provided in the solenoid adapter cover plates. The nuts on the forward mounting bolts should then be tightened and the cotter keys replaced. Electrical cables with AN plugs are provided at each gun and these shall be connected to the firing solenoids.

LINK EJECTION CHUTES

10. A link ejection chute is provided with each gun to connect the links from the gun to the ejection passageway. It is mounted on the gun between the link stripper and the front ammunition stop and is held in place by the feed pawl pin as shown on Figure 5. To install the link chute the feed pawl should be retracted, the gun cover opened and the chute inserted in place with the tongue forward. The feed pawl pin shall then be replaced in its original position.

MANUAL CHARGER

11. Each gun is normally equipped with a standard manual charger which is located on the right hand side of the gun. These charger assemblies were removed when the guns were installed (see paragraph 5). The charging lever and three studs should be removed from the assembly and replaced with parts SG-1101, SG-1103, SG-1104 and SG-1105 which are provided with the turret. See Figure 5. On the left-hand charger, the charging lever spring shall be replaced by part SG-1631. Both chargers and the charger pulley brackets (SG-1121-1 and SG-1126-2) should then be mounted on the guns by replacing the mounting bolts and inserting the three hexagon head mounting screws (SG-1667) provided with each

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charger. The charger should be mounted on the side of the gun nearest the center of the turret. The wood grips which were removed with the standard charging levers, should then be assembled to the charging handles which are provided with the turret. The charging cables are attached to the charging handles within the turret and they should be fastened in place after the dome has been installed. This shall be done by first detaching the cable clevises and the floating pulleys from the cables and attaching the cable clevises to the charging levers. The brackets holding the floating pulley should be attached to the coil springs located at the top of the dome near the gun slots. The cables should then be threaded consecutively over the fixed pulleys in the roof bracket, the floating pulleys, and the pulleys on the gun yoke and the charger assemblies and then attached to the cable clevises as illustrated in Figure 5.

AMMUNITION FEED

12. The guns are normally assembled for left hand feed. The gun assembled in the left hand side of the turret must be connected for right hand feed in accordance with the standard instructions issued by the Ordnance Department.

COVER LATCH OPERATING LEVER

13. The guns can be assembled with the cover latch operating lever at either the left or right hand side of the cover. This lever should be attached to the side of the cover nearest the center of the turret. When necessary, the conversion should be made by removing the cotter pin from the end of the latch pin, withdrawing the pin and inserting it from the opposite side. Then replace the cotter key.

BACK PLATE LATCH LOCK

14. The latch lock on the back plate of the gun is normally assembled so that the hinged portion protrudes from the left hand side of the gun. This latch lock should protrude from the gun on the side away from the center of the turret so that it will not interfere with the charging mechanism. This makes it necessary to change the latch lock on the gun installed in the left hand side of the turret. This is done by removing the escutcheon pin which retains the latch lock and then swinging the latch lock around to the other side, taking care to keep the latch lock spring in place. The escutcheon pin and cotter key should then be replaced.

F - INSTALLATION OF OXYGEN BOTTLE AND REGULATOR

15. Each turret is provided with an oxygen bottle and regulator mounted within the structure. The oxygen bottle is arranged so that it can be swung out of the way to clear the passageway through the turret. Install the bottle with the outlet forward in the bracket and attach the flexible tube to the bottle outlet. Mount the oxygen regulator on its bracket located at the right hand side of the ring casting, just below the elevation hand crank. Sufficient tubing is provided for connection between the regulator and bottle.

G - INSTALLATION OF .50 CALIBRE AUTOMATIC COMPUTING SIGHT K-3

16. The following procedure is recommended for installation of the sight.

- (a) Remove the mounting pin from the mounting pin lugs on bottom of the sight

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by lifting the spring latch bar and pulling the pin free.

(b) Hold the sight in both hands and move it forward until the mounting pin and lugs straddle the yoke.

(c) Move the sight forward and to the right until the mounting pin hook engages the right hand mounting pin.

(d) Insert the left hand mounting pin through the holes in the yoke and the mounting pin lugs on the sight. When the mounting pin is fully and firmly against the yoke facing, push the latch pin in place.

17. When the sight has been installed as described above, the azimuth and elevation dials of the sight should be set as described in the following paragraphs.

18. The dials must be set before connection of the azimuth and elevation flexible rate shafts to the pinion gears of the sight, since these gears are not accessible for turning by hand directly, and the other ends of the flexible shafts are properly aligned to the turret mechanism and should not be disconnected unless absolutely necessary. The free end of the range shaft may be used for this purpose, using the range knob for turning the input pinions.

(a) Connect the free end of the range shaft to the elevation pinion gear of the sight.

(b) Position the guns at zero elevation, and zero azimuth, using the hand cranks.

(c) Turn the range knob until the elevation dial reads zero.

(d) Remove the range shaft and connect the elevation flexible shaft to the elevation pinion gear, meshing them carefully to the nearest tooth.

(e) Repeat parts (a) to (d) to obtain zero setting of the azimuth dial (using azimuth in place of elevation references).

19. Electrical connection to the sight is established by connecting the power cable plug to the receptacle on the back of the sight.

H - DOUBLE POWER UNIT (MINOR REASSEMBLY)

20. Before the turret is shipped, a small amount of oil is removed from the hydraulic systems and the breather cups are removed. These breather cups should be reassembled to the pipe connectors at the tops of the units and clean servo oil shall then be added until the breather cups are filled to one quarter of their capacity. The insides of the breather covers may be used as mirrors for convenience in checking the oil level.

I - INSTALLING THE TURRET DOME

21. After the sight has been installed, set the dome in place on its mounting flange and tighten evenly the eleven elastic stop nuts on the studs in the flange. The two halves of the gun slot covers should be brought together and the four retaining screws put in place. After the dome installation is complete, the charging cables should be installed as described in paragraph 11 of this section.

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J - BORESIGHTING

22. Following complete installation of the turret and the computing sight, the original alignment of the guns should be checked and the sight then aligned with the guns. The following procedure is recommended.

(a) Remove the gun bolts, and sight through each gun bore at an object at least 1000 yards distant. If the gun alignment procedure described in paragraph 5 has been carefully followed, little or no adjustment may be required for both guns to be aligned on the same object. Make any necessary adjustments on the rear trunnions of the guns.

(b) Disconnect azimuth and elevation flexible shafts from the sight.

(c) With sight switch "OFF", remove lamp housing cover and lamp from sight and direct a light into the bulb housing cover so that the reticles can be seen. An ordinary pocket flashlight may be used for this purpose.

(d) Set sight target dimension dial at 20 feet and rotate the range knob to set the range dial at 1000 yards. This will make the reticles appear as a slightly offset cross hair.

(e) The deflection dials on the right hand side of the sight should be made to read zero by disconnecting the range input shaft and then connecting it alternately to the elevation and azimuth input connectors of the sight, rotating the range knob in proper direction to obtain zero deflection readings.

(f) Sight through the gun bores at the target 1000 yards or more away and adjust the screws on the deflection shafts just above the dials until the cross hair of the sight reticles is on the same target. These screws are accessible when the glass cover plate on the right side of the sight is removed.

(g) Replace the lamp, lamp housing and cover plate, and gun bolts.

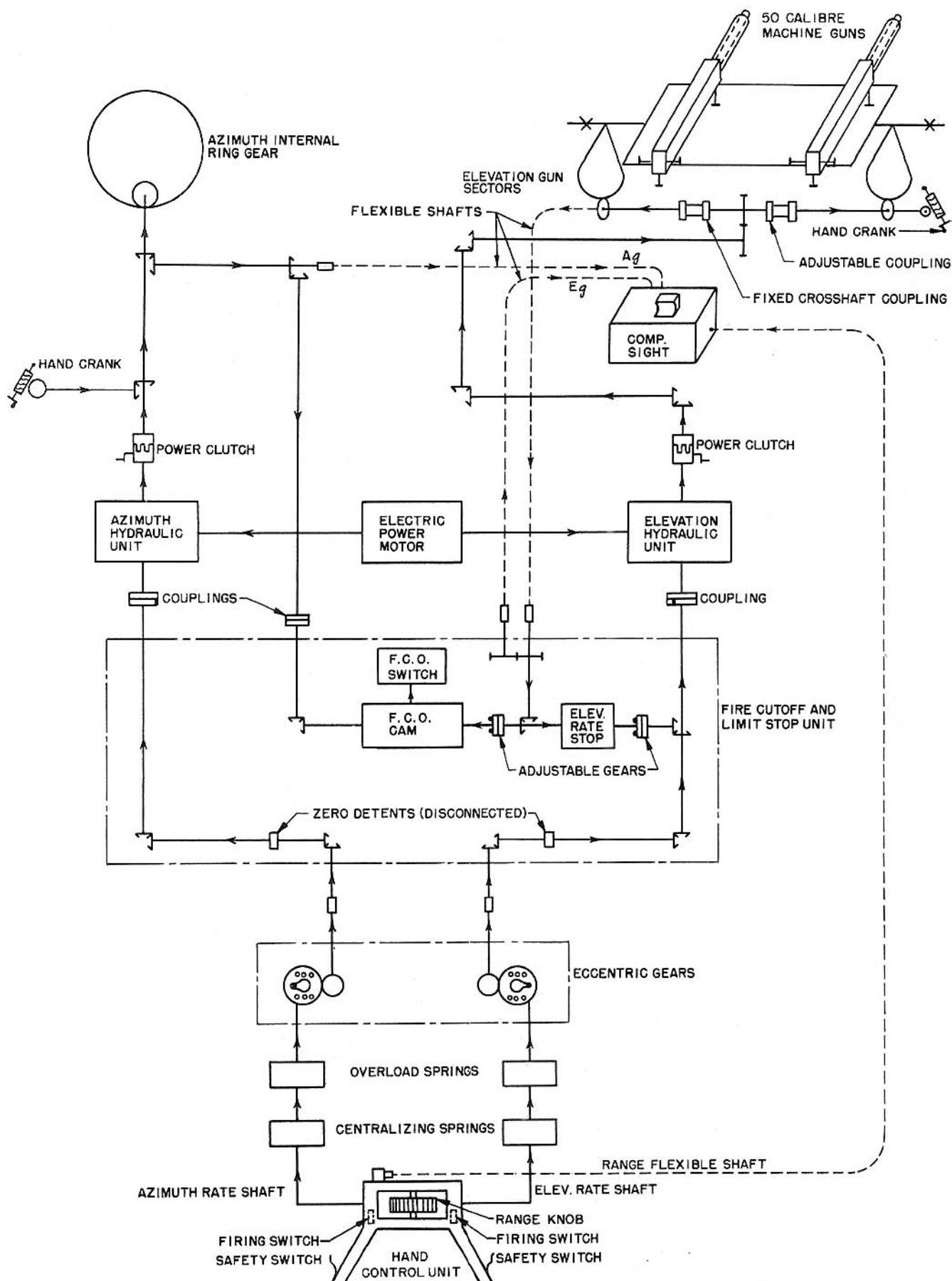
(h) Turn on sight switch and move turret to zero azimuth and zero elevation.

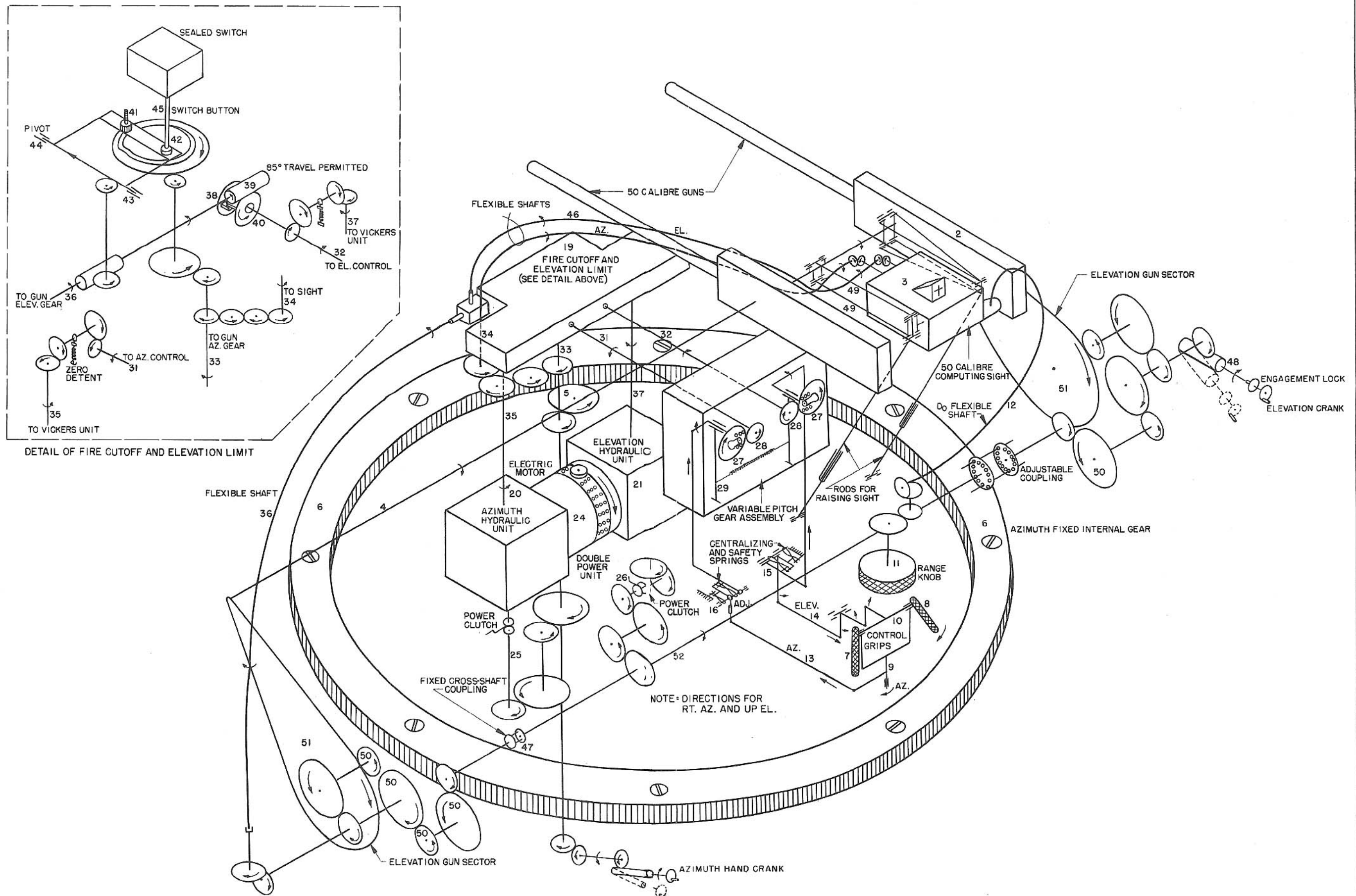
(i) The elevation and azimuth dials on the top and bottom respectively of the sight should now be made to read zero by alternately connecting the range flexible shaft to the elevation and azimuth connectors of the sight and rotating the range knob.

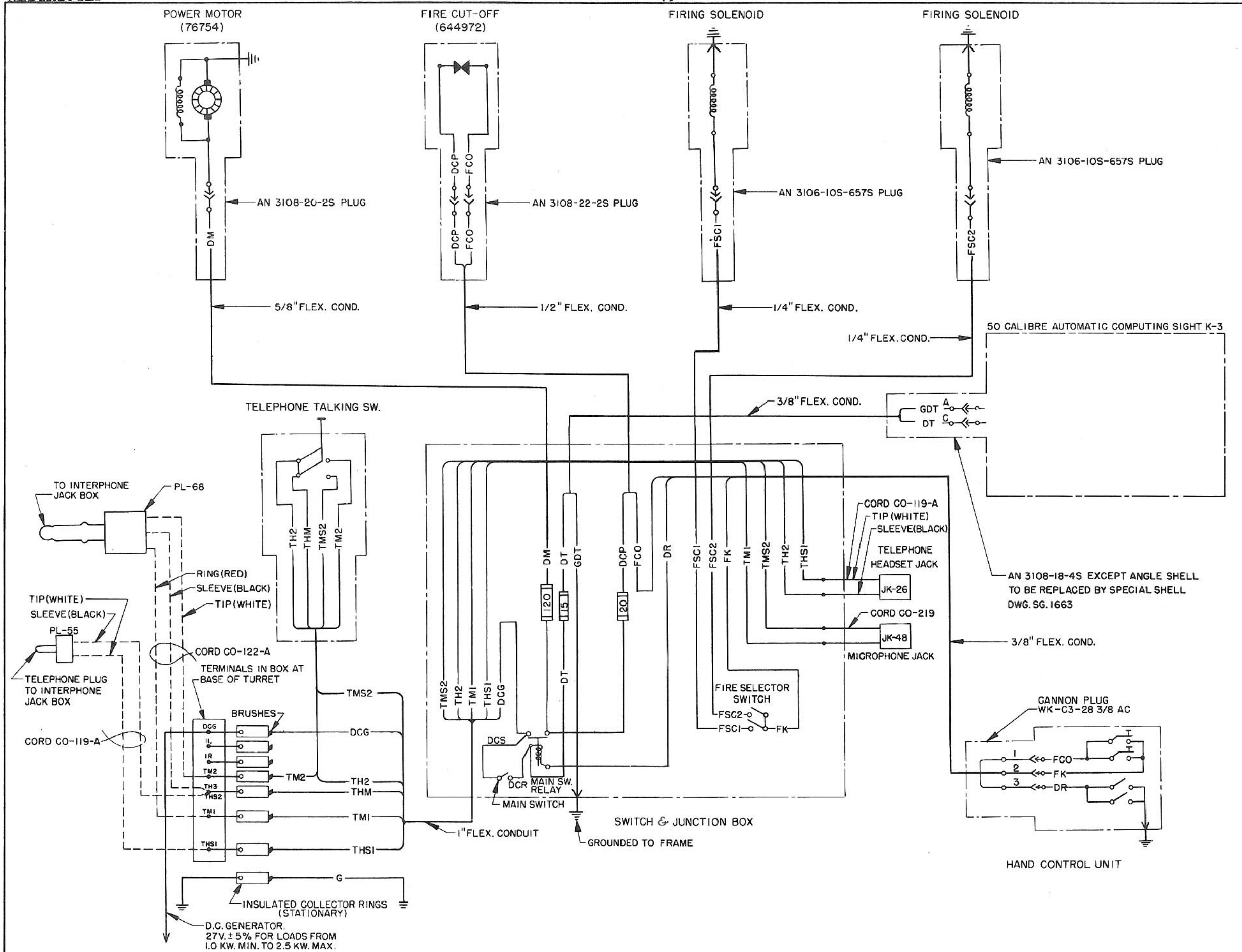
(j) Attach all flexible shafts to their proper connectors on the sight.

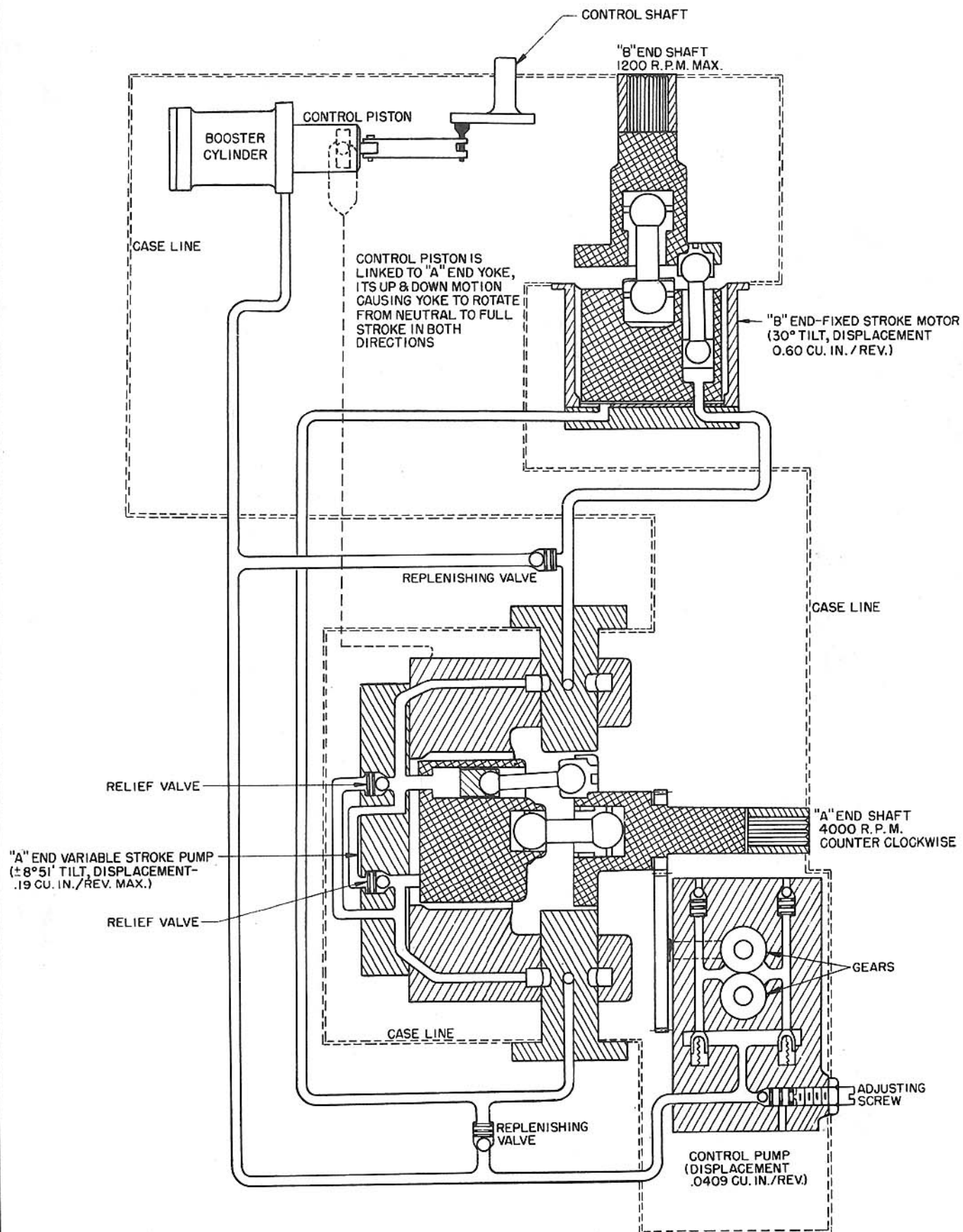
(k) Be sure that handcranks are disengaged and are safety wired in position.

(l) Be sure that power clutches are engaged and are taped up.







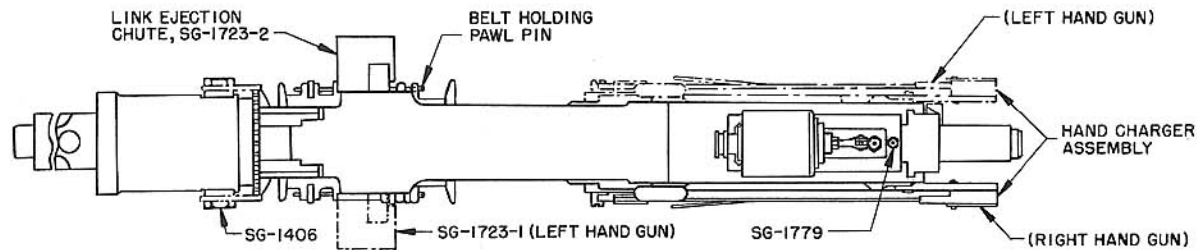


HYDRAULIC POWER UNIT
(CROSS SECTION OF ONE HALF OF DOUBLE POWER UNIT)

FIGURE-4

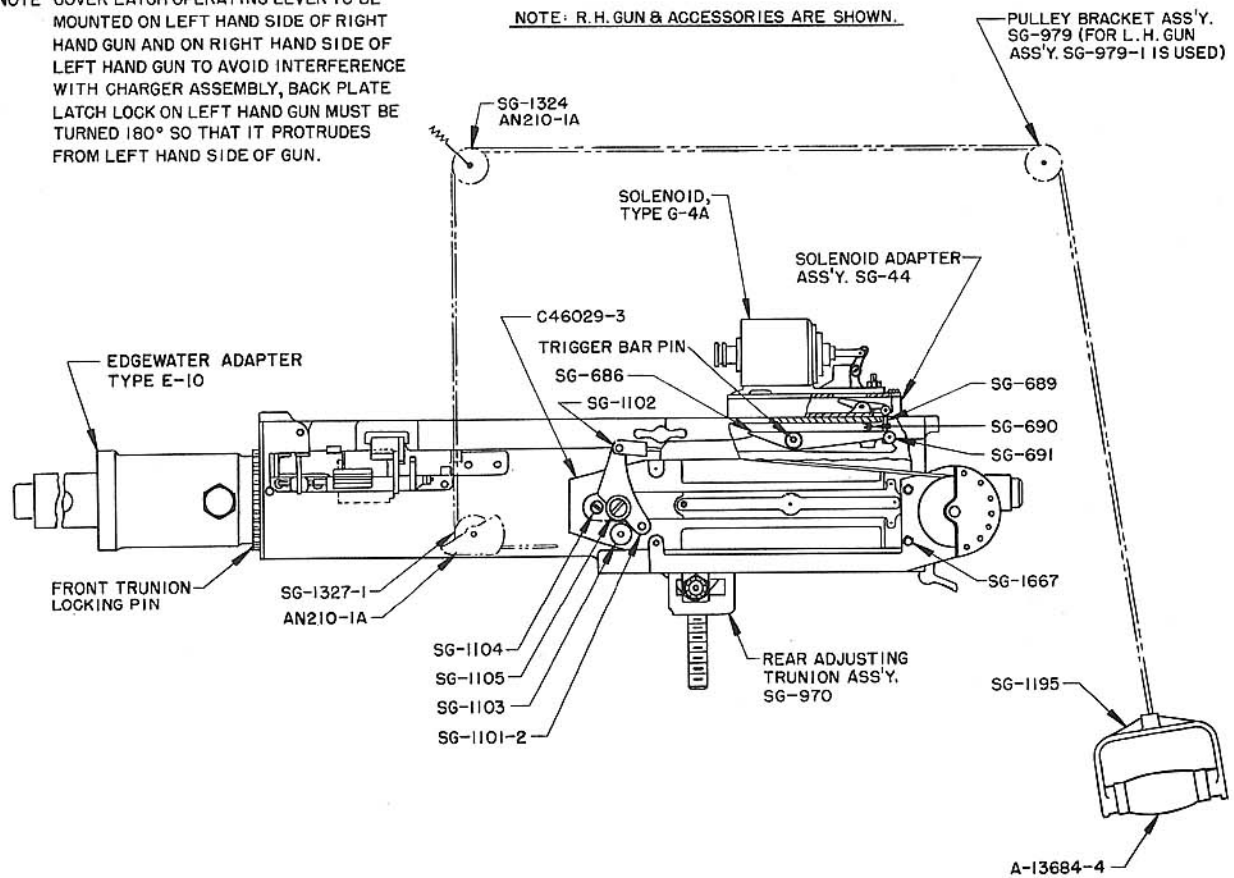
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NOTE COVER LATCH OPERATING LEVER TO BE MOUNTED ON LEFT HAND SIDE OF RIGHT HAND GUN AND ON RIGHT HAND SIDE OF LEFT HAND GUN TO AVOID INTERFERENCE WITH CHARGER ASSEMBLY, BACK PLATE LATCH LOCK ON LEFT HAND GUN MUST BE TURNED 180° SO THAT IT PROTRUDES FROM LEFT HAND SIDE OF GUN.

NOTE: R.H. GUN & ACCESSORIES ARE SHOWN.



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MOUNTING OF GUN ACCESSORIES

FIGURE-5

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