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CHAPTER 11

AIRCRAFT TURRETS

CHAPTER 1

WHY TURRETS?

DEBUT AT DUNKERQUE

Aircraft turrets made their debut at Dunkerque. A Hollywood script writer could hardly dream up a more dramatic situation.

You remember the scene. The beaches were littered with destroyed and discarded British equipment. Under pounding German artillery fire and constant aerial attack, men crowded into tiny fishing boats, and pushed onto the decks of destroyers and small patrol craft.

The British army was licked — for the time being. But in the sky, the RAF was STILL FIGHTING, throwing men and planes at the Luftwaffe's air armada.

It was on the second day of the battle of Dunkerque that an RAF squadron of Boulton-Paul "Defiants" handed Air Marshal Goering's boys a tremendous surprise. These two-seat British fighter planes had seen action before. But today, SOMETHING NEW HAD BEEN ADDED. Each Boulton-Paul was equipped with a hydraulic-powered turret, mounting two .30 caliber machine guns!

Into the swarms of Messerschmitts, Focke-Wulffs, and Junkers they flew, with turrets blazing.

What happened? That's what the Nazis were asking. After that first encounter the score stood, GERMANS—0, VISITORS—37. The turret-equipped Defiants had shot down 37 enemies without losing an airplane! And they had demonstrated to the world that the aircraft turret was HERE TO STAY.

POT SHOTS AT THE ENEMY

The PRINCIPLE of the turret is not new. King Arthur and his knights used it. Centuries ago, warriors realized the strategic importance of being able to heave a spear or fire a crossbow from a fortress into some direction other than straight out the window.

In other words, they wanted to INCREASE THEIR ANGLE OF FIRE. So they added a turret tower that stuck out from the main fort. Then they could stand in the turret and take pot shots along the wall to the left, along the wall to the right, or to any point in the three-quarter circle which formed the new angle of fire.

Airplane turrets INCREASE the gunner's ANGLE OF FIRE in the same way. Also, they furnish power-controlled movement of the turret and guns against the force of the slipstream.

At the beginning of World War I, airplanes were used only for observation purposes and were not armed with machine guns. With the development and adoption of the two-seater observation plane, a single machine gun was mounted in the observer's cockpit. It was set on an upright post with a swivel on top so the gun could be swung in the desired direction.

When the speed of airplanes was increased, it was impossible for the gunner to swing the guns against the terrific PRESSURE OF THE SLIPSTREAM. So the gunner and guns were enclosed in a glass dome with the guns sticking out through slots. As the guns were still swung manually, the gunner was not much better off than before.

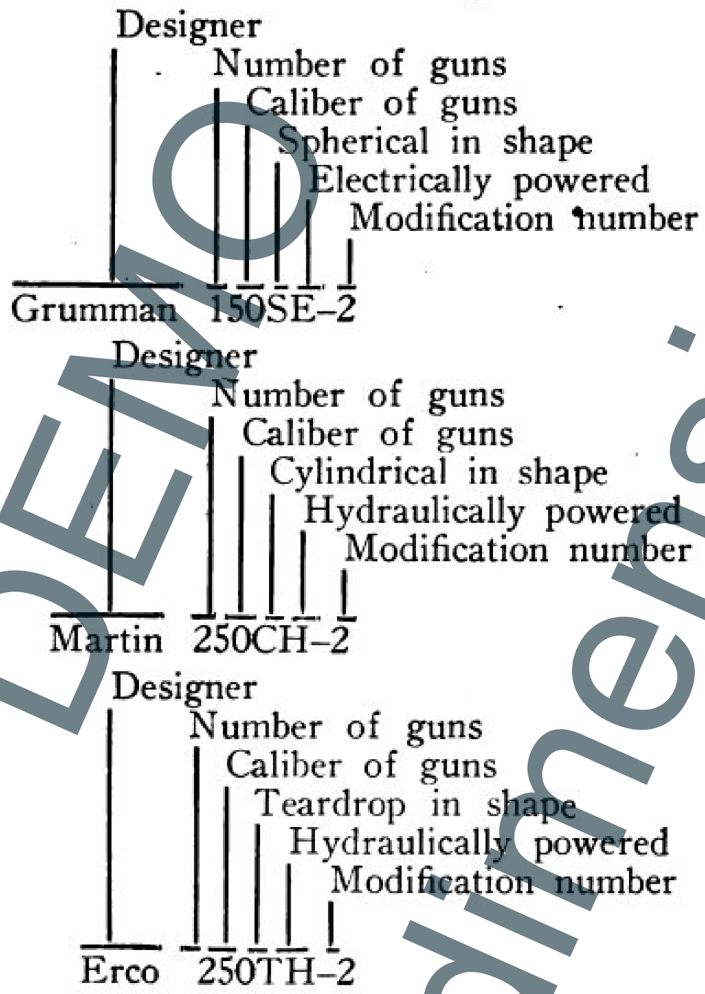
Then HYDRAULIC POWER was used to swing the turrets, but the guns were still elevated by the gunner. This was a great

Martin 250 SH–3A	Bow of PBM–5
Martin 250 CH–1B	Upper Deck PBM–5
Martin 250 CH–2B	Tail PBM–5
Grumman 150 SE–2	Upper TBF–1
Martin 250 CE–13	Upper PV–2

You can identify Navy turrets easily if you know how to read the code designations.

Take a Grumman 150 SE–2 turret, which is installed on a TBF–1. First the name "Grumman" means that the turret is designed by the Grumman Aircraft Corporation. The number "150" means that the turret is armed with one .50 caliber machine gun. The first letter of the code "SE" tells you that the turret is spherical (ball) in shape. The "E" informs you that it is electrically operated. The number "2" at the end is merely a modification number. An additional letter, usually "A" or "B," denotes a further slight modification.

The following diagrams will give you a still better idea of how to read the code designations of different Navy turrets.



All the turrets the Navy uses can be broken down into three mechanical classifications and two power-operating mechanism classifications.

Mechanically, turrets are classified according to their shape. First, there is the ball or spherical type on which the gunner, guns, and sight rotate about a common axis in ELEVATION and

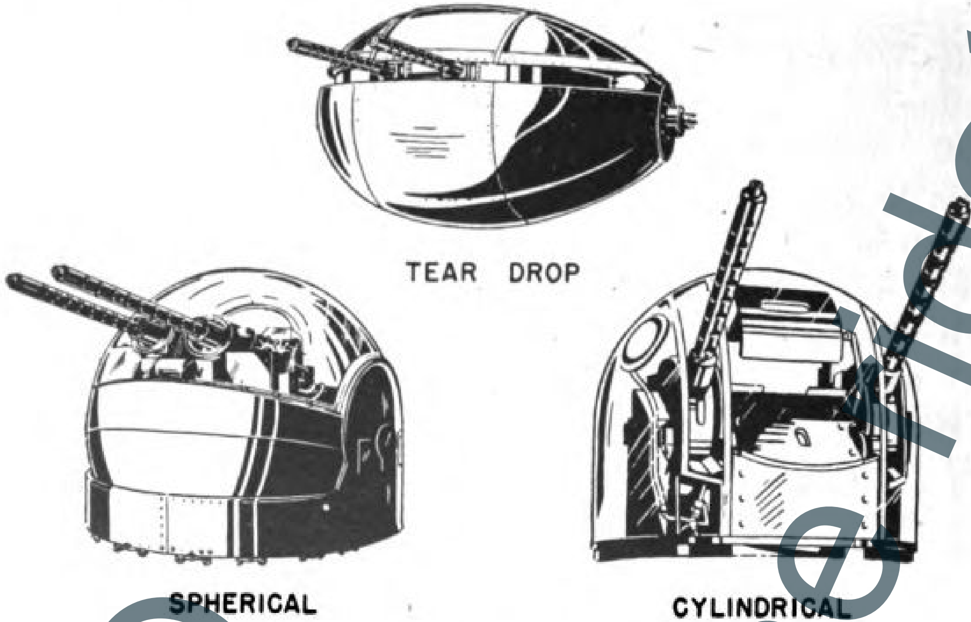


Figure 1.—Turret shapes.

a common axis in AZIMUTH (horizontal). The second type is the cylindrical turret in which the gunner, the guns, and the sight rotate about a common axis in AZIMUTH while only the guns and sight operate in ELEVATION. The third, a teardrop turret, is one which is essentially a streamlined shape with one axis of rotation along the chord of the streamlined shape. Gunner, sight, and guns all move together both in AZIMUTH and ELEVATION.

CHAPTER 2

ELECTRIC TURRET SYSTEMS

ELECTRICITY, THE DRIVING FORCE

When a bolt of lightning blackens a tree — that's ELECTRICITY at work. Your girl combs her hair and little blue sparks crinkle through it. ELECTRICITY is working again.

And when a Grumman turret whirls around and gives an aerial gunner a nice bead on an enemy fighter, THAT'S electricity at work, too!

What is electricity? If you can answer that one, go to the head of the class. ANY class.

The fact of the matter is, no one really knows just exactly WHAT electricity is. But don't let that worry you. How to define electricity is a subject for the long-haired boys to argue about. What electricity DOES and how it ACTS are what should interest you in your study of electrical turret systems.

This book is not designed to give you a course in basic or advanced electricity. Don't get the idea that you have to be an electrical engineer to understand electric turrets. That certainly isn't true. But an understanding of electrical principles — the commonest ones — will help you a lot. What you will be dealing with primarily are electrical circuits — the flow of electrical current through a closed channel, starting at one point and returning to that point.

ELECTRICAL SHORTHAND

Ask an electrician a question, and he'll probably answer you by whipping out a pencil and drawing a quick sketch or diagram. In telling a technical story, diagrams are usually worth

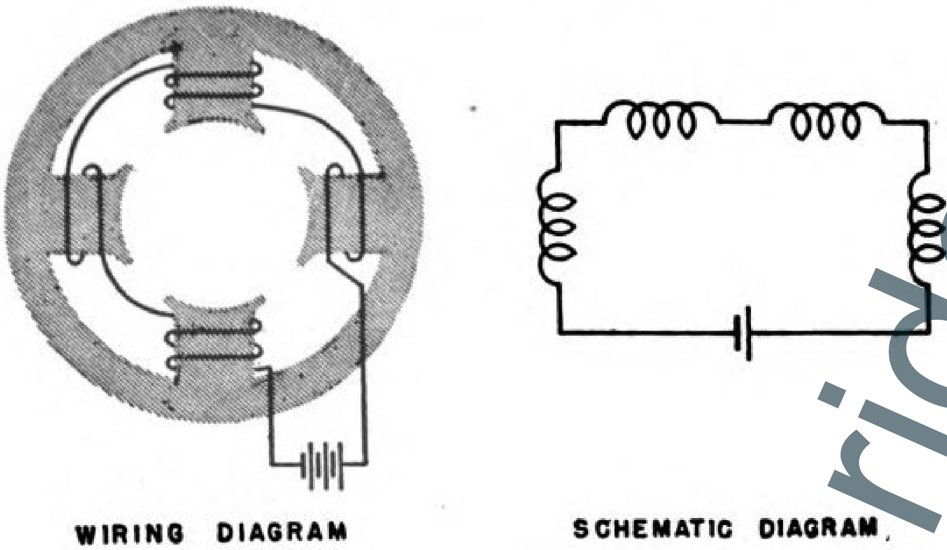


Figure 2.—Types of diagrams.

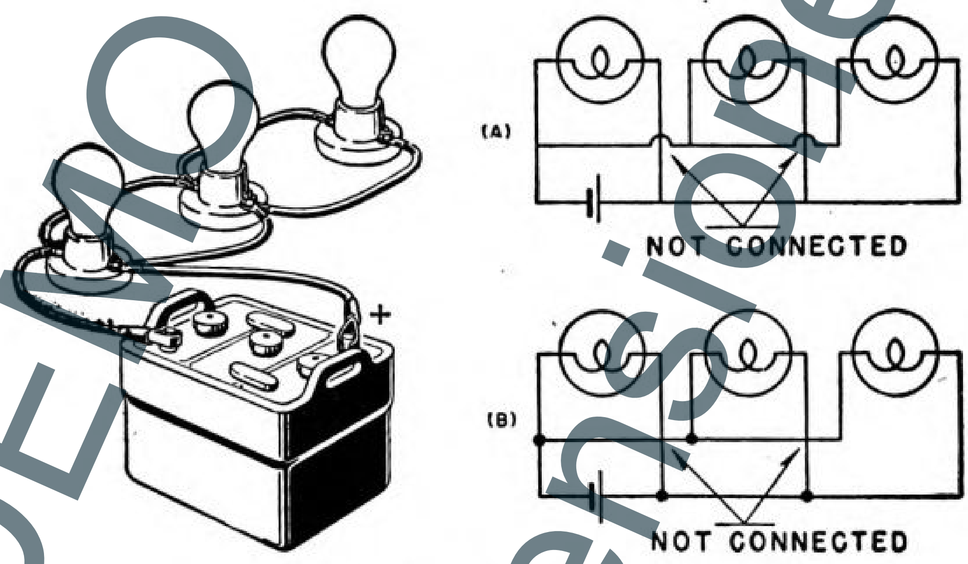


Figure 3.—Wire connections.

a good many thousand words. They get the POINT over fast and eliminate confusion.

Therefore, before going any farther with turret electrical systems, here's a short explanation of two types of diagrams commonly used to explain electrical installations.

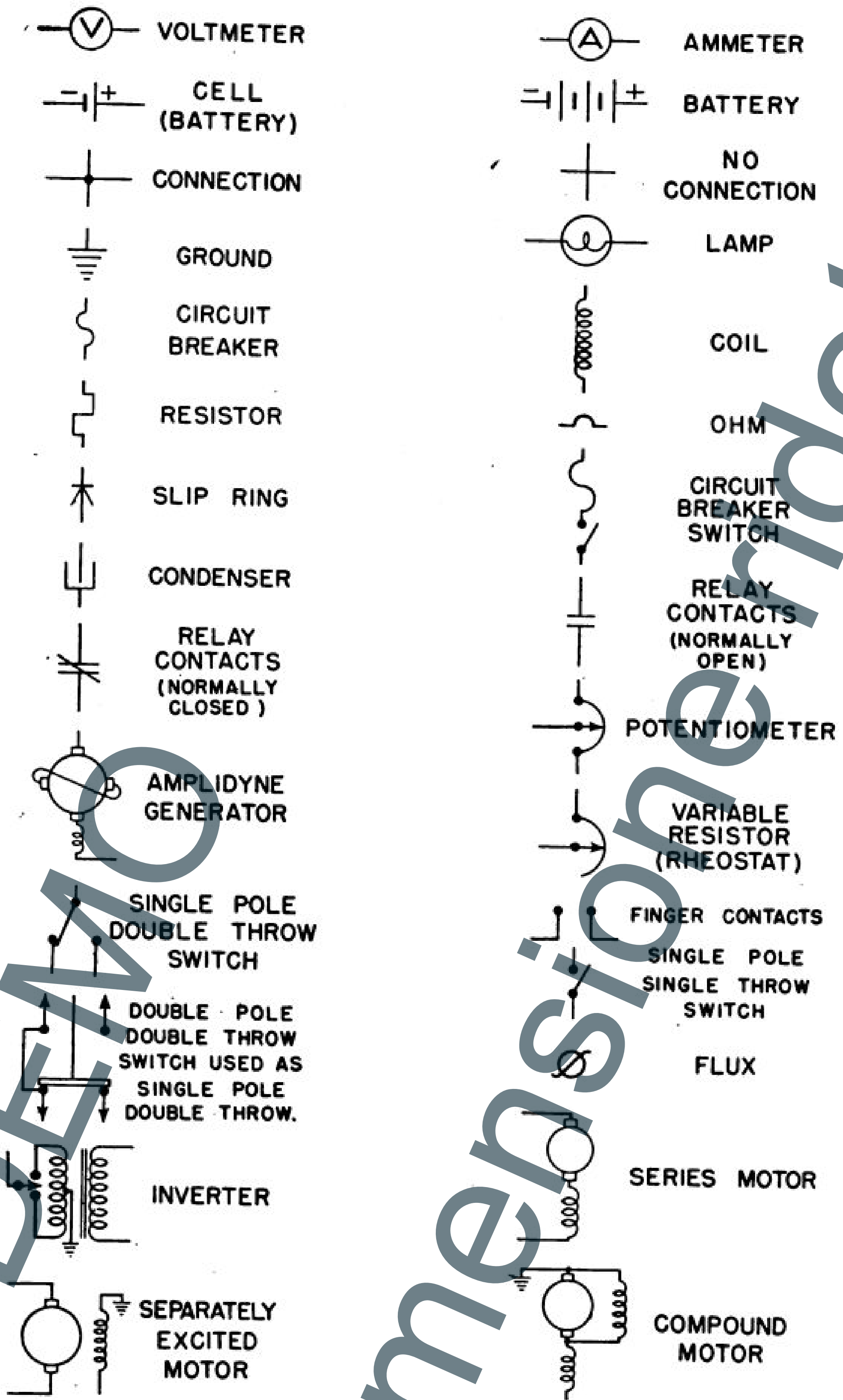


Figure 4.—Electrical symbols.

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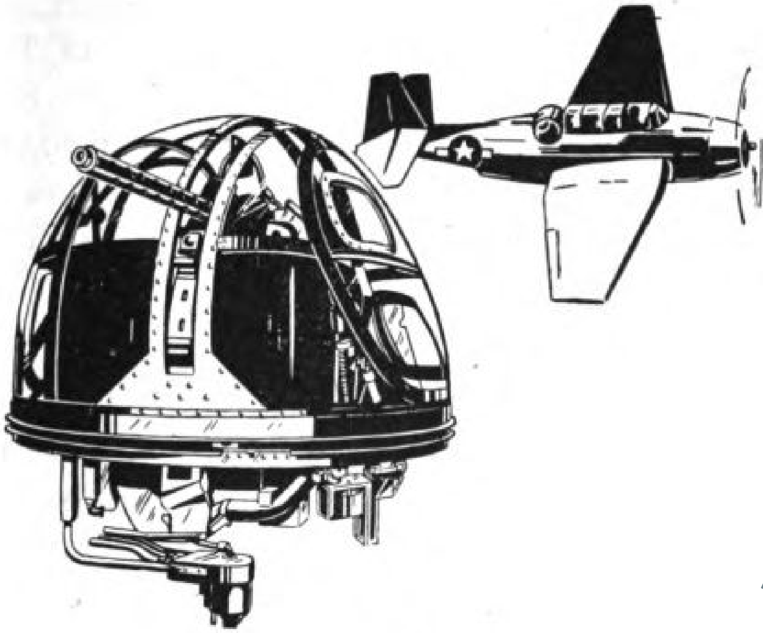


CHAPTER 3

GRUMMAN 150 SE–2 TURRET

THE AVENGER'S STING

A TBF is making a run at 300 feet. Two thousand yards from an enemy cruiser, its fish splashes into the water and speeds toward the target.

And, if there are hostile aircraft around, right here is where a big headache can develop. A torpedo plane must make its attack at low altitude. Getting back to the carrier sometimes means FIGHTING back.

That's where the Grumman 150 SE–2 turret — and its gunner — have a chance to PROVE THEIR WORTH. And they have, in HUNDREDS of combat missions.

Yes, the Grumman turret has proved itself to be a durable, reliable, and often indispensable piece of equipment on the TBF or TBM.

It mounts a single .50 caliber. But that's enough to do the job if the bursts land where you want them to land.

WHAT MAKES IT CLICK?

The Grumman is a ball turret — one in which you ride with the turret in both train and elevation.

A 24-28 v. d.c. system powers both the vertical (elevation and depression) and train (azimuth) motion of the turret. The vertical range of 115 degrees includes the 85 degrees can't develop enough torque because it has no field excitation. elevation above the horizontal and 30 degrees below the horizontal. The train motion is 360 degrees, either clockwise or counterclockwise.

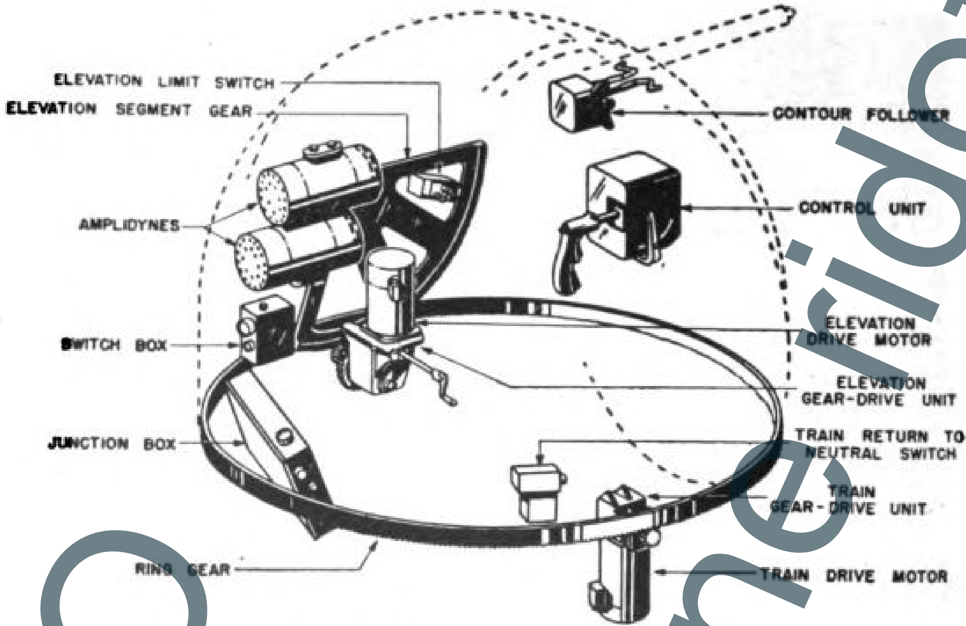


Figure 49.—Units making up Grumman 150 SE-2 turret.

The turret drive consists of these parts —

1 control unit,
1 train drive unit,
1 elevation drive unit,
1 elevation upper limit switch,
1 elevation return to neutral switch,
1 train return to neutral switch,
1 contour follower switch unit,
1 junction box,
2 amplidyne motor generator units,
1 slip ring unit,
1 elevation gear segment or quadrant, and
1 azimuth or train ring gear.

Analyze each part individually. Figure 49 shows you where all these units are located. You can refer to it as you take up each part.

The CONTROL UNIT, operated by a control handle, completely controls all electric motion of the turret and the firing of the gun. It is shown in figure 50.

The master switch is on the left side of the controller box. When the master switch points up, the switch is ON.

The action switch, located on the control grip, must be closed before the potentiometers are energized and before the turret can be operated. When you release this switch, the turret will AUTOMATICALLY return to stowing position with the gun pointing aft and parallel to the longitudinal axis of the ship.

The turret will return to neutral in train by the shortest path and remain there while the gun returns to neutral in elevation.

On the control handle there's a high speed switch, the gun firing trigger switch, and the action switch. At the right and bottom side of the controller box is a latch which, when released, permits you to tilt the controller box up to allow room for entering and leaving the turret.

When the control handle is moved to the right, the turret will turn counterclockwise in train, and when the control handle is moved to the left, the turret will turn clockwise in train. Simple enough.

When the control handle is depressed from the neutral position, the gun will move upward, and when it is elevated from neutral position, the gun will move downward. By moving the control handle diagonally, you can get simultaneous train and elevation movement.

The speed of both train and elevation or depression movements is proportional to the deflection of the control handle from neutral position. The equipment is so designed that a minimum velocity of a half degree per second in either train or elevation can be maintained. Normal elevation speed is approximately 12 degrees per second, and normal train speed is 20 degrees per second.

By closing the high speed switch, you cut out a portion of the feedback voltage resistors, thus giving an increased range of speed. You can get approximately 30 degrees per second for elevation, and 45 degrees per second for train operation.

Operation of the control handle actuates two sliding pointers (contacts) on two potentiometers. One is for the TRAIN AMPLIDYNE and one for the ELEVATION AMPLIDYNE. The potentiometers are center tapped, thereby making it possible to reverse the polarity of the generator output by reversing the control field polarity. The generator output is controlled by varying the generator control field excitation. All of this is accomplished through the DIRECTION and the AMOUNT OF DEFLECTION of the control handle.

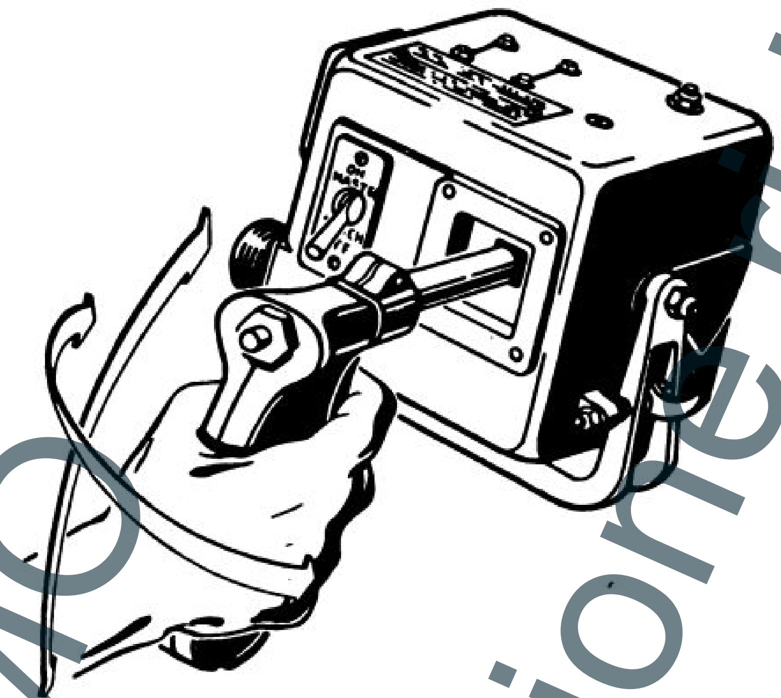


Figure 50.—Control-grip movements (schematic).

The train and elevation turret drive motors are directly connected to their respective amplidyne units, so their speed and direction of rotation is controlled by the polarity and size of the output of each respective amplidyne.

The TRAIN DRIVE UNIT is located on the gunner's right and directly below the right trunnion end-frame. It consists of an electric motor, gear box, and hand clutch. It is geared directly to the azimuth ring gear, which is secured to the track and train unit.

What's it for? You know the answer. The purpose of this unit is to drive the turret in train operation. The schematic of this unit appears in figure 51.

The purpose of this unit is to drive the turret in elevation and depression operation, as you know.

The unit is geared directly to the elevation gear quadrant, which is stationary and secured to the left trunnion end-frame.

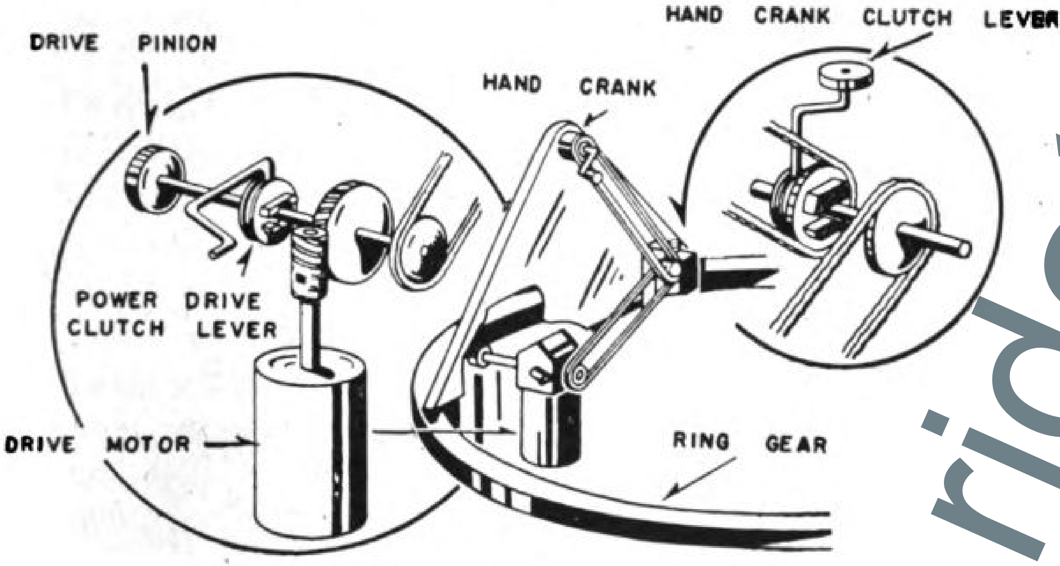


Figure 51.—Train drive (schematic).

The TURRET ELEVATION DRIVE UNIT is located on the gunner's left between the ammunition box and the elevation gear quadrant. It consists of an electric motor, hand clutch, and gear box. Take a look at the schematic in figure 52.

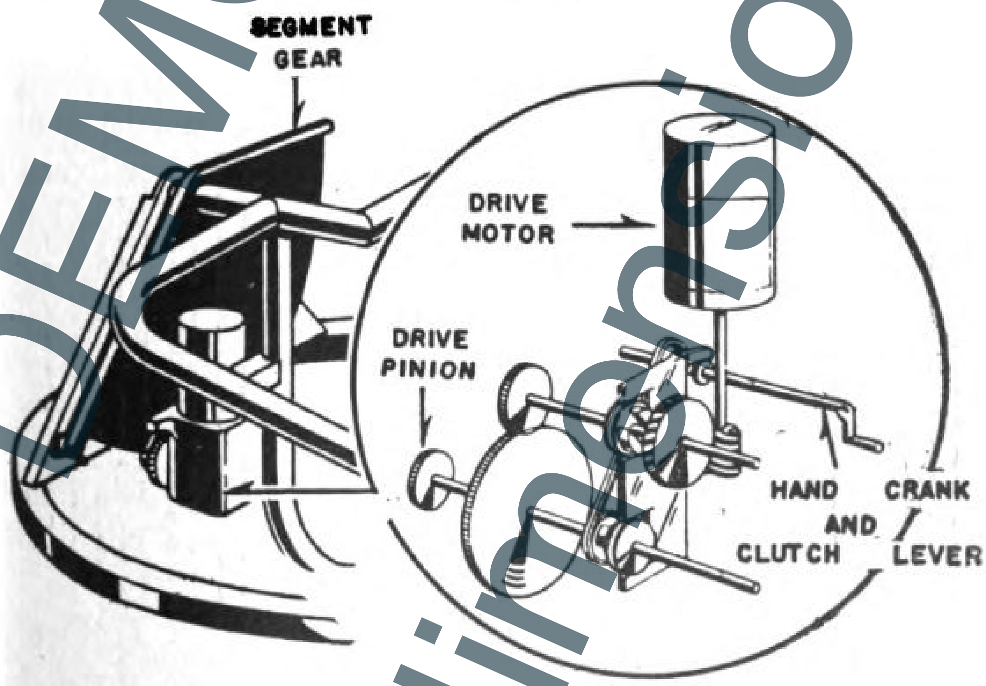


Figure 52.—Elevation drive (schematic).

Now a word of caution — DO NOT ENGAGE GEARS WHEN TURRET DRIVE MOTORS ARE RUNNING IN EITHER TRAIN OR ELEVATION.

Both elevation and train drive motors are equipped with a distinctive feature — a BRAKE SOLENOID, which stops the turret immediately after the current is shut off.

The ELEVATION UPPER LIMIT SWITCH is a micro-switch which is housed in a switch box in conjunction with another micro-switch. It is secured to the left trunnion end-frame, and is operated by a cam which is fastened to the equipment plate between the amplidyne units and the elevation gear quadrant.

As the gun nears the zenith point or maximum elevation, the upper limit switch is actuated by the cam striking the actuating roller of the switch plunger. The cam depresses the plunger, which closes the switch, thereby energizing the RNDR (return to neutral in depression relay). This places a reverse potential on the control field, and the gun depresses. The gun will only depress far enough to allow the micro-switch to open again by rolling off the cam. If you are holding the control handle in a depressed position, the gun will be elevated again, and the sequence will be repeated.

The TRAIN RETURN TO NEUTRAL SWITCH (TRNS), and the DEPRESSION RETURN TO NEUTRAL SWITCH (DRNS) accomplish the automatic return of the turret and gun to neutral or stowing position.

The TRNS is located on the gunner's right, and is secured to the U-channel ring. This unit includes two micro-switches in one housing. They, in turn, are operated by a cam wheel that is rotated by four pins secured in the track-and-train unit. The inside switch is the "B" switch, which governs the direction of rotation in which the turret will return to neutral. The outside, or "A" switch, determines when the RNT (return to neutral in train) circuit is closed or opened.

The DRNS (depression return to neutral switch) is a micro-switch on the left trunnion end-frame, in the same box as the elevation upper limit switch.

On the release of the action switch, the RNTR (return to neutral in train relay) is energized, provided the turret has been moved out of stowing position. When the RNTR is energized, the control of the turret is automatically removed from the gunner, and the turret will return to stowing position in train. The direction of return (clockwise or counterclockwise) will be dependent upon the position of the "B" switch. The turret will return by the SHORTEST PATH to the stowing position.

As the turret moves into stow in train, the cam wheel is rotated by the RN pin. The DRNR (depression return to neutral relay) is energized through the DRNS, and the gun is returned to neutral in depression. As the gun nears the hori-

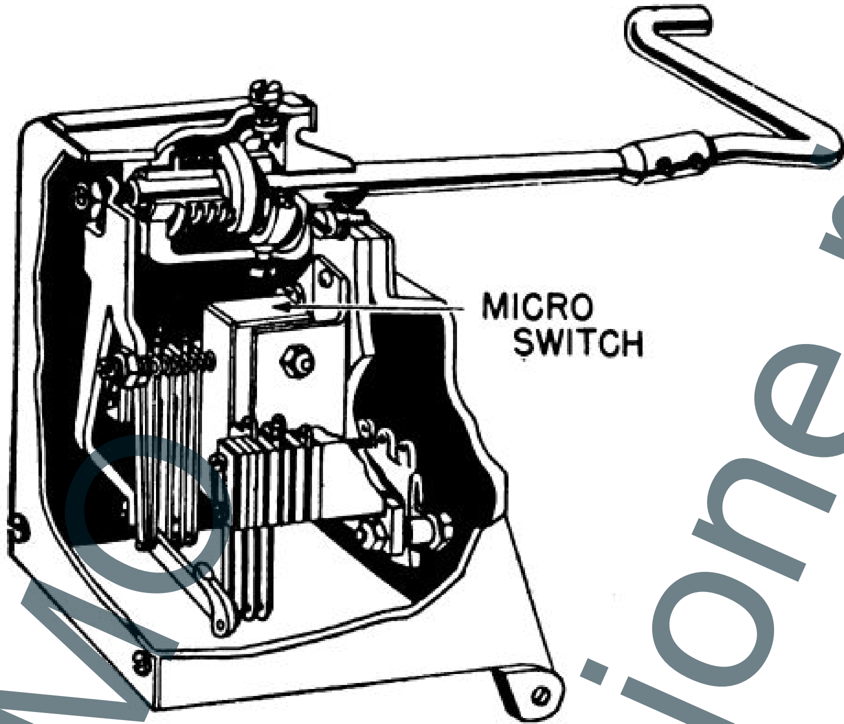


Figure 53.—Contour follower (cutaway).

zontal position, the DRNS is opened by the cam, the electrical system is opened, and power to the amplidyne units is cut off.

The CONTOUR FOLLOWER is your SAVE THE FUSELAGE assistant. The contour follower is mounted under the barrel of the gun. To see what it looks like, refer to figure 53.

The box contains a two-position micro-switch, six pairs of contacts, and two resistors (12 ohms and 25 ohms). There are two pivoted arms projecting through the gun slot in the turret dome, which ride against the contour rail.

When these arms strike the rail, they actuate the various switches in the contour follower box. The only function of the contour follower is to prevent the gun from striking any part of the fuselage. It has no connection with the profile interrupter circuit.

The JUNCTION BOX is mounted on the rear of the seat, and incorporates four relays, five resistors, two condensers, and necessary wiring. Also located around three sides are seven disconnect plugs.

You'll find the SWITCH BOX located on the gunner's left, shoulder high. It has nine cables leading off, and houses both amplidyne switches, trouble light switch, gun reset, and six condensers for the amplidyne drive motors. These condensers prevent radio interference set up by commutation.

As you know by now, the AMPLIDYNE MOTOR-GENERATOR UNITS (MODEL # 5AM31NJ18A) are really the HEART of the turret drive. They are horizontally mounted on the gunner's left between the left trunnion end-frame and the expended clip and shell box. The upper unit is the elevation unit, and the lower one is the azimuth or train unit. There is one flexible cable leading to each of these amplidyne units. Each amplidyne, you will find, has two variable compounding rheostats mounted on it.

The SLIP RING UNIT is placed directly under the turret, and it is secured to the deck. It is rotated by an L-shaped drive arm.

The slip ring includes two metal cases which house the internal mechanisms. The top half of the ring is free to rotate, while the bottom half is stationary. It contains 10 rings, 10 brush holders, a swivel joint for oxygen, and ground friction plates. There are two disconnect plugs on the upper half of the unit, and three on the lower half. These plugs are for interphone, radio, and power connections.

The FIRE INTERRUPTOR SWITCH ASSEMBLY is actuated by cams which are made to follow the shape of the surfaces to be protected from your gunfire (in other words, the tails, fins, and wing tips of your airplane). The cams are machined on a rotating cylinder, which moves as the turret moves. When the turret moves to a point where the gun would fire into a portion of the plane, the cams on the cylinder press against the fire interrupter switches. This instantly shuts off the fire of the gun until the turret moves on past the "danger zone."

HELPING THE GUNNER

When you come right down to it, the turret is just a gun mount — a device designed to help the gunner do a better job.

So this is where you can learn about the armament characteristics of the Grumman turret. As you already know, there is one .50 caliber M-2 BROWNING MACHINE GUN. To supply this gun, you have provisions for carrying 200 rounds of ammunition in an AMMUNITION BOX located just below the gun.

The FEED CHUTE on the left side of the gun has a built-in "no-return" ratchet which prevents a belt of ammunition from falling back into the chute.

Then there is an EJECTED LINK AND CASE CONTAINER. This will hold 200 links and empty cases, and it is mounted just below the gun. You can pull out a lever mounted at the forward base of the container to open an ejection door so you can dump out the contents into a bag underneath.

A Mark 9 illuminated GUN SIGHT is standard equipment with the Grumman turret. It's mounted on a bracket forward and left of where the gunner sits.

You can locate these various armament units on the X-ray view of the Grumman turret shown in figure 54. You can't miss the machine gun in the upper left of the picture. You can also see the ammunition box, feed chute, and ejected link and case container. The Mark 9 gun sight is a gadget that looks like a little rural mail box, located just to the right of the ejected link container. Note that there is a ring sight mounted up in the back of the bullet-resistant glass shield. This auxiliary sight is to be used in case the Mark 9 gives out.

If you study this cutaway view a little, you can get a pretty good idea of just where the various parts you have learned about are located. This also shows the mechanical features of the turrret.

MECHANICAL FEATURES

In addition to the various electrical devices which make up the Grumman turret, there are important mechanical features. Here are some you'll want to know about.

There's the MOUNTING RING, a special ring which forms an integral part of the TBF's structure, parallel to the aircraft's longitudinal axis.

And there's the TRACK AND TRAIN UNIT, which consists of a two-piece steel ring, upon which there are two machined tracks. The weight of the turret is carried on the upper track, and the turret is stabilized by the lower track. There are 44 holes for

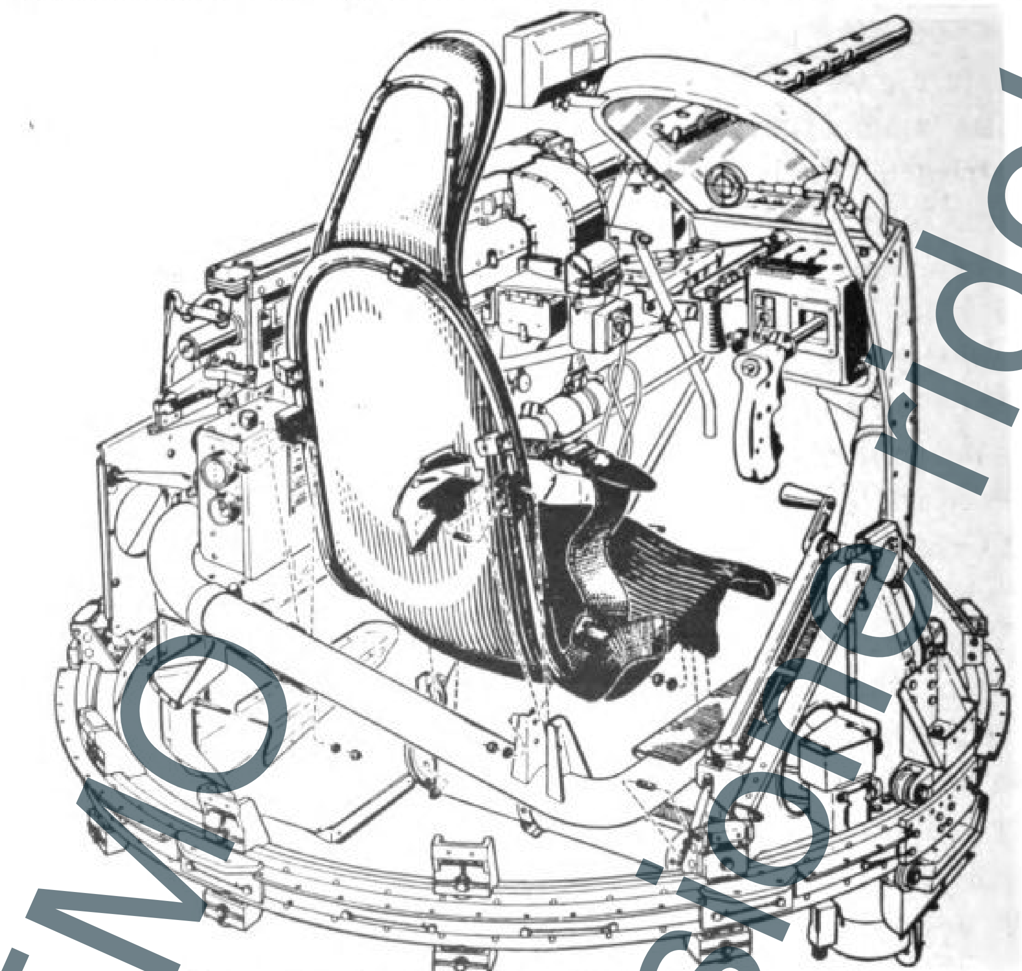


Figure 54.—Grumman 150 SE–2 turret (cutaway).

mounting the azimuth ring gear and 4 holes for mounting the return-to-neutral track pins.

Another mechanical feature is the TRACK SPLICES located at an angle of 180 degrees to each other. They couple the two pieces of steel of track-and-train unit.

The TRAIN RING GEAR is a one-piece steel ring with 44 holes for mounting to the track and train unit. Machined into the bottom side of the steel ring are the teeth for driving the turret in train.

The U-CHANNEL RING OR SADDLE is a circular steel ring located just inside the azimuth track and train unit. The

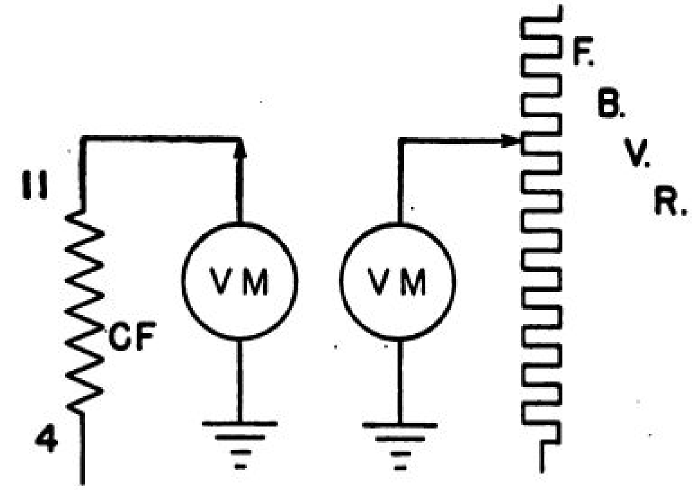


Figure 77.

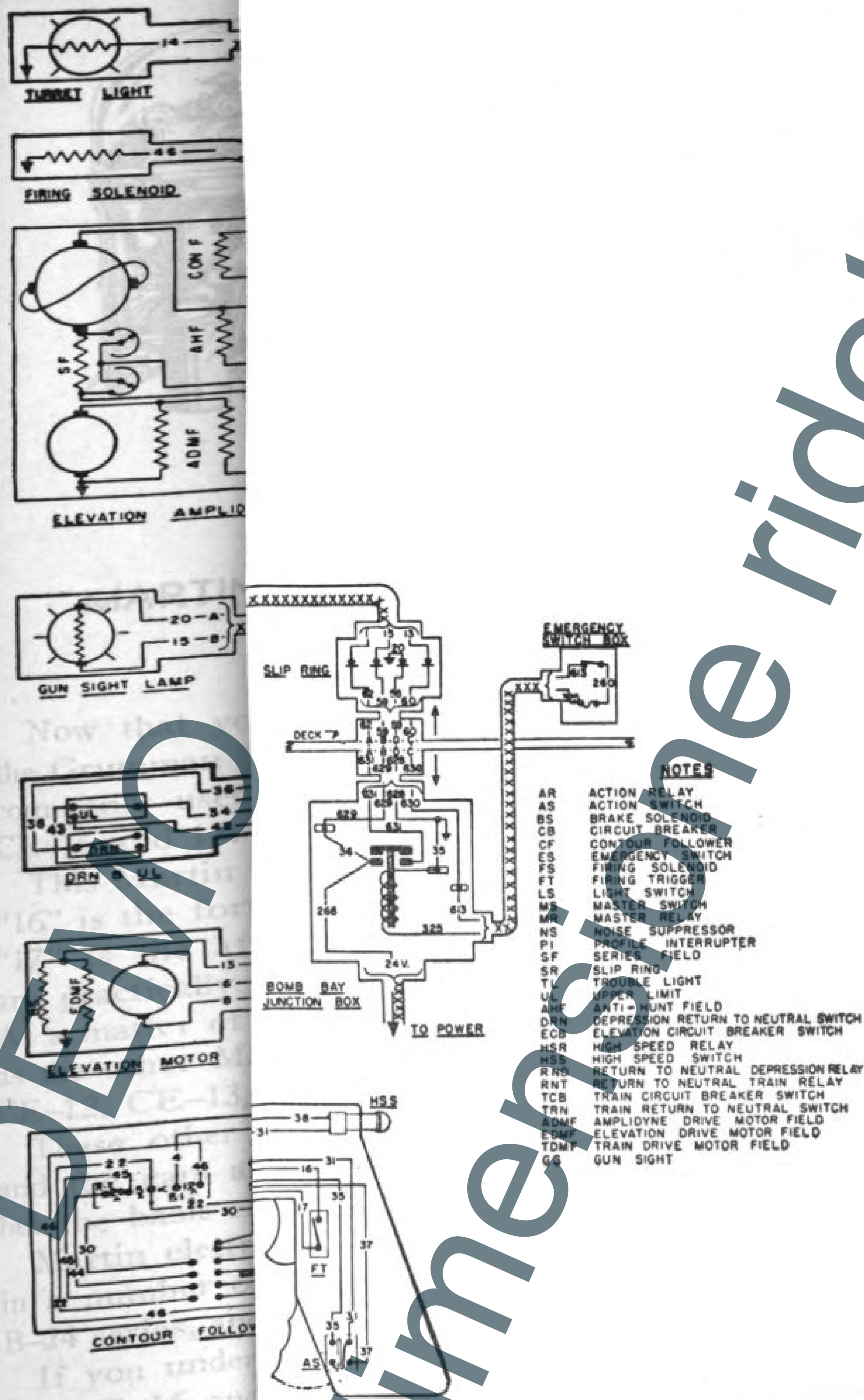
No deflection of controller

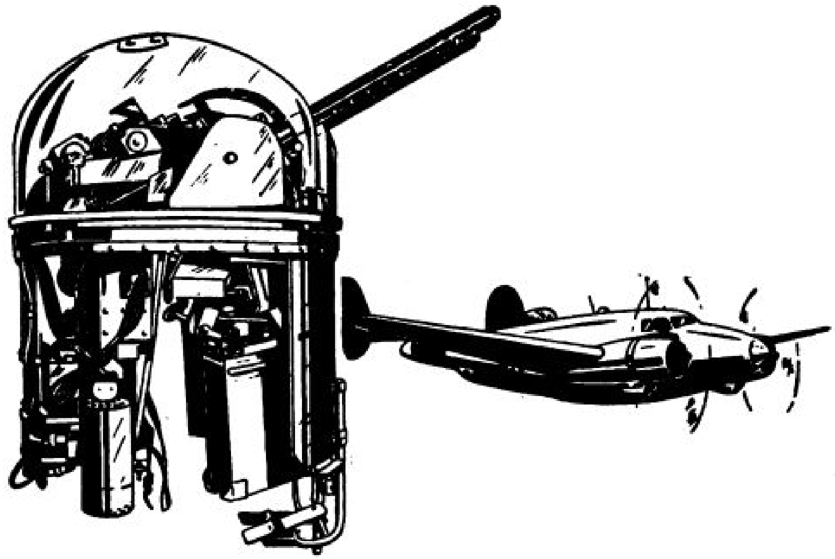
Mid-tap	Pot. arm
24	24

The normally closed RND contact between wires 5 and 8 is internally or externally shorted.

Mid-tap	Pot. arm
12	0

The RND normally open contact between wires 13 and 8 is not closing. Wire 13 is open, feeding normally open RND contact.


TURRET LIGHT
FIRING SOLENOID
CON F
AHF
SF
ADMF
ELEVATION AMPLID
GUN SIGHT LAMP
SLIP RING
EMERGENCY SWITCH BOX
DECK
DRN & UL
BOMB BAY JUNCTION BOX
24 V.
TO POWER
EDMF
ELEVATION MOTOR
HSS
FT
AS
CONTOUR FOLLOW
NOTES
AR ACTION RELAY
AS ACTION SWITCH
BS BRAKE SOLENOID
CB CIRCUIT BREAKER
CF CONTOUR FOLLOWER
ES EMERGENCY SWITCH
FS FIRING SOLENOID
FT FIRING TRIGGER
LS LIGHT SWITCH
MS MASTER SWITCH
MR MASTER RELAY
NS NOISE SUPPRESSOR
PI PROFILE INTERRUPTER
SF SERIES FIELD
SR SLIP RING
TL TROUBLE LIGHT
UL UPPER LIMIT
AHF ANTI-HUNT FIELD
DRN DEPRESSION RETURN TO NEUTRAL SWITCH
ECB ELEVATION CIRCUIT BREAKER SWITCH
HSR HIGH SPEED RELAY
HSS HIGH SPEED SWITCH
RND RETURN TO NEUTRAL DEPRESSION RELAY
RNT RETURN TO NEUTRAL TRAIN RELAY
TCB TRAIN CIRCUIT BREAKER SWITCH
TRN TRAIN RETURN TO NEUTRAL SWITCH
ADMF AMPLIDYNE DRIVE MOTOR FIELD
EDMF ELEVATION DRIVE MOTOR FIELD
TDMF TRAIN DRIVE MOTOR FIELD
GS GUN SIGHT



CHAPTER 4

MARTIN 250 CE–16 AND CE–17 TURRETS

THE PB4Y'S LINE OF DEFENSE

Now that you have become familiar with the operation of the Grumman 150 SE–2, you will want to learn about another commonly used Navy electric turret. This is the Martin 250 CE–16 and 17.

This Martin turret helps to defend the famous PB4Y–2. The "16" is the forward upper deck turret in the PB4Y–2, and the "17" is the aft upper deck turret. These two modifications are practically identical, so they will be considered together. As a matter of fact, the "16" and the "17" are amost the same as the other Martin 250 CE turrets, such as the CE–5, CE–7, CE–12, CE–13, and CE–15.

These other modifications differ as to certain armor plate and the cam arrangement in the profile gun fire interrupter, but the basic electrical system is the same in all of them.

Martin electric turrets are used in the PV–1 and PV–2 and in a number of Army planes, including the B–26 series, the B–24 series, and the B–37 series.

If you understand the Grumman 150 SE–2 and the Martin 250 CE–16 and 17, you can consider yourself an AUTHORITY on Navy electric turrets.

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WHAT MAKES THE MARTIN TICK?

As with the Grumman, the Martin CE turret drive consists basically of a CONTROL UNIT, two AMPLIDYNES, and two ELECTRIC MOTORS.

The turret obtains its power from the airplane's own generator. Power is taken in from a silver-plated copper COLLECTOR RING mounted on the inner side of an azimuth ring gear by insulated bolts. Then the power goes from the ring to the moving part of the turret through brushes. From there, power is transmitted to the various individual units.

What happens when the power gives out? Fortunately, provision has been made for this emergency. The turret may be operated mechanically in both train and elevation. There are cranks for this purpose. The guns may be charged by hand and, as you know, a machine gun will fire mechanically.

INDIVIDUAL ELECTRICAL UNIT

Many of the electrical units on the Martin are practically the same as those used on the Grumman, which you already know about. Therefore, all you will be doing in the rest of this chapter is reviewing and remembering the Grumman material and learning about any DISTINCTIVE FEATURES of the Martin.

The AMPLIDYNES on the Martin turret are exactly the same as those used on the Grumman.

The DRIVE MOTORS are very similar, except that they do not have a brake solenoid.

Now comes the CONTROL UNIT. This unit, by means of control grips, permits you to move the turret in azimuth and to control the movement of the guns in elevation.

When the control grips are deflected DOWN, the guns will move UP, and vice versa. When you move the control handles CLOCKWISE, the turret revolves clockwise, and when you move them in the opposite didrection, the turret will revolve the same way.

The Martin may be rotated through 360 degrees in either direction in azimuth. In elevation, it will boost the guns 85 degrees above horizontal and depress them six and a half degrees below horizontal.

The turret will make one revolution in 18 seconds in normal speed and in eight seconds in high speed. And that EXTRA SPEED counts when you have a half dozen enemies swarming in on you.

To understand the layout and arrangement of the control unit, look over figure 79 for a minute.

Now that you've seen figure 79, you can begin to analyze the functions of the important parts that make it up.

THE BIG BRAIN

This control unit is the real BRAIN, or NERVE CENTER, of the Martin turret. Impulses originating from this central point

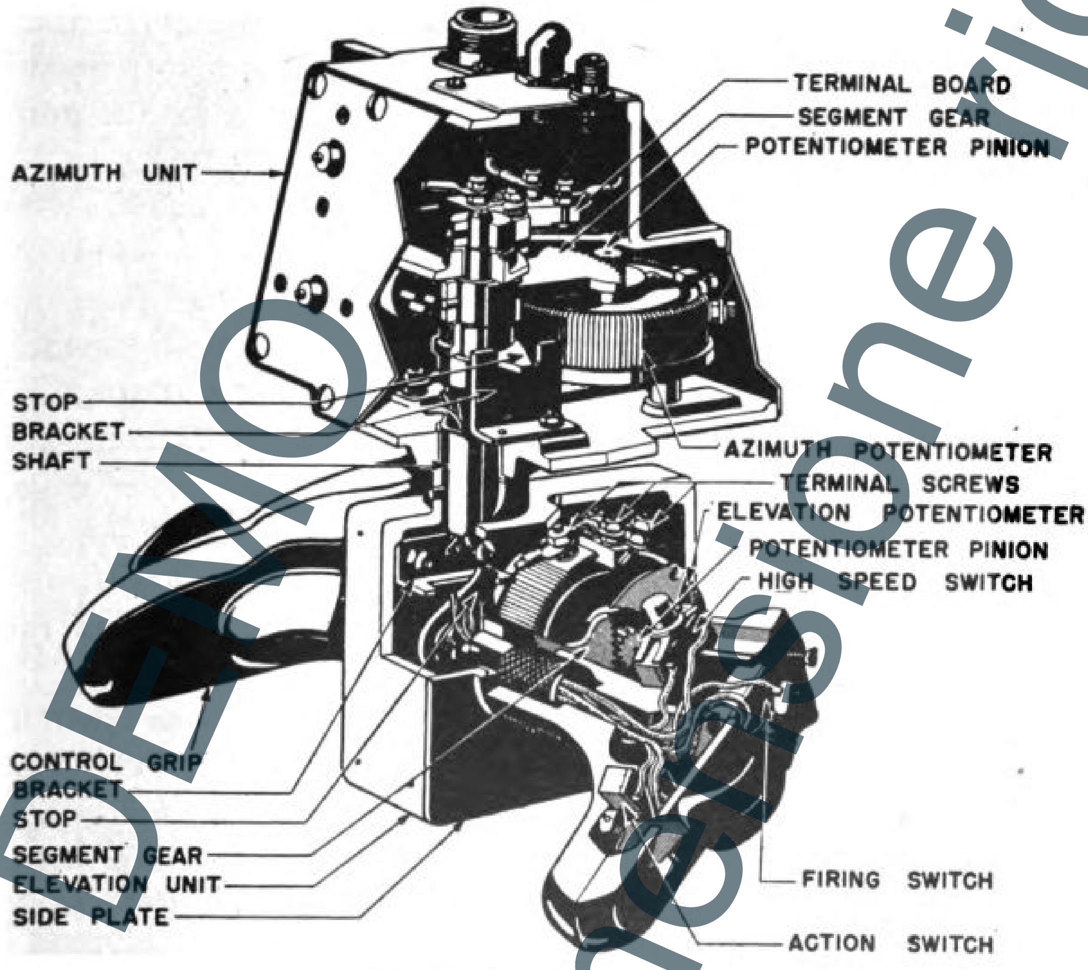


Figure 79.—Control unit.

determine everything the turret does, just the way YOUR brain and nervous system control YOUR movements.

When you grasp the grip handles of the control unit, you depress an ACTION SWITCH on each grip. These switches energize the potentiometer coils, located in the unit itself.

Now what happens? As you move the grip handles to direct the action of the turret, they cause sliding POINTERS to pick off voltages from the two potentiometers (one for train and one for elevation).

The polarity and magnitude of the voltages are applied to the amplidynes, which in turn, supply power to the TDM's.

When you want high speed, you press with your thumb the HIGH SPEED BUTTON, located on the right hand grip.

If you want to talk with a fellow crew member, you press a microphone switch on the left hand grip in the same corresponding position.

How DO YOU FIRE THE GUNS? First, turn the gun switch (on the right of the control box) to "ON." There is a selector switch beside the gun switch which permits you to set the guns for individual or collective fire.

You can reach a trigger switch on each grip handle with your index finger. If you set the selector switch on "INDIVIDUAL," your right trigger switch fires your right hand gun, and the left switch fires the left gun. If you set the selector switch on "BOTH GUNS," either firing trigger will fire both guns.

Additional switches and overload circuit-breaker resets are located on the control panel to protect the potentiometer coils, the ammunition booster circuit, and the firing circuit.

There is a JUNCTION BOX which serves as the CENTRAL DISTRIBUTION point for the electrical impulses originating in the control unit. It is under the gunner's seat.

This is what it contains. First, there's the master switch, on the right side of the box. A TERMINAL BOARD is located in the center of the box. It carries incoming electrical connections to the high-speed relay and the FBVR resistors. The LINE CONTACTOR relay is mounted inside the box, and next to it are two ANTI-HUNT CAPACITORS. Below them are four enameled RESISTORS, which are necessary for making speed adjustments by providing a path for the feedback voltage.

The HIGH-SPEED RELAY is mounted on the same bracket as the capacitors.

Also in the junction box you'll find the VIBRATOR INVERTER.

whose purpose you'll learn about later in this chapter. There's also a RADIO NOISE FILTER, to keep down radio interference (similar to the one on your car), and two overload circuit breakers to protect the amplidynes.

The STRUCTURAL INTERRUPTER AND LIMIT SWITCHES are electrical devices found on the Martin turret to protect your

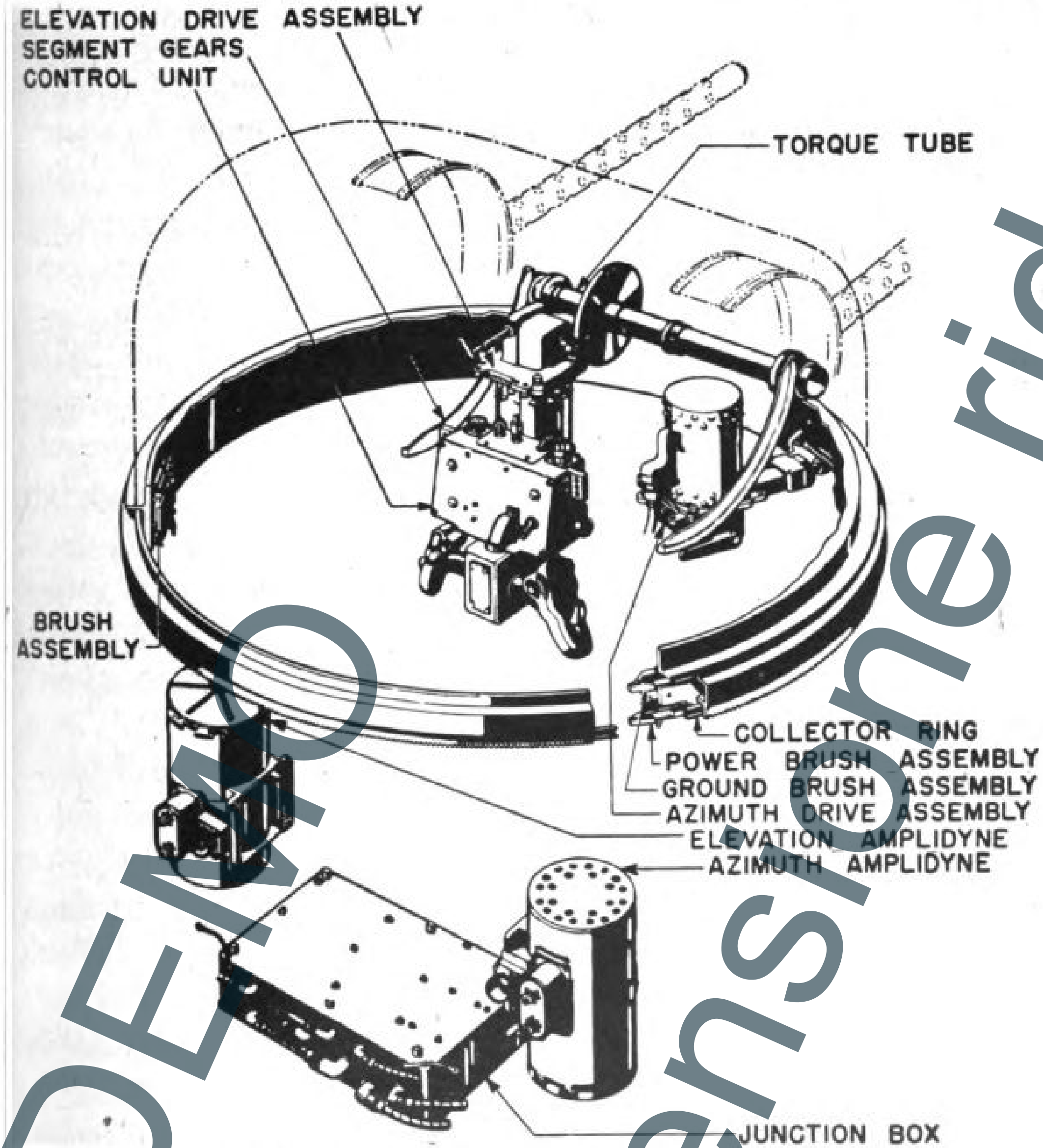


Figure 80.—Units making up Martin 250 CE-16 and 17 turret.

airplane from damage, either from your own gunfire or the motion of the guns. Exactly how they work will be explained with schematics when you come to the auxiliary circuits a few pages farther along.

The Martin also has a profile gunfire interrupter which works similarly to the one on the Grumman.

MECHANICAL FEATURES

Just as in the electrical units, there are a few mechanical features of the Martin which you haven't come across in previous discussions on the Grumman or on turrets in general.

There's a MOUNTING RING which comes right with the aircraft. Strictly speaking, it's part of the airplane rather than part of the turret. The turret is mounted in this ring.

The AZIMUTH RING GEAR is the steel ring about which the turret revolves in azimuth. The load rollers, carrying the weight of the turret, ride on the upper part of the track of the ring. Then there are guide rollers which help keep the turret in the groove by riding against the vertical track. The ring's gear teeth are machined into the lower sides of the steel ring.

As far as TURRET ROLLERS are concerned, there are 26 of them — 10 load rollers, 12 guide rollers, and four adjustable stabilizer rollers for good measure. All of them follow separate tracks. The stabilizer rollers keep the turret from joggling up and down as it rotates.

The turret's MAIN CASTING is a rotating frame which forms the support for the turret parts. Attached to it is the azimuth TDM, which, by meshing with the azimuth ring gear, causes the casting to rotate.

The TORQUE TUBE is mounted in the bearing housings of the main casting. It transmits power from the elevation drive motors to the segment gears, which raise and lower the guns.

SEGMENT GEARS located on the outside of each gun carriage mesh with the small driving gears on the torque tube and afford movement of the gun in elevation and depression.

You know what the GUN CARRIAGE is — it's fastened to the main casting and mounts the BAM's.

Three steel eye-bolts known as HOISTING LUGS are fastened to the main casting for hoisting the turret in and out of the airplane.

There is a small metal COMMUNICATIONS AND OXYGEN JUNCTION BOX above the azimuth amplidyne. This houses connections for the communications system and the gunner's oxygen supply.

The turret's SWIVEL JOINT is a collector ring assembly mounted to the airplane directly below the center of the turret. Through this come the communication and oxygen connections.

PLENTY OF ARMAMENT

You have figured out from the designation "250" that the Martin's WALLOP consists of TWO .50 caliber machine guns. For protection, there are two half-inch steel armor plates bolted to the main casting in front of the gunner.

Today, Martin turrets are equipped with the MARK 18 GUN SIGHT, a self-computing illuminated sight which can do practically everything but cook. When this sight is added to a turret, its designation includes the letter "a" or "A." For example, 250 CE–16*A*. The sight is mounted in a cradle — a semicircular aluminum casting attached with trunnion pins to the main casting. It connects to the gun carriage with tie rods, so the sight raises and depresses with the guns.

Four AMMUNITION BOXES carry 200 rounds each. The Martin is equipped with an automatic FEED BOOSTER, one unit for each gun. These consist of small electric motors, spring mounted, and equipped with sprockets which mesh with the ammunition belt. The boosters are controlled by varied tension on the amunition belt, energizing and deenergizing the motors through micro-switches.

Gun mount adapters and guides, which are part of the gun carriage assembly, permit movement of the gun necessary for adjusting for boresighting and for locking the gun in firing position after boresighting.

A feature of the gun assembly on the Martin turret is the addition of E5A shock dampeners. These take up the recoil of the guns and minimize the vibration resulting from firing.

Another armament feature of the Martin is the MECHANICAL FOOT TRIGGER. This is a pedal mounted on a bar above the foot rest. It is connected to the trigger motor by a series of levers, a pole rod, and a flexible cable. This is really for emergency use only — when you want to fire the gun mechanically in the event of power failure.

HOW THE MARTIN OPERATES

You will remember in the case of the Grumman 150 SE–2, that certain auxiliary circuits help to provide smooth operation of the turret. It's the same way with the Martin CE's.

So you can understand the purpose and operation of these circuits more easily, there are schematics of each of them in the following pages.

To save time and space, abbreviations will be used in the schematics and explanations. Here they are —

MS	Master switch.
LCR	Line contact relay.
Amp.	Amplidyne.
CF	Control field.
HS	High speed.
HSS	High speed switch.
AS	Action switch.
FBVR	Feedback voltage resistor.
TDM	Turret drive motor.
ADM	Amplidyne drive motor.
AHF	Anti-hunt field.
CR	Compounding resistor.
SF	Series field.
LLR	Lower limit resistor.
ULR	Upper limit resistor.
SI	Structural interrupter.
ULS	Upper limit switch.
LLS	Lower limit switch.

NORMAL OPERATION

You already know what normal operation means on other turrets, and it means the same thing on the Martin. It's when the gunner has full control of the speed and direction of the turret's movements.

YOU DO THIS	WHAT HAPPENS?
Close the MS.	Current flows through the MS, energizing the LCR. LCR contacts being closed places 24 v. potential on line 9, energizing both amp. drive motors and putting both amp. in operation.
Close AS. Deflect control grip as shown.	Current flows through both potentiometers. Current flows from a high potential to a low potential through CF's, driving turret in desired direction.

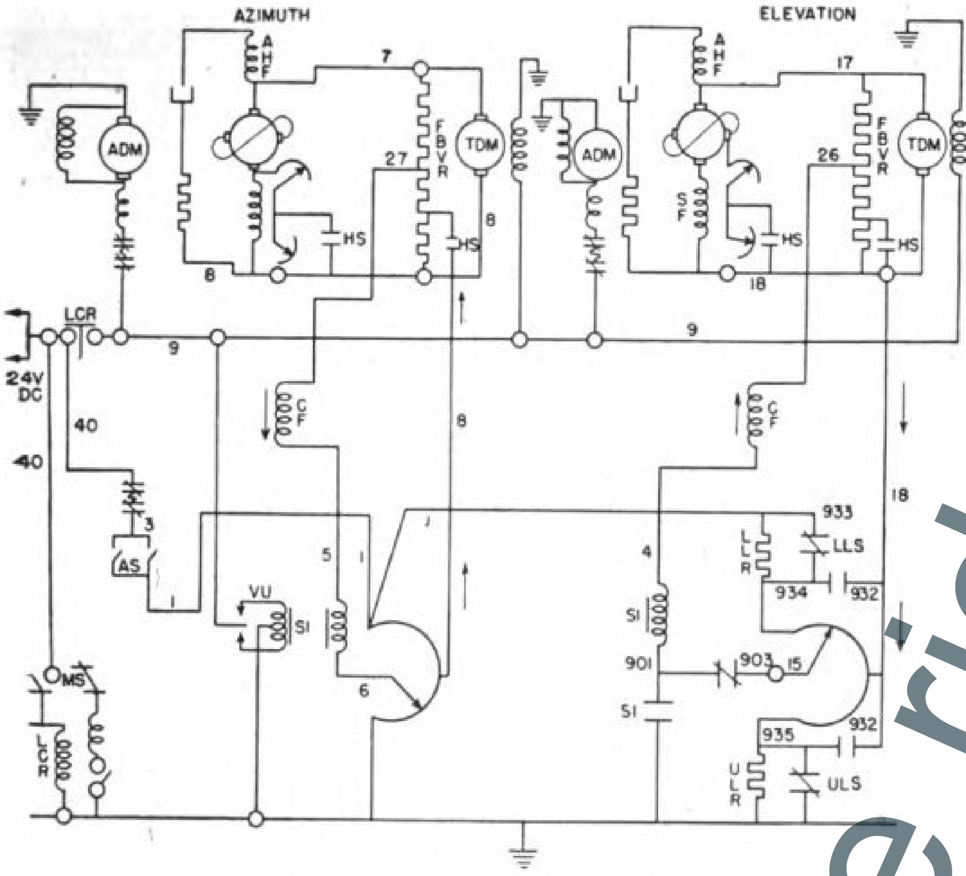


Figure 81.—Normal operation.

YOU DO THIS	WHAT HAPPENS?
Close MS and AS. Close HSS (energizing HS relay).	Turret is placed in normal operation. HS contacts close, decreasing the FBVR and also decreasing the resistance in parallel with series field (as shown).

USE OF VIBRATOR-INVERTER

Did you ever build a toy electric motor? At least, you've fooled around with them. You noticed how, when you turn on the juice, the motor is likely to buzz and strain, but it won't start. Then you give it a spin with your finger and AROUND IT GOES. It just needed that little extra push to overcome what's known as STARTING FRICTION.

Part of this friction is mechanical and part of it is electrical in origin. Once this initial drag is overcome and the motor starts turning, most of the effect of the friction disappears as the momentum increases.

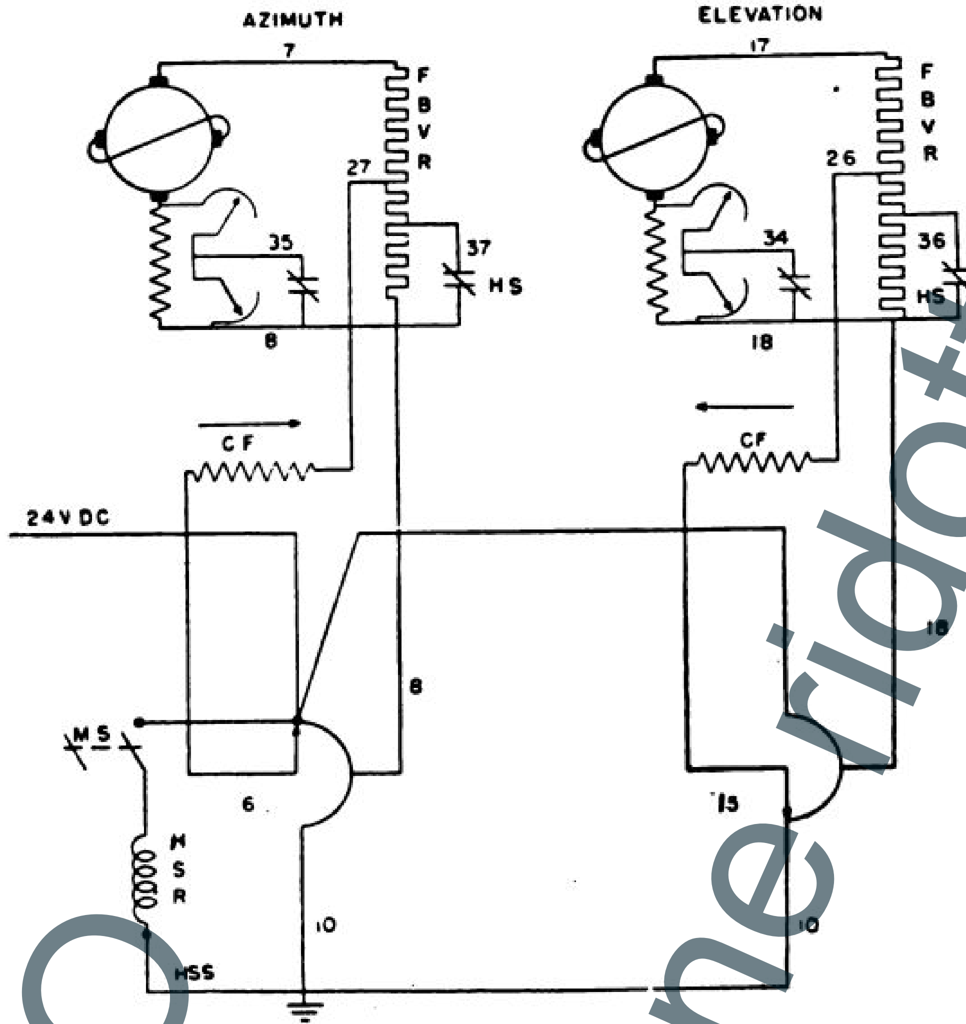


Figure 82.—Normal operation with HSS closed.

A turret, or any motor-driven equipment, reacts like your toy electric motor on a much bigger scale. The drag of friction will slow up the turret drive motors when you first feed electric current into them.

Moreover, a certain amount of "residual magnetism" — magnetism which stays on after the current is turned off — remains in the control field of an amplidyne. Sometimes there is enough of this magnetism to activate the amplidyne sufficiently so that the turret will begin to CREEP.

Now this is where the VIBRATOR-INVERTER comes in. Its purpose is twofold. It helps to lick that original friction drag which slows down starting in the TDM. And in addition, it eliminates the RESIDUAL MAGNETISM in the amplidynes, which can lead to creeping.

How does it accomplish this?

What the inverter does is change DIRECT current to ALTERNATING. The airplane's generators furnish d.c. of course, and this feeds into the primary winding of the inverter from line 9 (shown in the schematic in figure 83). A vibrator breaks and then closes the circuit alternately to secure alternating current. Then the current is fed through a step-down transformer

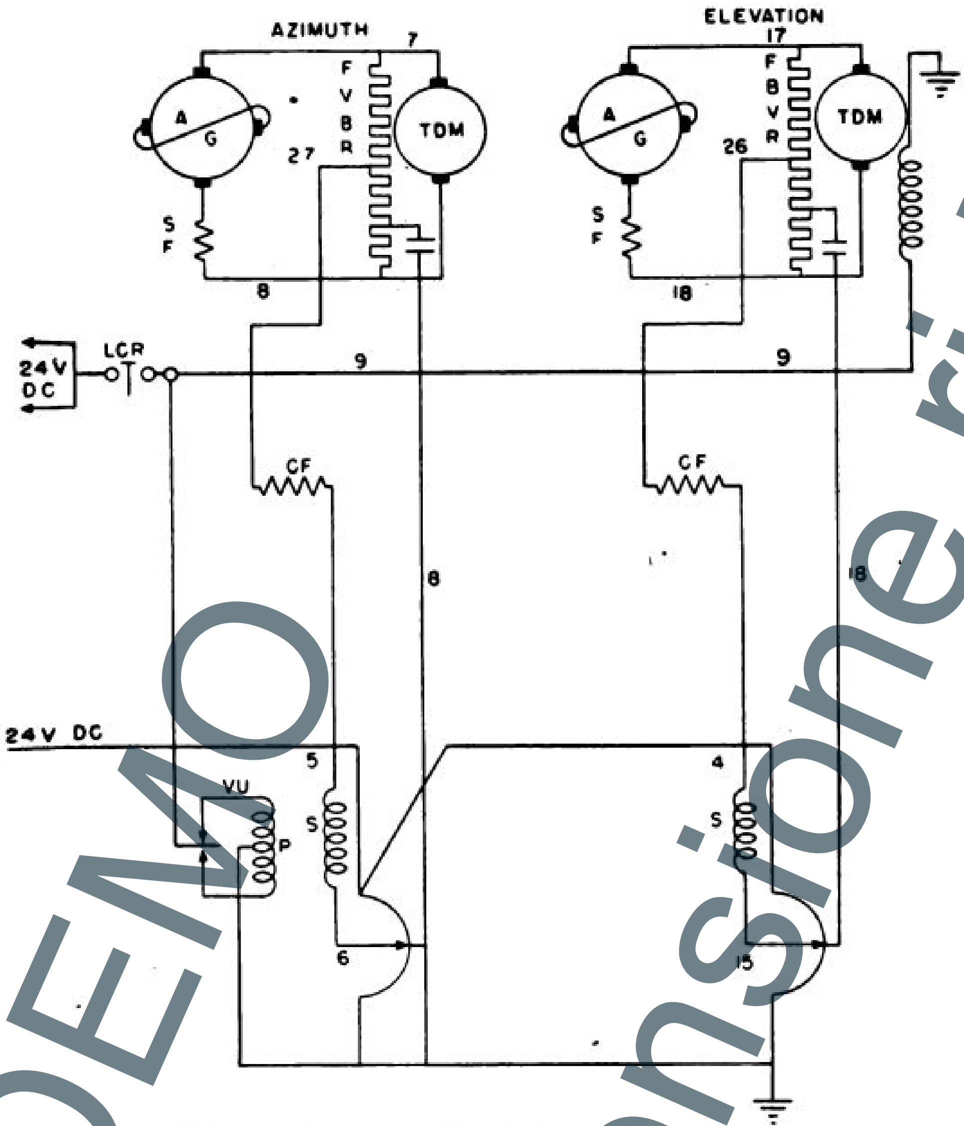
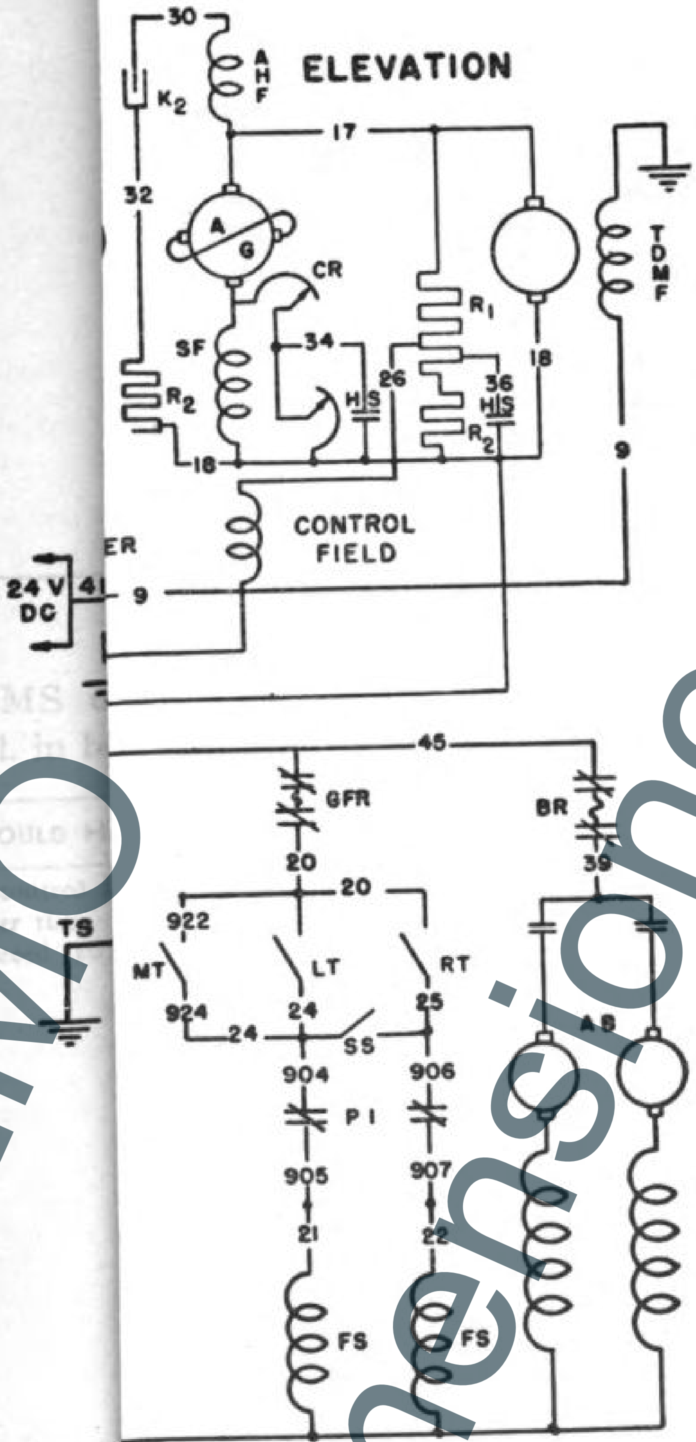


Figure 83.—Operation of the vibrator-inverter.

whose secondary winding is in series with the amplidyne control fields. It applies to proper voltage (16 v.) to the control field of the amplidyne.

This 60-cycle a.c. in the control field tends to stabilize generator commutation, eliminating residual magnetism. By its effect on the output of the amplidyne, it reduces the starting friction in the TDM.


ELEVATION
AHF
K2
30
17
32
A
G
CR
SF
34
R1
R2
26
36
H S
18
TDMF
9
CONTROL FIELD
ER
24 V DC
41
45
GFR
BR
20
39
922
MT
LT
RT
924
24
25
SS
TS
904
906
P I
905
907
21
22
FS
AB

WHAT SHOULD HAPPEN	IF THIS HAPPENS	YOUR TROUBLE IS
VM reading should decrease to approximately .5 v. Proceed to thirteenth step.	VM reading increases.	Wires 37 and 5 are reversed, feeding control field, or wires 7 and 8 are reversed before FBVR.
	VM reading does not change.	Open in wire 7 feeding FBVR, or FBVR is open above control field tap, or amp. generator armature is open, or series field is shorted.
	VM reading decreases to approximately .1 v.	FBVR is open below control field tap, or too much FBVR.
	VM decreases to 0 v., then off scale.	Turret is over-compounded or there is too much FBVR.
	VM reading decreases slightly.	Series field is shorted, or short circuit wire is open, or faulty brushes, or faulty armature.
	VM reading decreases to approximately 2 v.	Anti-hunt condenser is internally or externally shorted, or short circuit wire is open, or series field is shorted, or faulty brushes, or faulty armature.
	VM reading decreases to approximately 1 v.	Not enough FBVR.

TWELFTH STEP

Close AS. Connect VM across El. CF and deflect control grip to full deflection. Close MS.

WHAT SHOULD HAPPEN	IF THIS HAPPENS	YOUR TROUBLE IS
VM reading should decrease to approximately .5 v. Proceed to fourteenth step.	VM reading increases.	Wires 26 and 4 are reversed, or wires 17 and 18 are reversed before FBVR.
	VM reading does not change.	Wire 17 open feeding FBVR, or open in FBVR above control field tap, or amp. generator armature is open, or series field is shorted.
	VM reading decreases to approximately .1 v.	FBVR is open below control field tap, or there is too much FBVR.

0	0–12	0–12

FBVR is internally or externally shorted.

0	0	0

CF is internally or externally shorted.

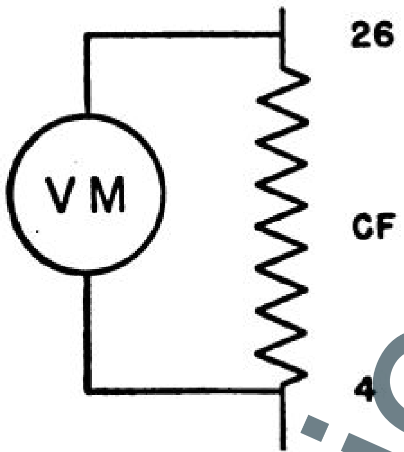
0	0–6	0–6

Not enough FBVR.

0	0–2	0–2

Go back to eleventh step and check as indicated there.

Open MS and AS. Replace wire 26. Close AS. Check IR drop across CF with no deflection. Then check IR drop across El. CF with full deflection to the left and then to the right. Record checks and compare with those shown below to find fault.



WIRE #26 ON FBVR
AND WIRE #4 ON
VIBRATOR UNIT

Figure 91.

No deflection of control grip.	Deflect control grip slowly to maximum left.	Deflect control grip slowly to maximum right.
VM reads	VM reads	VM reads
0	0 to approximately 4 v.	0 to approximately 4 v.

These are normal voltage checks. Continue with twelfth step and check as indicated.

0	0–12	0–12

FBVR is internally or externally shorted.

CHAPTER 5

HYDRAULIC TURRET SYSTEMS

PASCAL'S PRINCIPLE

Some 300 years before the first hydraulic turret, a clever French philosopher named Pascal hit upon a basic hydraulic principle. Pascal realized that AN INCREASE OF PRESSURE ON ANY PART OF A CONFINED LIQUID CAUSES AN EQUAL INCREASE IN PRESSURE THROUGHOUT THE LIQUID.

Now this means that when you apply a pressure in pounds per square inch (psi) to the liquid at one end of a pipe, the same pressure in pounds per square inch will be exerted on every square inch of the surface of the pipe that is in contact with the liquid. The shape of the pipe or other container makes no difference in the transfer of pressure.

You can see from this example that it is possible to build up ment of PASCAL'S PRINCIPLE. But you are more used to the term FORCE when speaking of applied loads.

WHY THE DISTINCTION?

Well, the term PRESSURE always refers to the force applied to EACH SQUARE UNIT of area, whereas the term FORCE is used to designate the TOTAL LOAD that is applied to the TOTAL AREA. This means that the force on a piston one square inch in area is also equal to the pressure on that piston. But the force on a piston ten square inches in area is ten times the pressure on that piston.

It is important that you realize and remember that hydraulic liquids are **INCOMPRESSIBLE**. This means that they **CANNOT BE SQUEEZED** into a smaller space than that originally occupied. Thus, when you apply pressure at one end of a hydraulic line, it is transmitted instantly to the other end. The transfer is as quick as though you had pushed on a steel rod.

So that you can see how hydraulics work, suppose you have a small cylinder and a large cylinder connected by a tube, as in figure 93. Both cylinders are full of liquid to within a short distance of the top. According to Pascal's principle, a force applied to each square inch of the liquid in the small cylinder is transferred undiminished to each square inch of surface of the liquid in the larger cylinder. Thus, the pressure applied to a small piston pushing down on the liquid in the small cylinder will be transferred through the liquid to a piston in the large cylinder. But, since the surface area of the large piston is greater than the surface area of the small piston, the sum of the unit forces acting on the large piston must be greater than the sum of the unit forces acting on the small piston.

For instance, if the area of the piston in the small cylinder is one square inch and the area of the piston in the large cylinder is ten square inches, a downward force of one pound on the small piston will cause an upward force of ten pounds on the large piston.

You will notice that the term **PRESSURE** was used in the state-tremendous forces by the application of relatively small initial forces. As a matter of fact, modern Naval aircraft make use of forces as high as 40,000 pounds.

Now take a look at figure 94. There you have a simple hydraulic mechanism. It is known as the hydraulic jack.

WHAT MAKES IT WORK?

If you push down on the handle, the oil is forced under pressure into the large cylinder. How come? Well, because the

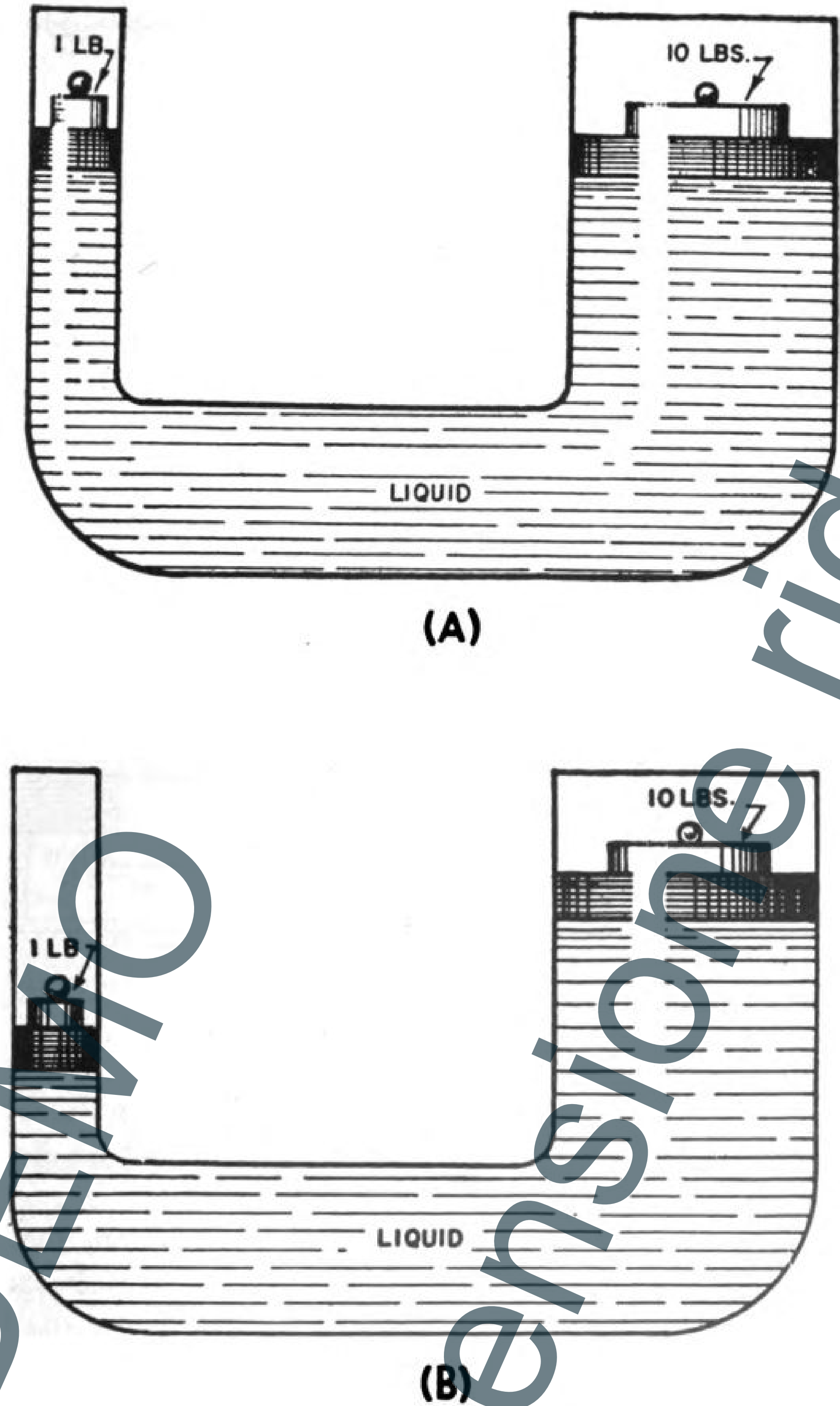


Figure 93.—Pascal's principle.

ball check valve is so designed that it permits the oil to flow only in one direction. The check valve to the cylinder is forced open, and the one between the pump and the reservoir closes.

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Then on the return, or UP STROKE, there is a decreased pressure area in the pumping cylinder, allowing the pressure in the large cylinder to seat that check valve.

However, because of the decreased pressure area in the pumping cylinder, the check valve in the line from the reservoir opens.

It is important here to understand WHAT opens that check valve.

The decreased pressure area or suction does NOT pull it down. A decreased pressure area is NOT the existence of a pulling force. IT IS THE LACK OF A PUSHING FORCE. Therefore, the ball check is NOT pulled open by decreased pressure, but rather it is PUSHED open by the greater oil pressure in the

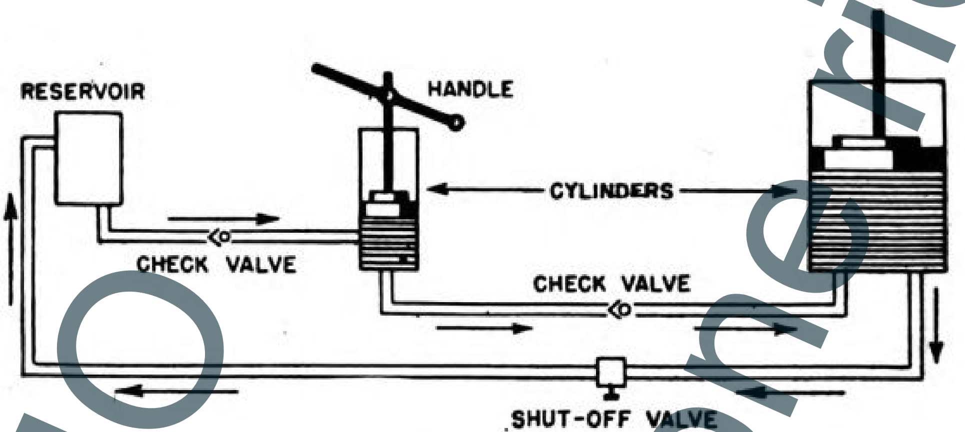

Figure 94.—Simple hydraulic system.

reservoir. The oil pressure in the reservoir is due to the weight of the liquid plus the atmospheric pressure acting on its surface through the vent lines.

When the pumping piston is in full UP position, the procedure is repeated again as many times as it is necessary to raise the large piston to its desired height. To lower the large piston, all you do is open the shut-off valve in the return line. This allows the oil a free flow back to the reservoir, and the return spring pushes the piston down.

Now that you understand the operation of a hydraulic jack, you can go on to investigate the various units that make up a turret hydraulic system.

And if you understand the operation and function of the individual units in a turret hydraulic system, then it will be easy for you to master the operation of any particular hydraulic turret. Just to give you a preview, here's a list of these basic units—

Reservoir	Pressure Regulator
Hydraulic Fluid	Selector (control) Valve
Hydraulic Lines	Power Actuating Units
Pump	

WHAT THE RESERVOIR DOES

You can start with the reservoir. You know what it is—a storage tank for fluid. It serves as a tank from which the fluid

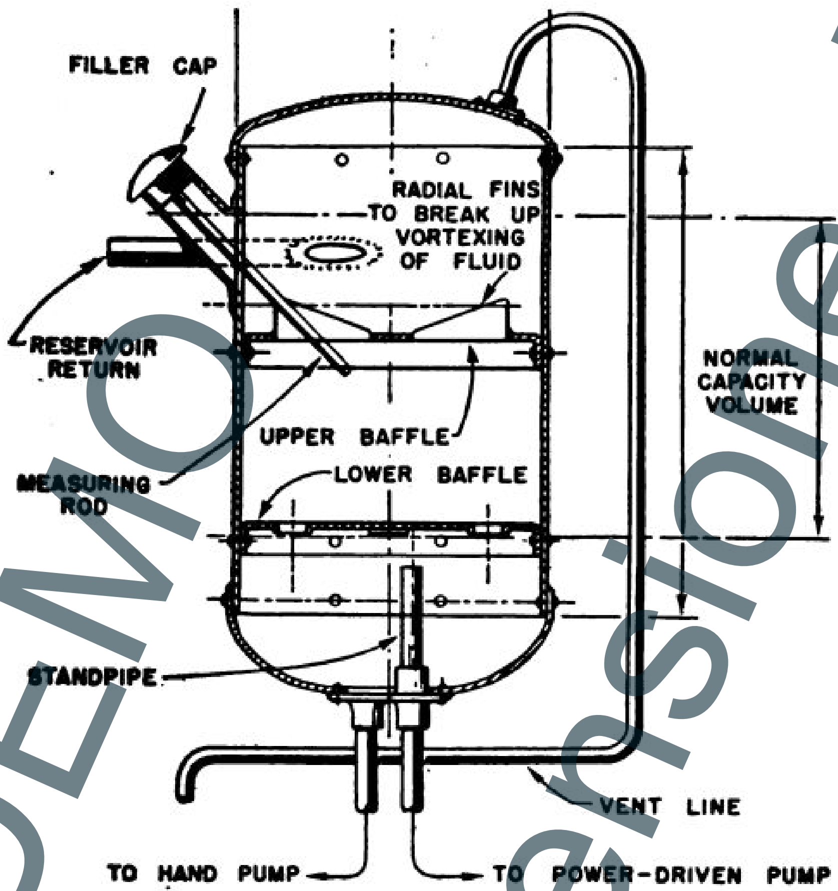

Figure 95.—Reservoir.

is supplied to the pumps and to which excess fluid forced out of the system is returned.

When additional fluid is needed in the system, either for operating additional units or to replenish fluid lost through leaks or seepage, the pump can draw that fluid from the reserto function, there's still enough fluid available for the hand pump.

Instead of using a standpipe, some systems get the same results by attaching the power pump outlet to the side of the reservoir at a point above the bottom of the tank.

The FLUID RETURN LINE usually enters the reservoir at a spot below the normal level of the fluid in the reservoir in such a manner as to cause the least possible disturbance of the fluid. In figure 95, this is accomplished by attaching the return line at a tangent to the reservoir shell.

HYDRAULIC FLUID

This is the LIFEBLOOD of the hydraulic system. It starts in the reservoir and flows from there to fill the entire hydraulic system, furnishing the basis for transmitting hydraulic power.

There are different TYPES of hydraulic fluids just as there are different types of blood. Airplane systems use two kinds—MINERAL base and VEGETABLE base fluids

At present, turret systems use MINERAL BASE fluids.

When a wounded man is brought to a first aid station, the doctor doesn't look at him and say, "He looks like an 'O' type guy—let's give him a transfusion of 'O' type blood." Of course he doesn't. Giving a "B" man "O" blood is dangerous—AND a waste of blood. They just don't mix.

And NEITHER DO TWO TYPES OF HYDRAULIC FLUID. If you're working with a system which requires mineral base fluid, don't try to get by with a vegetable base fluid — even if you have a couple of spare tons of it.

There's a reason for not mixing these two types.

MINERAL OILS DETERIORATE NATURAL RUBBER the way week-end liberty deteriorates your bankroll. But natural rubber packing and natural rubber hose are not affected by vegetable base fluid.

It's another story with SYNTHETIC RUBBER. Mineral oil works fine with it, but VEGETABLE OILS RUIN IT. So use this rule—

VEGETABLE OIL FOR VEGETABLE (natural rubber) TUBING.

MINERAL OIL FOR MINERAL-TYPE (synthetic) TUBING.

How can you tell vegetable and mineral fluids apart? Aside from container labels, there's an easy way.

VEGETABLE FLUID IS COLORED BLUE.

MINERAL FLUID IS COLORED RED.

Just remember that red-blooded turret men prefer red mineral oil base fluid.

An aircraft hydraulic system, like the human body, is dependent on fluid for LIFE. A break in the feed line is like a severed artery. Both the human and hydraulic systems give up the ghost when life-giving fluid is allowed to drain out.

Even a little "bleeding" causes trouble. Turrets require transfusions, too. New fluid must be introduced into the system immediately to replace bleeding losses. And, of course, any breaks in the line must be repaired at once.

HYDRAULIC LINES

That brings you to the lines—the arteries and veins—which carry the fluid through the system.

They are metal tubes and rubber tubes, and they are joined by tube connectors and tube fittings of many shapes and sizes.

ALUMINUM ALLOY tubing is used in most turret systems because it is light and pliable and yet strong enough to withstand up to 1,500 psi.

SYNTHETIC RUBBER, along with fabric, is used where flexible hose construction is necessary. After natural rubber becomes available in larger quantities, it may be used. And, as you'll remember, that means vegetable oil base fluid will be used, too.

In a hydraulic system, various packings serve to seal fluid under pressure in the system and to keep air out. Wherever the various hydraulic units are connected to the hydraulic lines, you have DANGER SPOTS. Because this is where you will have moving parts, vibration, access ports (to get at the units), and so on.

So you'll watch these spots particularly to guard against fluid leaks and air getting into the hydraulic lines—two BIG HEADACHES which must be avoided if you're going to have smooth hydraulic operation.

If the hydraulic fluid is the lifeblood and the hydraulic lines are the arteries, the hydraulic pump could be considered the HEART of the system.

Two types of power-driven pumps are ordinarily used in hydraulic turret systems. They are VARIABLE DISPLACEMENT and CONSTANT DISPLACEMENT pumps. Sometimes they're called variable volume and constant volume.

The names of these two pumps give you a tip-off on how they differ. The variable displacement type puts out at a varying rate, depending on the volume requirements at a given time. The constant displacement job pumps at a constant rate—its capacity and volume are fixed.

There is another type of pump which comes with a turret, a HAND PUMP. This is really an emergency item, and cannot be considered one of the basic hydraulic units which you are

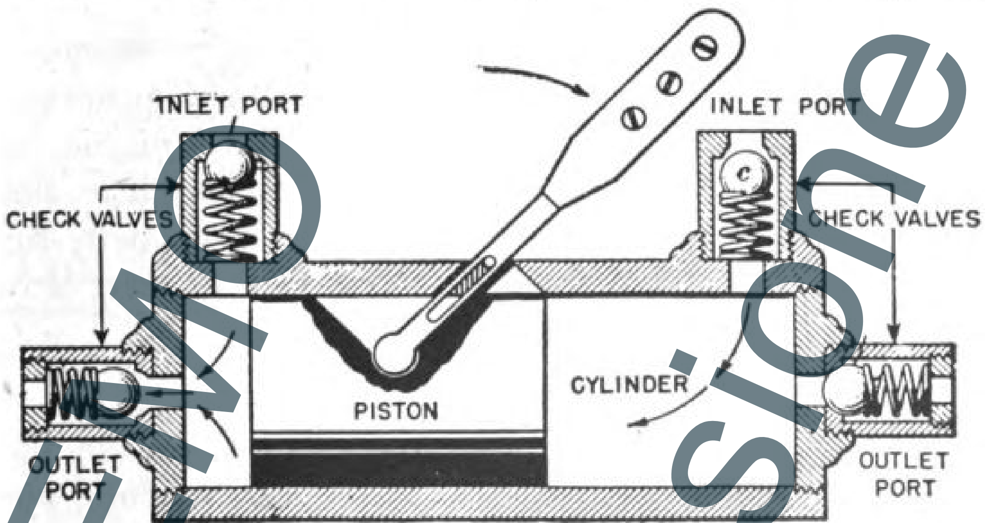

Figure 96.—Hand pump.

reading about now. In other words, this pump is designed to go to work when the power fails and the electrically-driven pumps quit on you.

It can also be used to check the hydraulic system when the engines of the airplane are not running and consequently you have no power.

One look at figure 96 and you can tell that the hand pump is really very simple in construction. It consists essentially of a cylinder having inlet and outlet ports, a piston, and a handle for operating the piston. Throw in a few necessary check valves, packings, and seals — and that's the works.

Here is how the pump operates.

You pull the handle toward the right, thereby moving the piston toward the left. The liquid in front of the piston (to the left of in the illustration) is forced out of the cylinder through the check valve of the outlet port. Meanwhile the piston is drawing in fluid through the inlet valve to the right. Then, when you pull the pump handle back toward the left, the piston moves to the right. Thus, liquid is forced out of the right-hand end of the cylinder while more liquid is flowing into the left-hand end.

The check valves in the inlet ports prevent the fluid in the pump from being forced back into the reservoir. The check valves in the outlet ports prevent the fluid in the system from being drawn back into the pump.

In well-designed hand-operated pumps, the area of the piston and the length of the handle are proportioned so that you can develop high pressures without working yourself to death.

The simplicity of construction and operation of the hand pump may lead you to believe that there isn't much to worry about in the way of service or maintenance. Well, you're right, there isn't. So suppose you move along to the power driven pump.

VICKERS PUMP

The Vickers VARIABLE DISPLACEMENT (or volume) pump is used on nearly all hydraulic turrets. It is ideally suited to turret operations since it is designed to produce constant pressure at a varying volume, depending on how much volume is required at a certain moment. When there is a greater demand for fluid in the system, the pressure tends to drop slightly. This is where the pump goes to work. It keeps the pressure up and supplies the necessary volume of fluid. If pressure is off just a fraction, then the pump will apply to the system just that fraction of pressure necessary to eliminate the deficiency.

And it does all this AUTOMATICALLY.

In order to understand fully how a variable delivery pump operates, think about hydraulic pressure and the relationship between pressure and volume. Remember that no comparison can be made between air pressure and hydraulic pressure. Air can be compressed in suitable containers, and the pressure so stored can be used later. Hydraulic fluid, however, CANNOT BE COMPRESSED. And hydraulic pressure can't be stored, to be used as needed.

In order to obtain hydraulic pressure, a DRIVING FORCE is needed—something to "push" the fluid through the tubing. Such a driving force is the HYDRAULIC PUMP, which creates hydraulic pressure within the system by PUSHING the hydraulic fluid through the passages.

However, in order to have hydraulic pressure, there must be a RESISTANCE of some kind. If the outlet port of the hy-

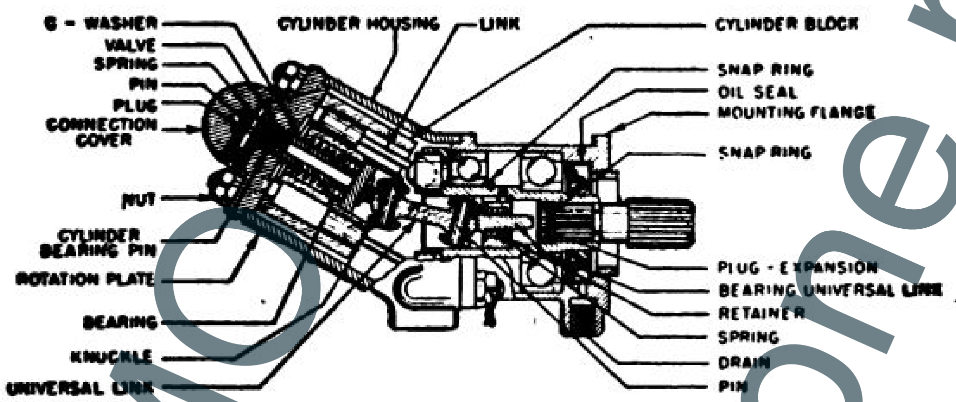

Figure 97.—Vickers piston pump.

draulic pump is connected to the inlet port by a long tube, the system filled with fluid, and the pump set in motion, NO PRESSURE WILL BE CREATED. The fluid will merely CIRCULATE slowly or rapidly, depending on the speed of the pump.

But if a hydraulic motor is installed in the line, and a load put on the motor shaft, pressure will build up in the lines. Because the motor with its load will be offering a RESISTANCE to the flow of fluid, while more fluid is being PUSHED against it, pressure begins to form at the point where the resistance is located and backs up toward the source of power.

Volume is the MEASUREMENT OF FLUID FLOW. Pressure is the AMOUNT OF POWER available. Once operating pressure has been reached, practically no volume is required, except to make the turret and contains the control handles, safety or "dead man" switches, and trigger switches.

The valve assembly consists of two four-way valves. Each is connected to and is controlled by the motions of the control handle.

The Clarke control valve takes the high pressure oil from the pump and valves it selectively in one of two directions in the ELEVATION and AZIMUTH SYSTEMS. In this way, movement of the control handle in any direction automatically regulates the flow to drive the proper (elevation or azimuth) CYLINDER in the corresponding direction. You'll find out how these cylinders work a few lines farther along.

The valve housing has six ports, two on the exterior surface and four on the bottom surface. The two ports on the exterior

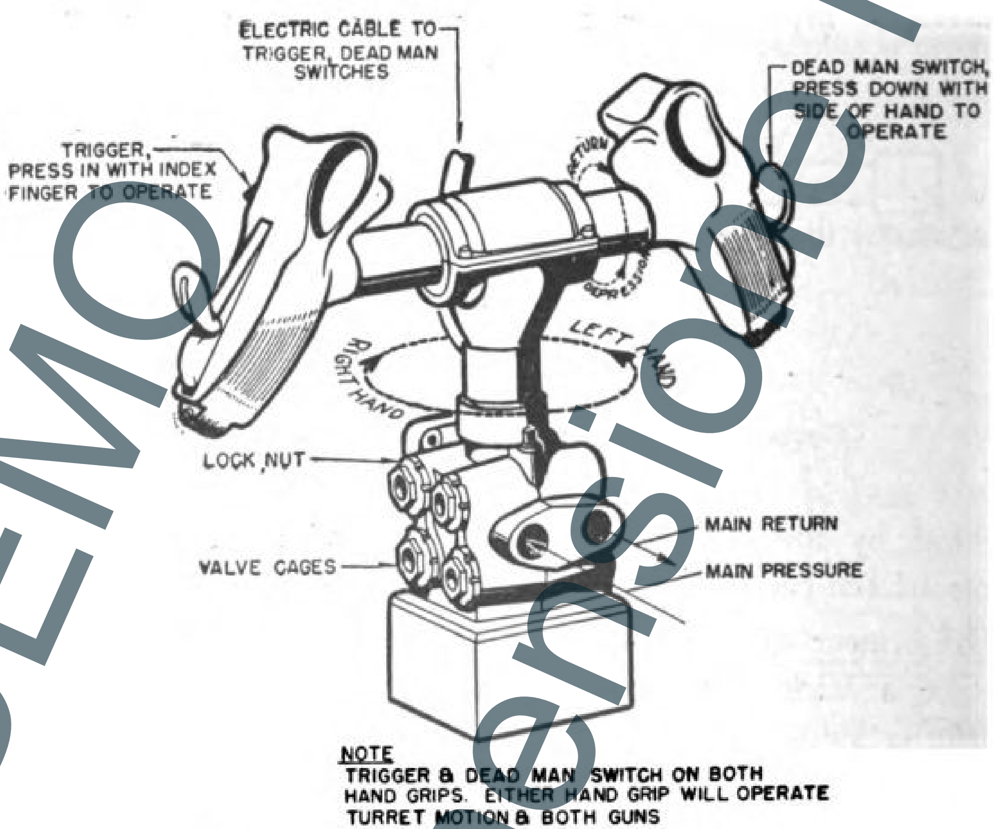

Figure 100.—The Clarke turret control valve.

surface are for the pressure and return lines. The four on the bottom are for the lines controlling both the horizontal and elevation movement of the turret and gun carriage.

You now have the hydraulic fluid being pumped through the system and its flow directed by the selector valves to and from a WORK UNIT, often an ACTUATING CYLINDER. But what is an actuating cylinder? What does it do?

Remember—hydraulics are never used alone to operate a mechanism. It is always necessary to use some form of mechanical device to start or finish the operation. The actuating cylinder is that device—the part of the hydraulic system that actually

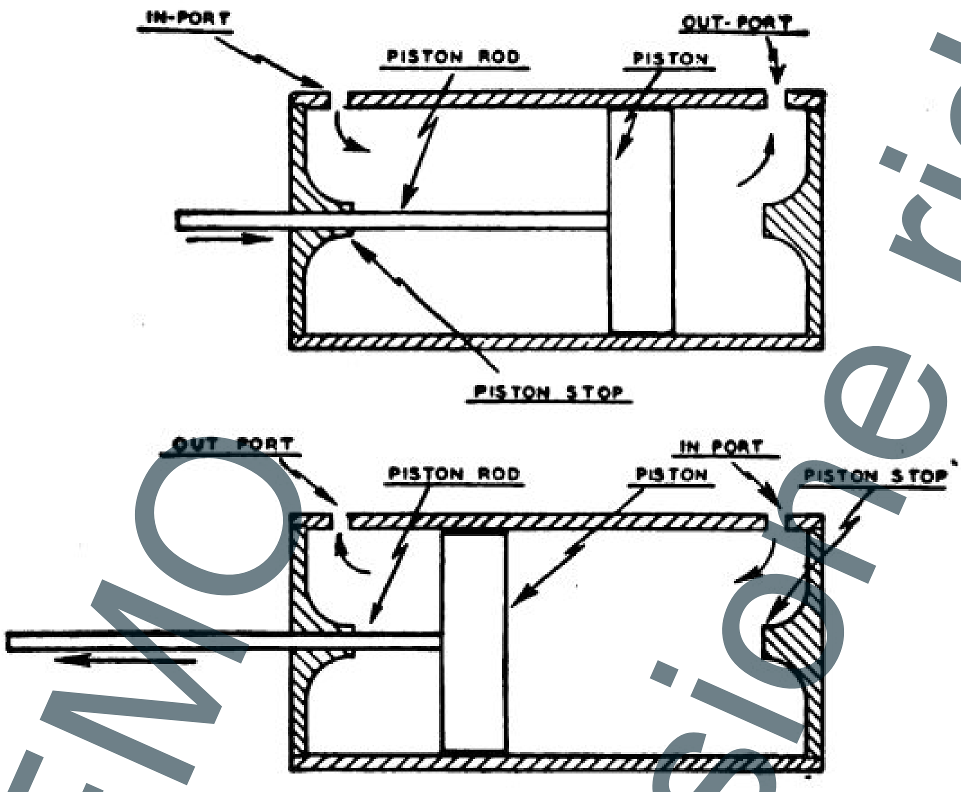

Figure 101.—Simple actuating cylinder.

imparts motion to, or actuates—the turret. Actuating cylinders are available in many shapes and sizes because their size and design must fit the job to be done. And these jobs vary a great deal.

The principles behind the operation of all such cylinders, however, are the same.

Figure 101 shows a simple actuating cylinder that operates in both directions by oil pressure. The cylinder is closed at both ends. Inside is a PISTON which operates a PISTON ROD on one end only. Seals or packings are installed on the piston and in the cylinder end around the piston rod to prevent the fluid from leaking.

Ports opening into each end of the cylinder allow the hydraulic fluid to enter and leave. These ports alternate as inlet and outlet ports, depending on the flow to the cylinder from the selector valve.

In the top view, fluid under pressure enters the left-hand port and forces the piston toward the right-hand end of the cylinder. The motion of the piston is transmitted to a movable object by the PISTON ROD. As the piston moves forward in the cylinder, it pushes ahead of it (and out of the cylinder by way of the right-hand port) any fluid that is in the forward end of the cylinder. This fluid is carried back to the reservoir by the return lines.

Now, if you change the setting of the selector valve, the pressure line becomes the return line, and vice versa. Then fluid enters the forward end of the cylinder and the piston moves backward. As it does this, the piston shoves the fluid out of the back end of the cylinder.

By varying the DIAMETER of the PISTON, the force applied to the device to be operated can be varied. Therefore, actuating cylinders are made in various diameters depending on the force desired. The length of the cylinder depends on the required amount of movement of the part that is to be operated.

Double-acting cylinders are SELF-BLEEDING because fluid from the cylinder is returned to the reservoir during each stroke of the piston. Therefore, all air can be removed from the cylinder and connecting lines by several strokes of the piston.

Incidentally, a SINGLE-ACTING actuating cylinder is used on the HYDRAULIC GUN CHARGER, which you'll find on some turrets. This is a SPRING-RETURN type cylinder. It has a single fluid port at one end of the unit and a spring opposite. When fluid pressure is released, the spring forces the piston back into position.

HYDRAULIC MOTORS

In some cases, HYDRAULIC MOTORS are used in turrets instead of actuating cylinders. These motors MUST BE USED when it is desired to obtain rotary motion. Hydraulic motors are similar in construction to piston-type hydraulic pumps. The principal difference between the pumps and motors is in the arrangement of inlet and outlet valves.

A special type of control valve is used to control the direction and speed of hydraulic motors. This valve controls the VOLUME of fluid as well as the direction of flow.

A PISTON TYPE hydraulic MOTOR looks exactly like the Vickers piston pump, illustrated for you in figure 97.

It operates like this —

Fluid under pressure is introduced into either of the two ports in the pump body depending on the setting of the control valve. The other port (as with the actuating cylinder) becomes the return port.

If the fluid flows through the motor in one direction, the motor drive shaft turns one way. If the fluid flows through in

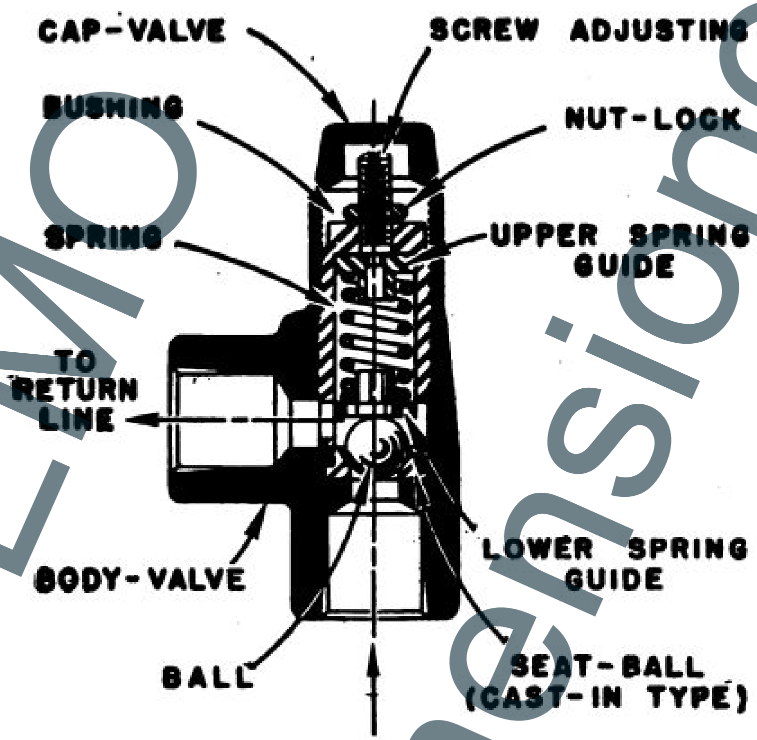

Figure 102.—A ball-type relief valve.

the other direction, the drive shaft turns the opposite way. The mechanical unit that is being operated turns in the same direction as the drive shaft.

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AUXILIARY HYDRAULIC UNITS

Now you've gotten the word on the more fundamental units making up a turret hydraulic system. There are other little gismos and gadgets, not so important fundamentally, perhaps, but helpful in a particular way to make the hydraulic operation smoother and more efficient.

Take RELIEF VALVES, for example.

They are placed in the hydraulic system to keep the pressure from too high a level and to control it if it threatens to get out of hand. In other words, relief valves are SAFETY VALVES.

Several types are used in the hydraulic systems.

In each case, the basic design involves a spring-loaded valve arranged so that it automatically opens to relieve the system pressure when the fluid pressure acting on one face of the valve becomes sufficient to overcome the spring pressure applied to the opposite face.

The relief valve closes immediately when the pressure drops to a value less than the spring loading.

Figure 102 shows a typical BALL-TYPE RELIEF VALVE. It employs a spring-loaded ball resting on a hardened steel valve seat inside a housing. An adjusting screw is installed so that the spring pressure can be varied and the operating limit of the relief valve regulated.

The valve is enclosed in a valve body containing integral inlet and outlet bosses and a valve seat.

A highly polished hardened-steel ball is held on the valve seat by a steel coil spring. This valve is held between two spring guides which are in the form of metal disks and have integral bosses which slip inside the spring ends. One of the spring guides bears on the ball while the other is in contact with the adjusting screw in the upper end of the relief valve.

The valve body is internally threaded at its upper end to receive a bushing that carries the adjusting screw and locknut. An aluminum alloy dust cap encloses the adjusting screw.

BALANCED RELIEF VALVE

The balanced-type relief valve, as illustrated in figure 103, has the advantage of smooth operation because it operates without the chattering effect produced by the ball-type valve. It operates in this manner —

Fluid from the pump enters port *A* and leaves through port *B* to enter the system. In the meantime, however, some of the fluid also goes through the metering hole *C* into the upper chamber and finds its way to the spring-loaded ball *D*. When the pressure reaches a predetermined value, it overcomes the spring *E* and unseats the ball *D*.

As the ball unseats, the fluid rushes past metering hole *C* and pressure is applied to the area of *H*. But, because the hole *C* is small, the hydraulic pressure reacts upward on *H*, moves

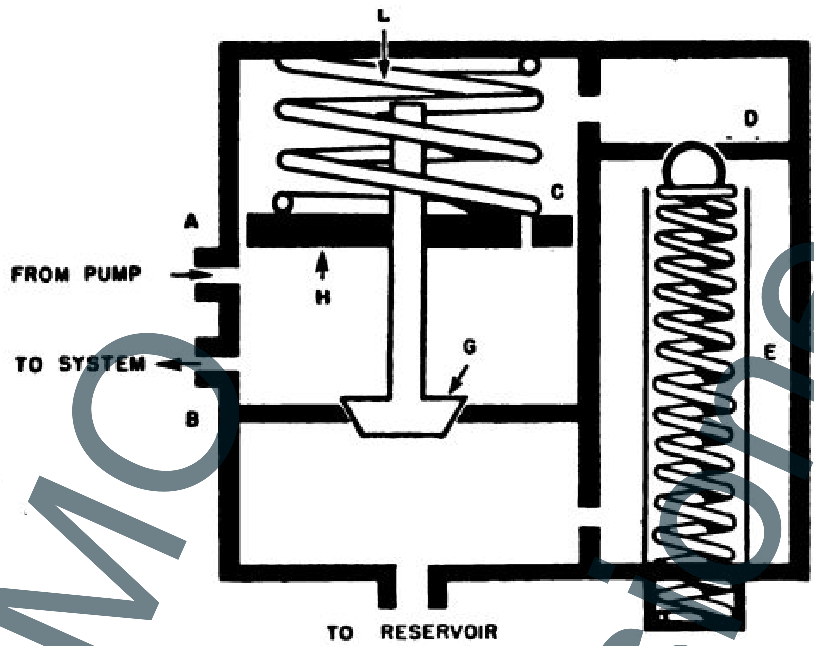


Figure 103.—Balanced-type relief valve.

it in the same direction, and at the same time unseats valve *G*. When this valve is unseated, the fluid from the pump is permitted to flow freely to the reservoir. When the spring *E* overcomes the oil pressure, ball *D* reseats and spring *L* assists *H* and *G* to return to their original positions. This permits the pressure to build up in the system again.

THE ACCUMULATOR—SYSTEM HANDY MAN

The ACCUMULATOR is just what you'd think it is. It ACCUMULATES potential hydraulic power.

The accumulator stores fluid when demands of the system are low. Then, when the capacity of the pump is insufficient to do all the work required of it, the accumulator feeds its reserve stock of fluid to the system units and keeps things going.

Not content with performing this valuable duty, the accumulator also serves as a SOURCE OF HYDRAULIC POWER when the pump fails to function and emergency operation of certain units is necessary. In its spare time, the accumulator acts as a surge

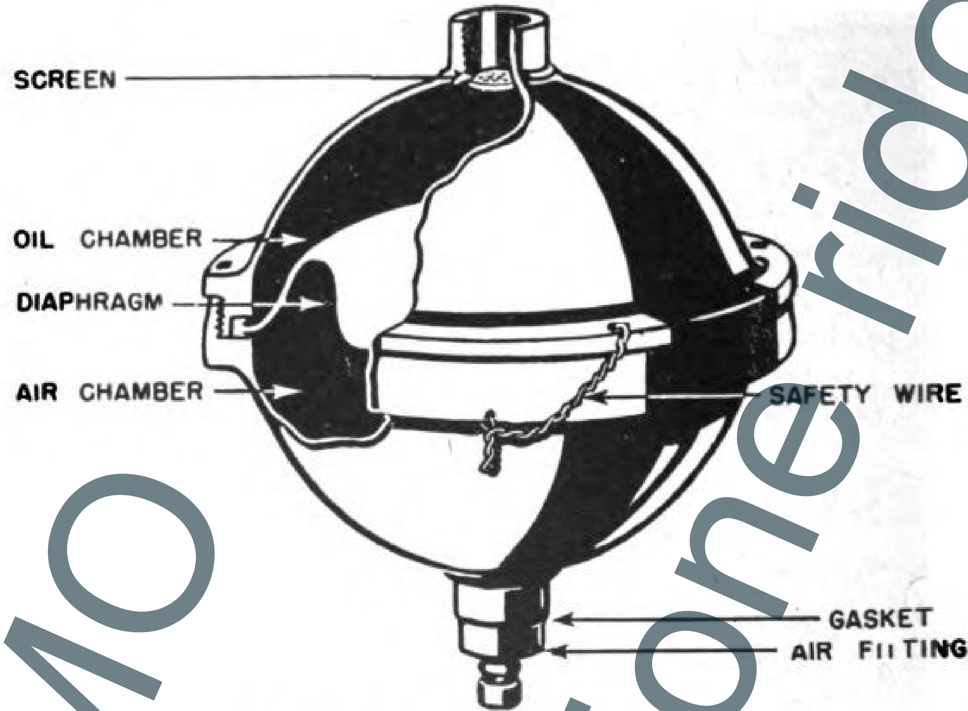


Figure 104.—Pressure accumulator.

chamber to prevent sudden surges of fluid pressure from damaging the system.

Actually, a pressure accumulator serves much the same purpose in the aircraft hydraulic system that the STORAGE BATTERY serves in the electrical system.

A spherical hydraulic-pressure accumulator, with a section of the outer shell removed, is shown in figure 104. This accumulator is made up of two forged steel hemispheres which are screwed together to form the complete sphere. The halves are separated by a rubber diaphragm thus forming two chambers. The upper chamber is the fluid chamber and is connected to the fluid supply line at a point close to the unit it is to operate. The lower half of the accumulator is the air pressure chamber and is fitted with an air valve (similar to the valve on automobile tires) for charging the chamber with compressed air. Air is pumped into the chamber at a pressure specified for each installation, usually one-third of the system operating pressure.

With the accumulator in the charged condition and the fluid chamber empty, the diaphragm is forced against the walls of the fluid chamber by air pressure. The introduction of fluid into the fluid chamber causes the diaphragm to be forced towards the walls of the air chamber. This further compresses the air charge and increases the pressure to that of the fluid.

When the fluid pressure in the line to which the fluid chamber is connected drops below the system's operating pressure,

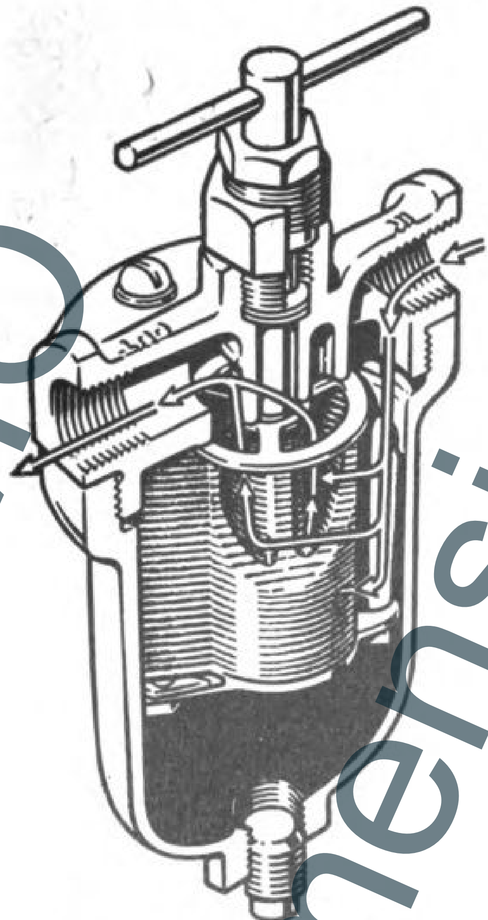


Figure 105.—Edge-type filter.

the air expands the forces the diaphragm toward the fluid chamber walls. This FORCES the fluid from the accumulator into the system.

The accumulator again becomes charged with fluid during periods when the demands of the system do not require the full output of the engine pump.

ROUNDING UP THE SABOTEURS

The filter (or strainer) stands guard at the reservoir to prevent any sabotage of the hydraulic fluid. Bits of metal, dirt, and other enemies are taken in hand and held in a concentration camp for ultimate disposal.

Figure 105 illustrates an EDGE-TYPE FILTER, the kind commonly used in hydraulic turrets. In this filter, the foreign matter is removed from the fluid when it passes between the surfaces of metal disks. It is then cleaned from the disks by rotating them with the handle. Cleaner blades which extend between each two adjacent rotating disks scrape the foreign matter from them and it drops to the bottom of the filter. These filters are also disassembled periodically and washed in a solvent.

Filters have integral bypass valves which open to allow fluid to pass if the filter element is clogged. This condition will not occur, however, if the filter handle is turned daily or before each flight and the filter element is cleaned regularly.

The filters are usually installed on the system return line, and that is the ideal location for them. Installation limitations, however, may make it necessary to install them on pressure lines.

CHECK VALVES

Check valves are the Shore Patrols of the turret hydraulic system. They are posted through the system, ever on the alert to keep the hydraulic fluid from entering spots that are out of bounds.

Spring-loaded ball-type check valves are encountered most frequently. The principle of operation is quite easy to understand.

The ball-type check valve is illustrated in figure 106. As you can see, the ball is held against its seat in the valve body by spring compression. Installed in a fluid line, the valve will remain in the closed position until the fluid pressure acting on the INLET side of the ball reaches a pressure greater than the combined spring and fluid pressure acting on the opposite side of the ball. Then — the ball leaves its seat and fluid is free to flow through the check valve in the direction indicated by arrows.

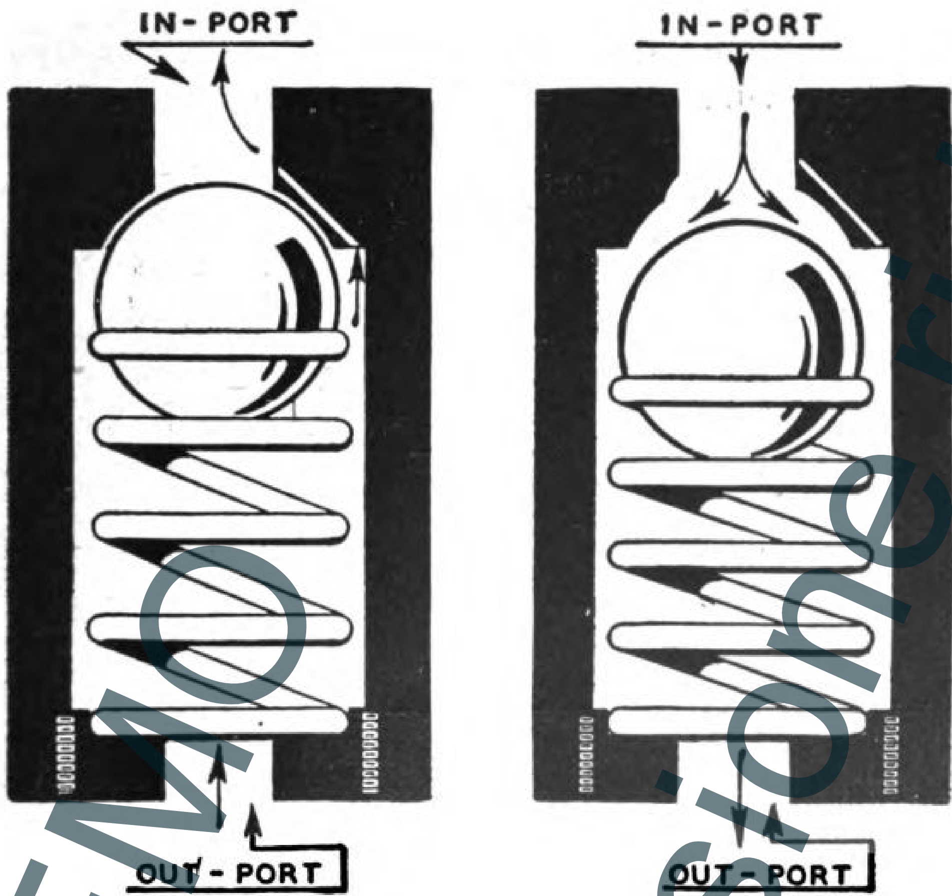


Figure 106.—Ball-check valve.

As soon as the fluid pressure in the INLET side of the ball drops below that on the OUTLET side, the spring returns the ball to its seat and prevents fluid from flowing in the opposite direction. In this way, fluid pressure is maintained in the portion of the system that is protected by the check valve.

In hydraulic lines where it is particularly important to prevent the reverse flow of any fluid, a DOUBLE ball-check valve is used. This valve has the same effect as installing two separate check valves in the line. There is not much chance of both valves in the double ball-check valve being held open by foreign particles at the same time. Thus the safety factor is doubled.

EVERYTHING AT ONCE

Now you can get down to business and tie the individual units of the turret hydraulic system together. Figure 107 is a schematic of a real turret system — that of the Erco 250 TH–1. Rather simple, isn't it?

Note that this particular turret uses hydraulic CYLINDERS as power actuating units, both in elevation and azimuth. Some

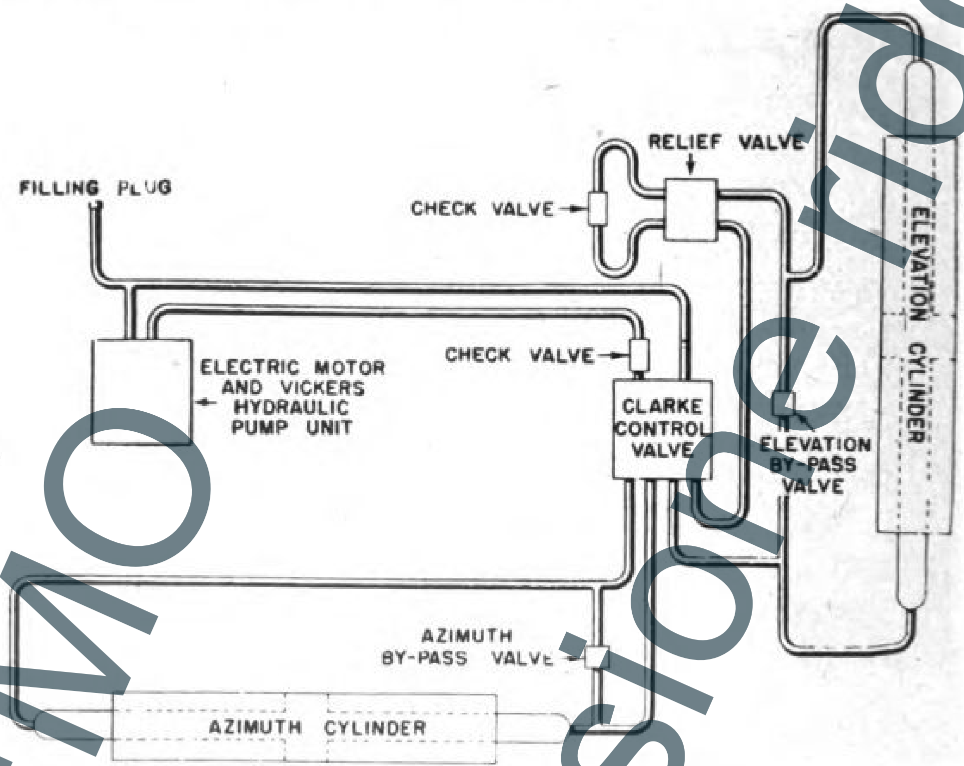


Figure 107.—Schematic of hydraulic system.

hydraulic turrets use hydraulic MOTORS as work units, particularly for rotary motion. Otherwise, the units of the Erco are common to all hydraulic turrets.

It's too bad, but to be quite frank, there isn't much uniformity in hydraulic symbols. Some manufacturers use one set and another manufacturer will make up a different set that suits him better. However, the symbols shown in figure 108 are used as much as any, and a little study of them will help you understand most hydraulic diagrams.

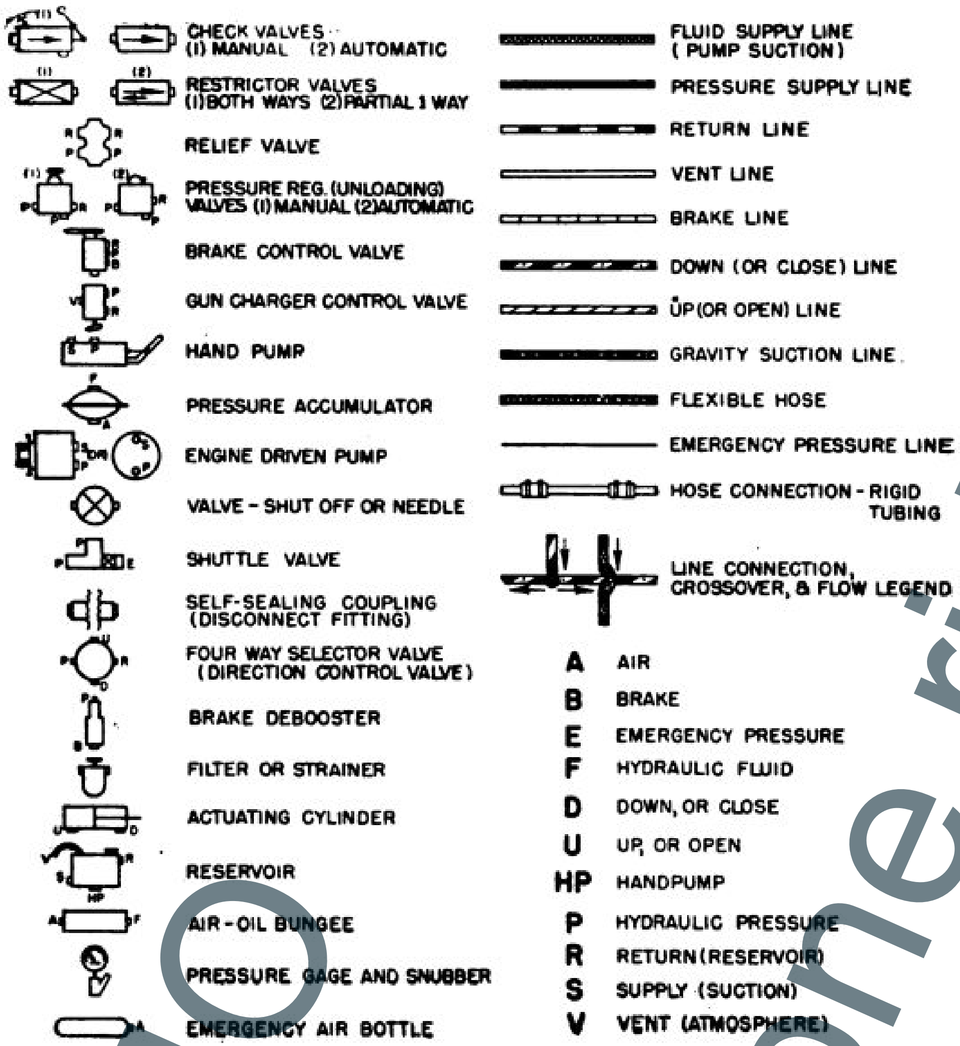
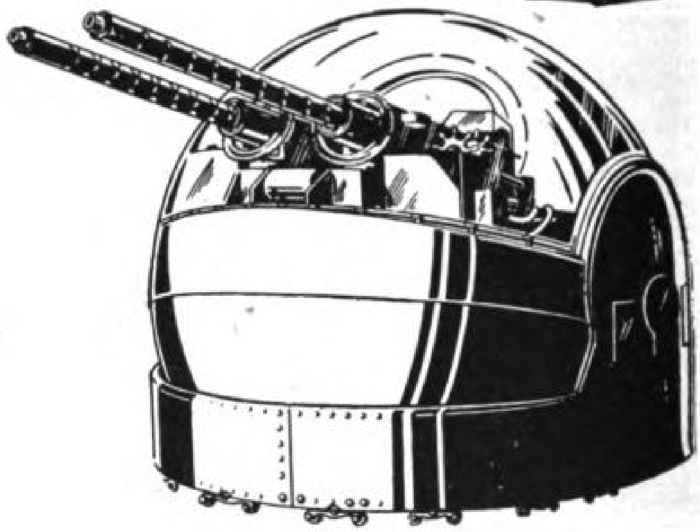


Figure 108.—Hydraulic symbols.



CHAPTER 6

MARTIN 250 SH–2 TURRET

HYDRAULICS AT WORK

Now that you are acquainted with the primary units of the turret hydraulic system and the auxiliary units which improve the efficiency of the basic system, you're about ready to put them together. When you do, you'll have a complete turret hydraulic system.

The MARTIN 250 SH–2 TURRET will give you a pretty comprehensive idea of how these units fit together and relate to one another. In fact, if you understand how this turret works, you won't have much trouble with any other hydraulic turret.

The 250 SH–2 is mounted in the bow position of the PB2Y. Very similar Martin turrets are used in the PBM. The Martin 250 SH–3 is the same as the 250 SH–2, except that the PARKER ELEVATION UNIT, which you'll learn about in this chapter, is replaced by the Vickers motor.

As the designation tells you, the Martin 250 SH–2 carries two .50 caliber machine guns. They protrude from the upper half of the turret. The turret carries 800 rounds of ammunition to feed into these guns. A one-piece, transparent plexiglas enclosure makes up the top half of the turret. It houses the gunner, the guns, accessories, armor plate, and all the operating mechanisms except the horizontal driving unit.

The MARTIN 250 SH–2 turret is composed of two main parts, known as the BALL and the SADDLE. As you can see in figure 109, the ball is a sphere slightly flattened on two opposite sides. These flat surfaces fit inside the hubs of the saddle, which is a cylindrical shell with the two hubs projecting above it. In

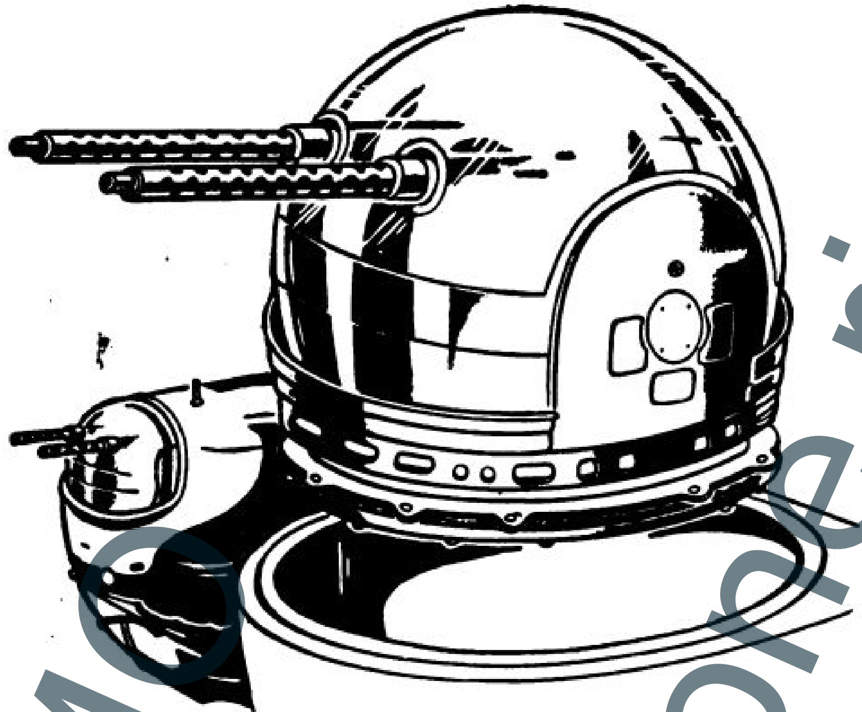


Figure 109.—Ball and saddle (assembled).

vertical rotation, the ball moves about the axis formed between two horizontal trunnion tubes which support it. Horizontal movement is accomplished by the rotation of the saddle on a track. Rollers on the saddle ride on this track, which is bolted to the airplane structure.

HOW TO OPERATE IT

This Martin turret will rotate in azimuth to 79 degrees on either side of the center line of the airplane. You can move the guns 87 degrees above the horizontal or depress them 33 degrees below horizontal.

Now assume that the turret is all set to operate. This means that the hydraulic system is completely filled with fluid (it holds six quarts) and all units are intact and in good working order.

BE SURE the turret is LOCKED before you start to get in. Otherwise, it can swing down and pin you part way in and part way out.

Facing forward, you enter the turret through an opening in the bottom and reach up, grasping the top of the front armor plate to pull yourself aboard. Once inside, reach down on your left side and release the seat lock, allowing the seat to follow the track to its seated position.

At this point, you can take a look through the Mark 9 illuminated sight to see if you're at the right height. If not, you can adjust the height with the seat adjustment handle, which you can reach with your right hand underneath the seat.

Take a look at your pressure gauge, which you'll find down by your right ankle. It should read 25-30 pounds before the turret is ready to operate.

Now unlock the elevation landing lock, which is on the forward left-hand side of the ball, by pulling out the handle and moving it UP. Then determine if the azimuth position lock on the lower left-hand side is in the extreme unlocked position. These two operations free the turret so it can rotate.

You can turn on the juice at this point. The main power switch is on the control panel, which is located on the upper right-hand side of the turret. When the switch goes on, a red indicator light shows up, both on the panel and outside of the junction box.

Then you can turn on the pump motor. The control switch is marked on the bottom of the control box. The pressure gauge should indicate that the pump has built up from 960 to 1,000 psi.

The turret actually rotates when you move the control handles. You can't miss these, since they are directly in front of the gunner's position in the turret. Moving them to right or left will move the turret correspondingly in azimuth. Moving them up or down will elevate or depress the guns. If you combine both motions, you can move the turret in a diagonal direction. The degree of rotation determines the speed.

inward an equal amount until the desired neutral play or "feel" is obtained. Now tighten the locknuts you loosened when you started to adjust the valve. When you tighten the locknuts the valve cages will be pulled slightly, so be sure and allow for this condition when adjusting.

If the control valve is giving trouble, check its performance with the descriptions which follow. But once again, DON'T TRY TO DO TOO MUCH. If it looks as if a major overhaul is required, call on the nearest overhaul point. That's what they're for.

Here are some common Clarke valve troubles and what to do about them —

TROUBLE: Stiffness and excessive handle load in train control

CAUSE	CURE
Mechanical friction occurring in the bearings.	Remove cover D1307B. Loosen the pivot arms and actuating link sub-assembly D1405A, by removing the screw that clamps it to the torque tube. Readjust the locknut, and clamp sub-assembly back in place.

TROUBLE: Leakage from around guide screw D1164A

CAUSE	CURE
Guide screw loose, or	Tighten screw.
Imperfect crush washer CS1289A.	Remove guide screw and replace crush washer. Care should be taken when replacing screw to see that the guide prong on the end of the screw properly engages the hole in the sleeve and the slot in the valve.

TROUBLE: Excessive neutral play in elevation control

CAUSE	CURE
Improper adjustments of elevation cages.	Loosen locknuts D1156A on the elevating cages and back each cage out the same amount until a very definite neutral position is noticeable. Turn each cage IN the same amount until a very definite neutral position tained. (The valve should be under full operating pressure when making this adjustment.)

TROUBLE: Excessive neutral play in train control

CAUSE	CURE
Improper adjustments of train cages.	Same as above operation with train cages.

TROUBLE: Mushy or spongy feeling in neutral position of valve

CAUSE	CURE
Foreign particles lodged between the valve plungers and the liners.	Remove cages, and check for dirt. Remove dirt, and flush with clean fluid.

TROUBLE: Stiffness or excessive handle load in the elevation control

CAUSE	CURE
Mechanical friction occurring somewhere in the linkage between hand grips and the cam shaft.	Move hand grips through the elevation cycles with the pressure OFF. If a noticeable amount of resistance is found, loosen the locknuts that hold the shaft in axial alinement. If the trouble is not in the adjustment of the handle shaft bearings, follow the linkage motion down through the column to the bottom of the valve, making sure that no dirt has worked into any of the moving parts.

WHAT MAKES IT ELEVATE?

A Parker hydraulic elevating unit is mounted on the left-hand side of the Martin 250 SH-2 turret on the horizontal and vertical centerline. It consists of a large housing which contains a central spur gear fastened to the left turret trunnion tube, which in turn is attached to the saddle. Above and below this gear are two racks lying in a horizontal plane and meshing with the gear.

On each side of the racks are pistons. These pistons are driven by HYDRAULIC PRESSURE, regulated by the CONTROL VALVE. This makes each rack DOUBLE-ACTING. Opposite ends of the two racks are interconnected. This provides rotation of the ball structure to aim the guns in elevation.

THE ELEVATING UNIT SHOULD NOT BE REMOVED EXCEPT TO REPLACE A DAMAGED UNIT, and the removal should be done only in a machine shop capable of such work.

The hydraulic SWIVEL JOINT fits inside the left-hand trunnion and elevating unit. It carries the flow of three separate hydraulic lines from the ball to the saddlle. Two of these lines run from the control valve to the azimuth motor, and the third is a drain line from the azimuth motor back to the low pressure side of the pump.

EXAMINE THE AZIMUTH DRIVE

The azimuth drive unit is bolted to the roller casting under the left-hand hub on the saddle. It consists of three parts —

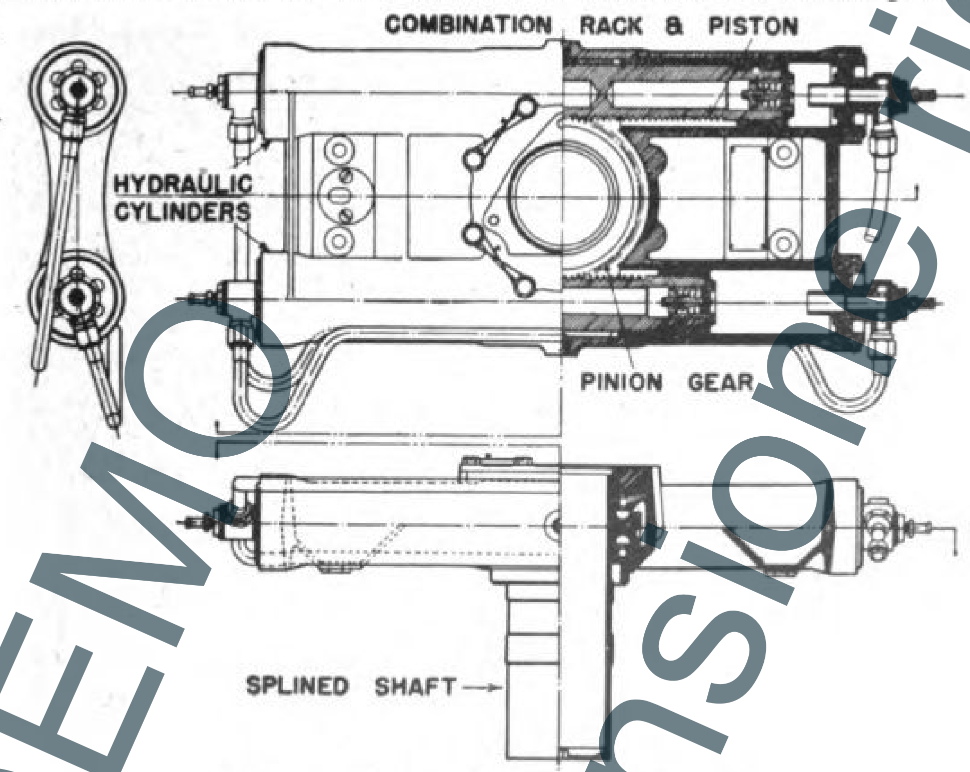


Figure 113.—The Parker elevating unit.

a main gear box, a hydraulic motor, and a 90-degree manual drive gear box.

The main gear box comprises a worm and gear enclosed in a housing with a small pinion outside on a shaft, which meshes with the large ring gear on the turret track. At right angles to this latter shaft is the worm shaft with a spline on each end. A seven-cylinder fixed-stroke motor connects on one end of the worm shaft.

On the other end of the worm shaft, the 90-degree manual drive attaches. There is a square shaft projecting from this,

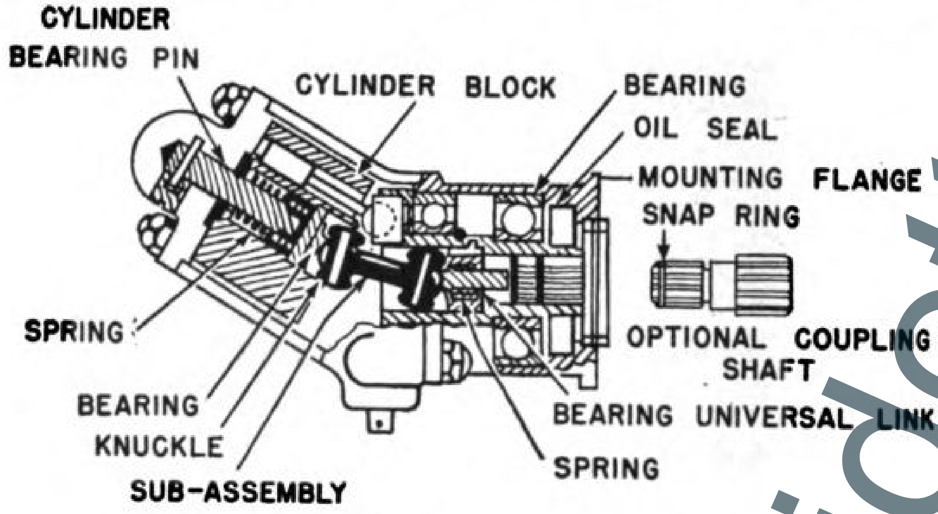


Figure 114.—Cross-section of azimuth motor.

to which may be attached a hand crank for manual movement (from outside the turret) of the turret in azimuth.

Here are a few common complaints that can develop in an azimuth motor —

TROUBLE: Motor not turning over or not developing sufficient speed or power

CAUSE	CURE
System overload relief valve not set at correct pressure, or	Check system pressure and reset relief valve.
Driving mechanism binding because of misalinement or other damage, or	Install new motor, unless you can easily realine.
Scored valving surface on connecting cover (X) or scored cylinder block (#46260) due to foreign matter in oil system.	Replace damaged parts.

TROUBLE: Motor not turning over or not developing sufficient speed or power

CAUSE	CURE
Pumps or other components in system not functioning as intended, or	Check system thoroughly—particularly pump pressure and delivery.
Incorrect motor model for particular circuit.	Check model number, replace with correct size motor.

pump is not running), check for loss of system pressure FIRST, then for the other possible troubles, described in the preceding list.

MEET THE CHARGERS

The two machine guns mounted in the Martin 250 SH-2 turret are provided with HYDRAULIC GUN CHARGERS, which are mounted to the outboard side of either gun. Pressure for their

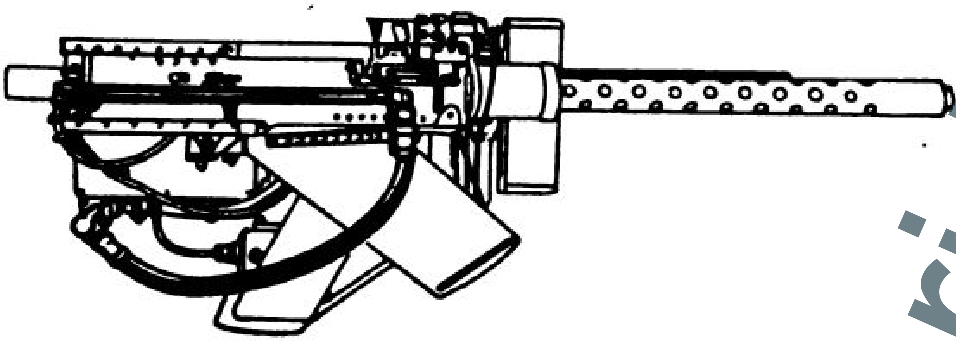


Figure 115.—Hydraulic gun charger (cross-section).

operation is obtained from the turret hydraulic system and the accumulator.

It is the operation of these gun chargers that makes the accumulator necessary, since it maintains reserve pressure to replace that diverted by the chargers.

The charger VALVE operates the gun chargers. The charger valve handle is pushed down to operate the chargers, and by rotating the handle, the charger is held in either a safe position or in the firing position.

Here's how to operate the gun charger —

Set the control handles in the firing position. Depress the plunger through a stroke of ⅜ inch. The valve plunger will remain in this open position. When the valve plunger is in open position, fluid is free to flow to the charger cylinder until the gun bolt is full retracted. When the gun bolt strikes the gun buffers, the valve plunger will automatically close, opening the passage from the charging cylinder to the return line and allowing the hydraulic charger cylinder piston to return as the fluid is discharged from the cylinder by action of the charger spring.

A SAFETY FEATURE is incorporated in the charging system whereby it is impossible to fire the gun, should the firing switch be inadvertently closed. To hold the gun safe, the control valve handle is turned counterclockwise, and then depressed. The valve will AUTOMATICALLY close in the manner previously described, but the hydraulic fluid will remain trapped in the line. In this way the gun will be safe until the handle is rotated clockwise to the firing position, in which case the fluid is exhausted from the cylinder and the bolt returns forward for firing. REMEMBER, this operation is safe only when the motor is running.

If, for any reason, you have taken down and reassembled the charger control valve, the spring will require adjustment. This can be done with either a hand pump or a power operated pump with an adjustable relief valve.

The valve should be put in the open position and the pressure gradually increased until the valve plunger kicks out.

The spring should be adjusted by the adjusting screw, in or out as required, until the necessary kick-out pressure is reached.

FILLING AND BLEEDING

You can save yourself a lot of time and possible worry if you will always remember that improper filling and bleeding is THE CAUSE OF MANY TURRET ILLS. Air in the hydraulic system is just as fatal to the proper operation of the system as air would be if it got into your own blood system.

The term "bleeding" the hydraulic system is nothing more than FORCING ALL AIR OUT of the system.

Filling, naturally enough, is filling the system with the hydraulic fluid. As long as this fluid is clean, and as long as the turret hydraulic system is filled to capacity, with NO AIR in the system, you will find that hydraulic turret difficulties are very few and far between.

Filling and bleeding is accomplished through the use of a FILLER CAN and in the case of turrets so equipped, with the use of the FILLER VALVE. The best kind of filler can is illustrated in figure 116. The two flexible hoses are about three feet in length, and they are equipped at the ends with shut-off valves. You can easily make a filler can out of an empty oil can, if you need to.

The operation you are about to undertake is a one-man job, due to the limited working space inside the turret. However, you will have to have an assistant to hold the can for you, or if this is not possible, you will need to attach the can to something HIGHER than the turret to be filled. It must remain higher AT ALL TIMES. The can should be filled with hydraulic oil, Specification AN-VV-O-336b.

Get inside the turret through the escape hatch, and take the flexible hose in with you, or get your assistant to pass it in to

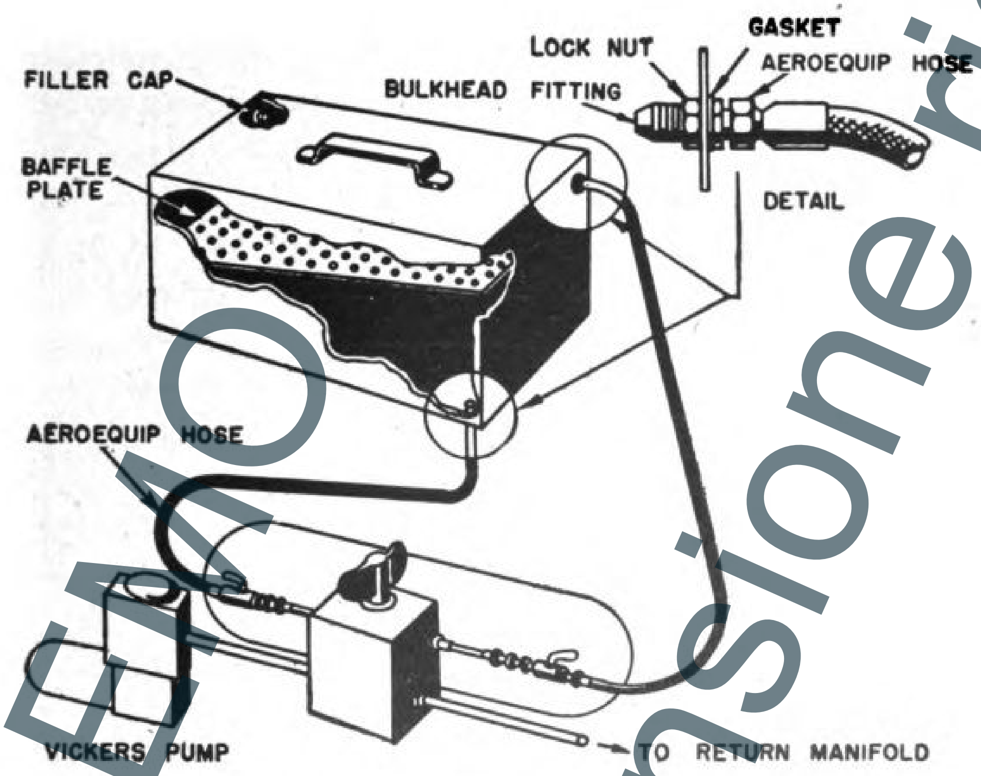


Figure 116.—Filler can.

you. There is a Schrader valve located on the Vickers accumulator. If you remove the valve core, you will reduce the preload to zero within the accumulator and you are ready to start your bleeding and filling operation.

Connect the tube at the bottom of the filler can to the INLET port (½ inch tube size) of the FILLER VALVE. Then connect the tube at the top of the filler can to the RETURN port ($\frac{3}{8}$ inch tube size) of the filler valve.

Now turn the lever at the top of the filler valve to the FILL position. Open both shut-off valves at the end of the hose connecting with the filler valve.

Now apply a pressure of 10 to 15 psi to the supercharging chamber of the Vickers pump. This pressure can be applied with an air line or with a hand pump. Check it with a reliable tire gauge.

The next step is to operate the turret slowly to all extreme positions until air is removed from the system. You can tell when this occurs by watching for bubbles in the filler can. When there are no more bubbles, there is no more air in the system. Don't forget to operate the turret slowly and to run it to the extreme limits both in azimuth and elevation. About one-fourth maximum speed should be tops in this operation.

The reason why it is so important to operate the turret slowly is that when a filling can is being used, the pump feed pressure is low. Therefore, if the pump is operated at too high a speed, it is likely to feed and draw air into the system, which is just exactly what you don't want to have happen.

Usually, you should get all the air out of the system in not more than ten minutes.

Now loosen the filler cap and nut on the line to the pump, and bleed both of your lines.

Operate the turret slowly for three minutes after the operation becomes smooth and free from jerkiness, and then turn the pump off.

Release the air from the pump supercharging chamber by removing the core of the pneumatic valve located on this chamber's cover plate. Now turn the turret power on again and run the turret for a couple of minutes more. This replaces the volume of air just released from the supercharging chamber of the pump with hydraulic fluid.

Now turn the turret power off again and switch the index lever of the filler valve to the RUN position. Replace the Schrader valve core in the supercharging chamber of the pump. Put the dust cap back on the valve and tighten it up with a wrench. It is VERY IMPORTANT that no dirt or dust get into the system.

Close both the shut-off valves which you opened previously at the end of the hose connecting to the filler valve. Disconnect this hose from the filler valve. Cap the two ports of the filler valve simultaneously with the removal of the hose.

You will have to be QUICK about this — otherwise you will lose too much oil from the system. If you are careful, however, just a tiny bit will escape. Now remove the cap from the filler tube. You will have to remove approximately eight ounces of oil from the filler tube to provide a space for the correct volume of air to be applied to the accumulator. You do this by applying air to the accumulator and making sure that you don't get too much air pressure, so that more oil will be displaced than you want to lose.

Replace the cap to the filler line. Put the Schrader valve core back in and supercharge the system by applying air pressure to the accumulator until the low pressure gauge indicates about 25 psi. Replace the dust cap to the Schrader valve and tighten it again.

Unless you want to see what it looks like when a turret blows up, NEVER charge any hydraulic equipment with oxygen, even if the oxygen bottle happens to be handy. A mixture of oxygen and hydraulic fluid creates an EXPLOSIVE combination which can be set off by gunfire or in many cases, by hydraulic pressure alone.

Use a standard hangar air line, if it is available — that is, a regular air hose such as the one found in any gas station. If you are working in a hangar, you are just about sure to see one attached to a compressor.

In case you don't have an air line, you can use an ordinary bicycle or automobile tire pump.

ADJUSTMENT OF TURRET ROLLERS

That just about covers the operation and maintenance of the hydraulic system in the Martin 250 SH–2.

There is one mechanical adjustment you should know about, however, before going on to the next turret. This is the ADJUSTMENT OF THE TURRET ROLLERS.

This isn't difficult. All you need in the way of equipment is one screwdriver and an open-end wrench.

There are three sets of rollers to consider. There's the AZIMUTH variety, on which the turret rides in azimuth on the saddle assembly, as it revolves around the ring track.

Then there are the UP rollers placed on the underside of the saddle structure and rotating against the upper flange of the turret ring. Finally, you have the DOWN rollers, located on the underside of the turret and rotating against the lower flange of the track, or outer turret ring.

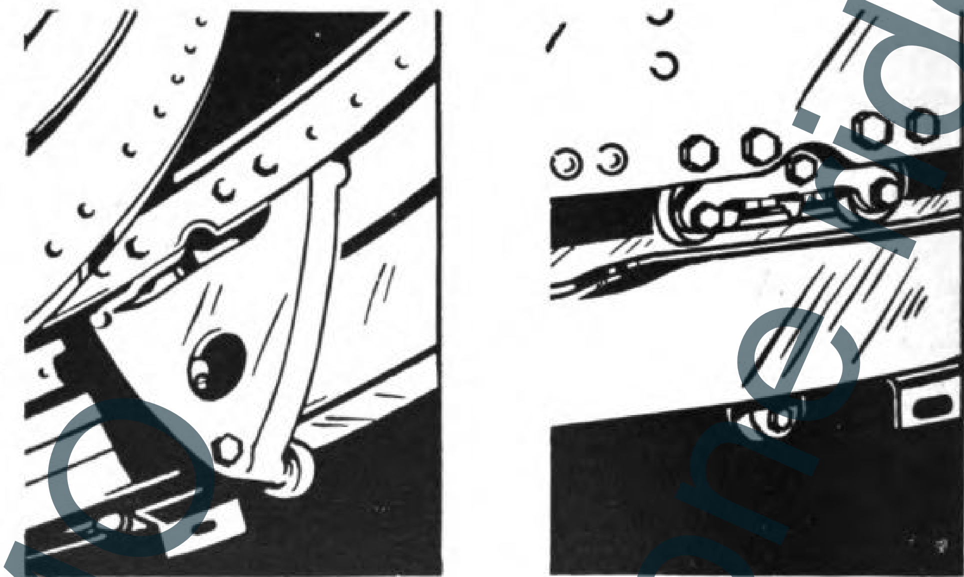


Figure 117.—Section showing rollers.

If the UP or DOWN rollers are too tight, they STICK. And so will the turret. If they are too loose, the turret can bounce and joggle around in a most disconcerting manner.

Now about the adjustment. All of these rollers are accessible to you and your screwdriver. They all have locknuts — in the case of the AZIMUTH and the UP rollers, these nuts are located above the rollers. In the DOWN rollers, they are below the rollers.

Loosen these locknuts. Now insert the screwdriver in the slot across the top (bottom of the DOWN rollers) of the bolt

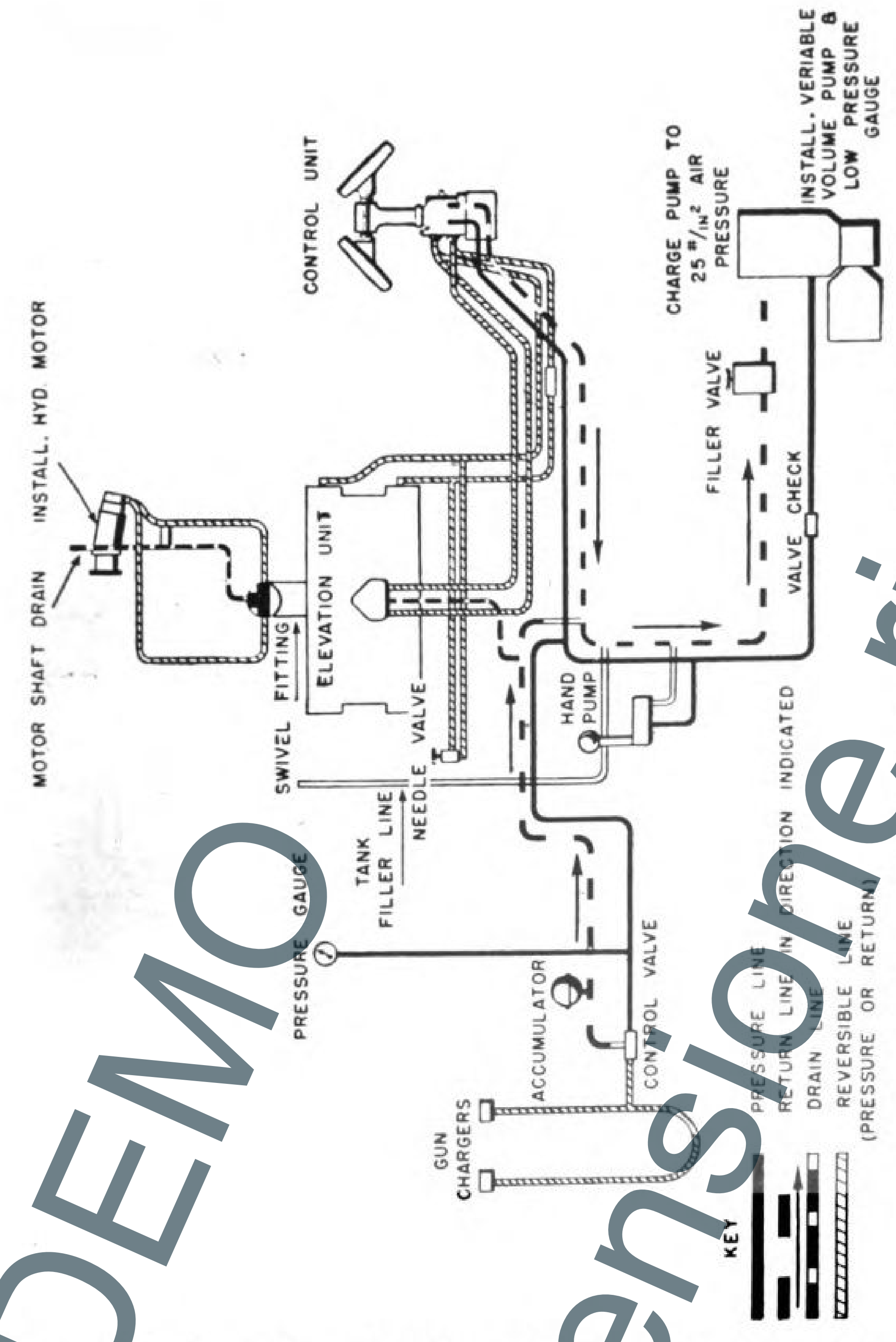


Figure 118.—Hydraulic system, Martin 250 SH-2.

on which the locknut is situated. Turn the screwdriver to the right or left until the RIGHT ADJUSTMENT IS ACHIEVED. What is the RIGHT adjustment? Well, that's something you'll just have to FEEL. Not too tight, not too loose, if that's any help to you.

But don't worry. You'll catch on quick as to what adjustment is the right one after a little experimentation. How the turret operates after you adjust its rollers gives the answer.

One other thing. At least 75 percent OF YOUR ROLLERS should be touching the outer turret ring.

You can FORGET ABOUT LUBRICATION. The rollers are self-lubricating. You never need oil or grease on the track or outer ring, either.

This roller adjustment is IMPORTANT. Even if you've got

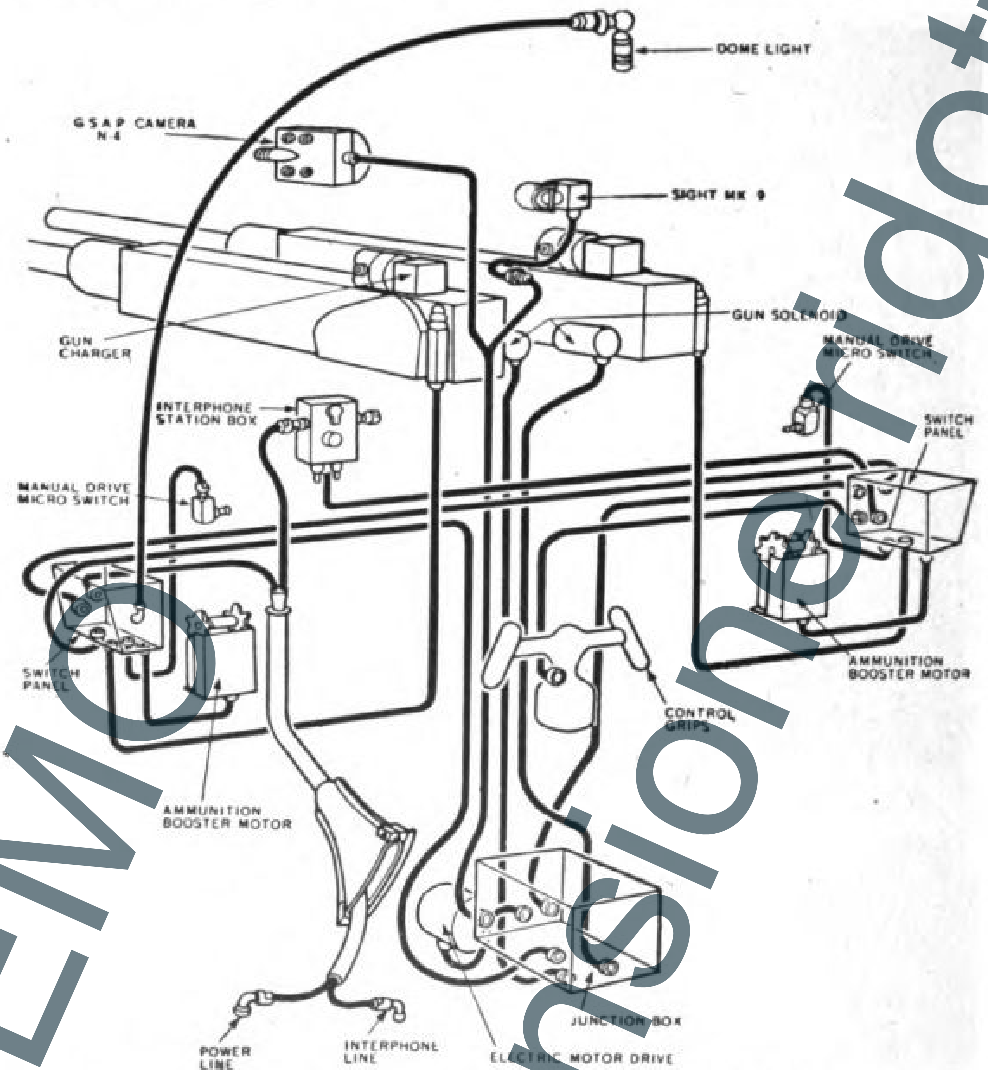


Figure 119.—Electrical equipment diagram, Martin 250 SH–2 turret.

the hydraulic system in apple pie condition, the turret won't perform smoothly if your rollers are out of line.

STUDY THE DIAGRAMS!

Now to top off your investigation of the Martin 250 SH-2 turret, check the diagrammatic hydraulic system shown in figure

118. The numbers enclosed in circles represent the part numbers of the various hydraulic lines and other units which you will want to refer to in ordering replacements or in following lists and diagrams in the Martin 250 SH–2 parts manual..

Remember that even though this Martin, turret operates HYDRAULICALLY, it still utilizes ELECTRICITY and a great many electrical units. You will see this very clearly when you look at figure 119, the electrical equipment diagram. Remember, too, that it takes a little electric motor to drive the hydraulic pump which sends the whole hydraulic force into action!

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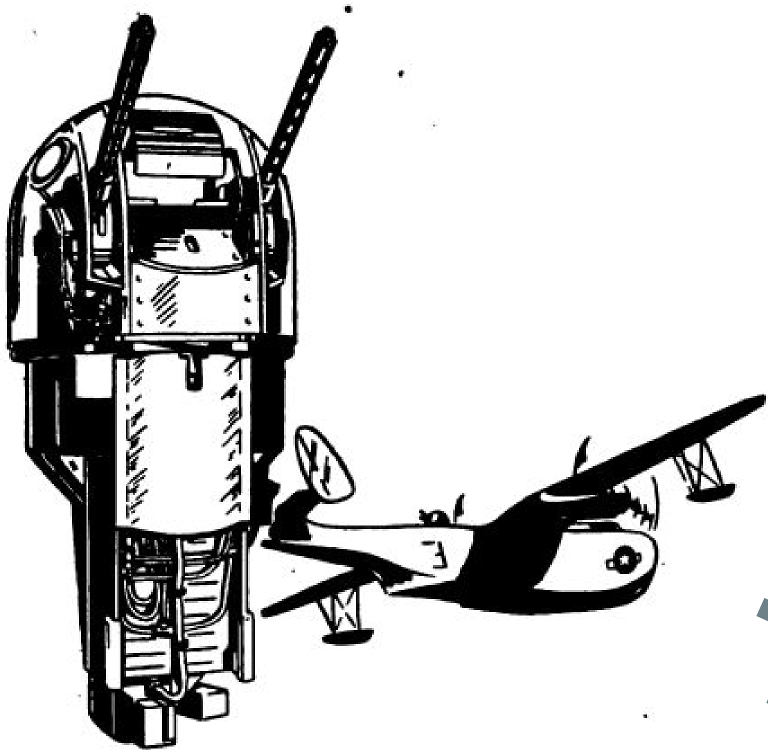

CHAPTER 7

MARTIN 250 CH–3 TURRET

WHAT IS IT?

Now that you are familiar with the Martin 250 SH–2 turret, you have a head start on understanding the operation of the Martin 250 CH–3. The main difference between the two is in their shape.

As the code tells you, the 250 CH–3 is a cylindrical hydraulically operated turret, mounting two .50 caliber machine guns.

You will recall that the CYLINDRICAL turret differs from the SPHERICAL turret in just one way. In the spherical turret, gunner, guns, and sight rotate about a common axis in BOTH azimuth and elevation. However, in the CYLINDRICAL turret, only the guns and sight can be elevated or depressed. The whole turret, including the gunner, rotates in AZIMUTH ONLY, and remains in a horizontal plane when the guns are elevated.

The Martin 250 CH–3 rotates a full 360 degrees in azimuth. The guns may be raised 80 degrees above horizontal and depressed 20 degrees below this level.

You will find this particular model Martin on the upper deck position of the PB2Y Coronado. The Martin 250 CH–1 and CH–2 are almost identical with the CH–3. They are installed

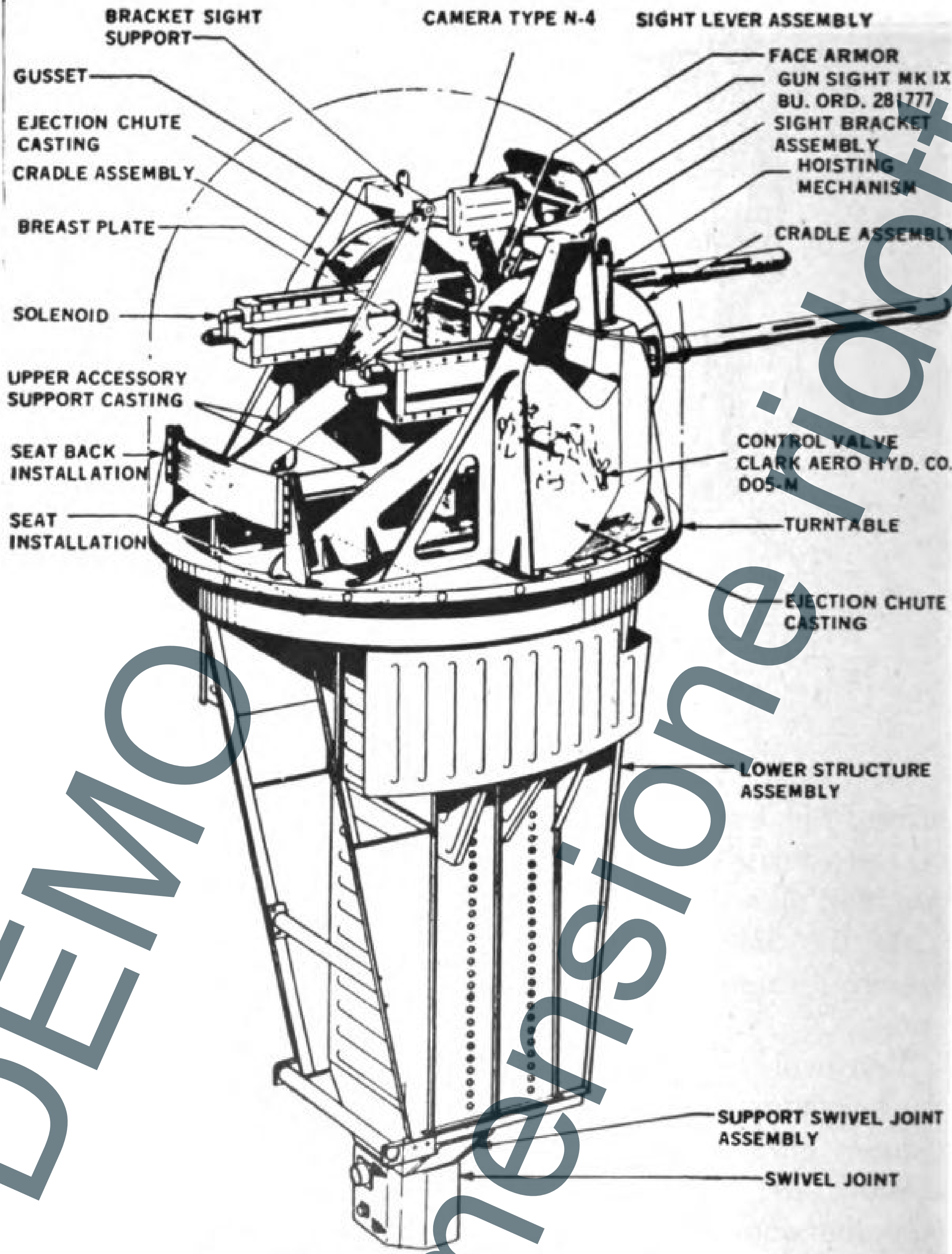

Figure 120.—Martin 250 CH–3 turret assembly.

in various models of the PBM. They operate in the same way, although their rotation in azimuth and their elevation and depression range are more restricted.

The hydraulic system in this turret is almost the same as the one in the Martin 250 SH–2, except for a few distinctive features. Figure 120 will give you a good idea of the Martin 250 CH–3 turret assembly and its parts.

DON'T SHOOT YOURSELF

In this type turret, it is necessary to control the movement so that the guns do not hit or bump any part of the structure of the airplane. That was not necessary in the 250 SH–2, since its position in the bow was such that this problem would not be encountered.

Remember that the 250 CH–3 is located on the UPPER DECK where its guns can easily come down and bounce off or through the fuselage.

Furthermore, you are in a position up there to shoot off the tail or the aft section of the fuselage on your own airplane if you're not careful.

Under the stress of combat, a gunner can hardly be expected to concentrate on shooting down enemies at the same time he

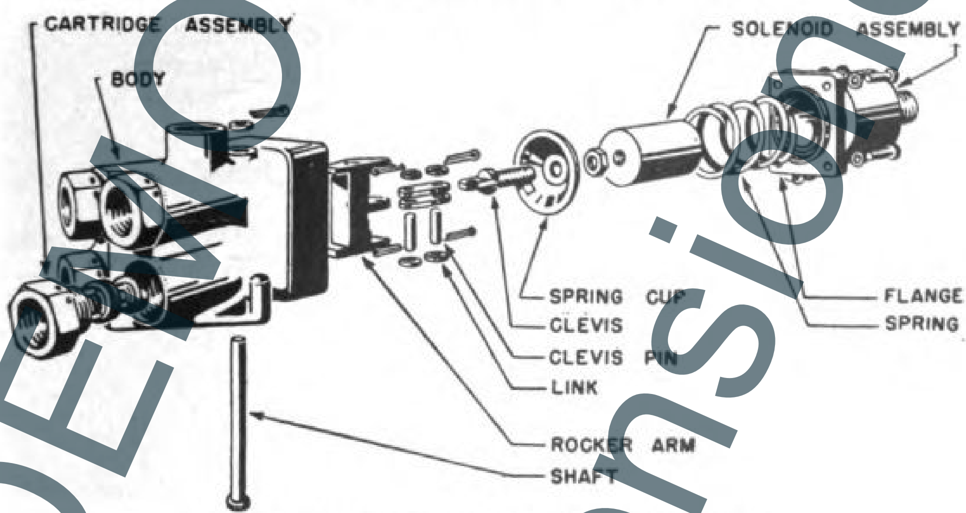

Figure 121.—Structural interrupter valve.

is concentrating on not shooting up the tail section of his PB2Y. So a couple of handy little devices have been designed to keep the guns and the bullets from doing any damage to the home team.

These are known as the STRUCTURAL INTERRUPTER and the PROFILE OR GUNFIRE INTERRUPTER. You can see them in figures 121 and 122.

The STRUCTURAL INTERRUPTER is the watch dog which keeps the guns from hitting the fuselage. As you will recall, the lower limit of the guns' traverse is 20 degrees below the horizontal. A cam assembly meshed with the turret drive system is so designed that when this lower limit is reached it puts the STRUCTURAL INTERRUPTER VALVE to work by actuating an electric solenoid. Poppets in this valve reverse the flow of hydraulic

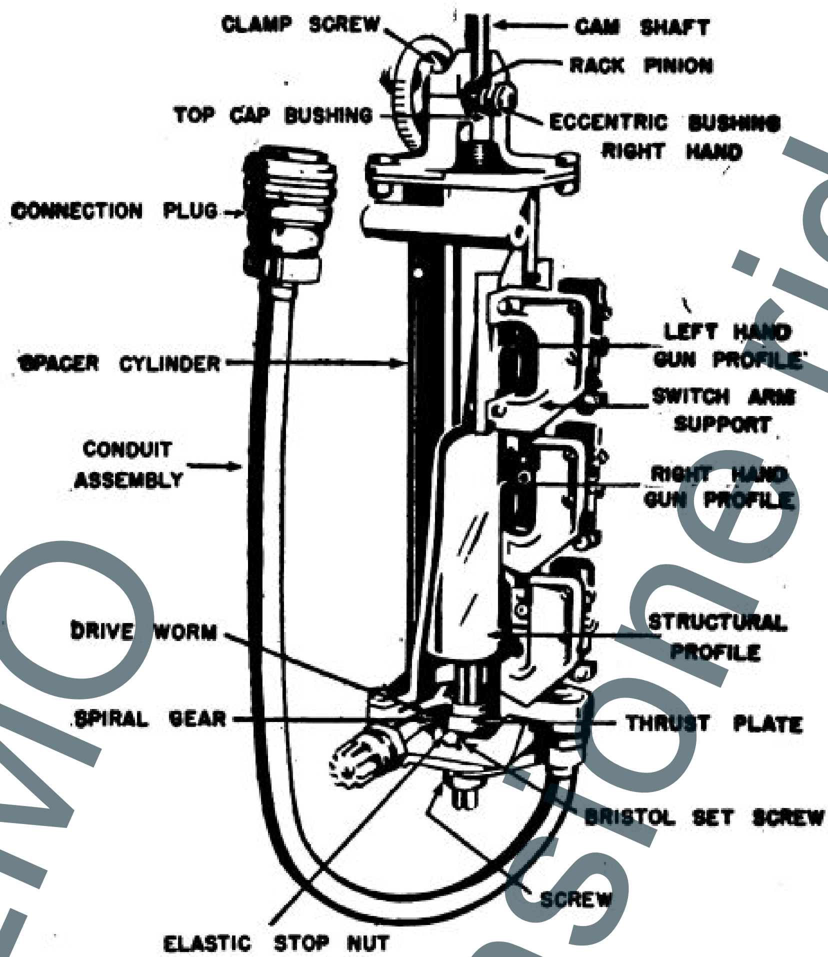

Figure 122.—Gunfire interrupter.

fluid to the elevation motor. This reversal of fluid reverses the elevation motors, causing the guns to lift up before they strike any part of the fuselage.

The PROFILE or GUNFIRE INTERRUPTER is interwired with the firing mechanism of the guns and is actuated through this same cam assembly. This cylindrical cam is fitted to a shaft which is rotated by the action of a drive piston meshing with the azimuth gear ring of the turret.

valve by opening and bypassing the oil back to the reservoir. When the pump stops, the check valve prevents the oil which is under pressure in the accumulator from back-loading the pump.

THE MECHANICAL PART

The azimuth mechanical control assembly includes the cylinder, rack, gibs, frames, shafts, and gears that convert the hydraulic power in the turret into MECHANICAL DRIVING POWER.

The application of hydraulic power to the cylinder moves the piston, forcing the piston rod in or out of the cylinder. The piston rod is fastened to a rack bar which slides back and forth on two brass strips known as GIBS, mounted on the frame.

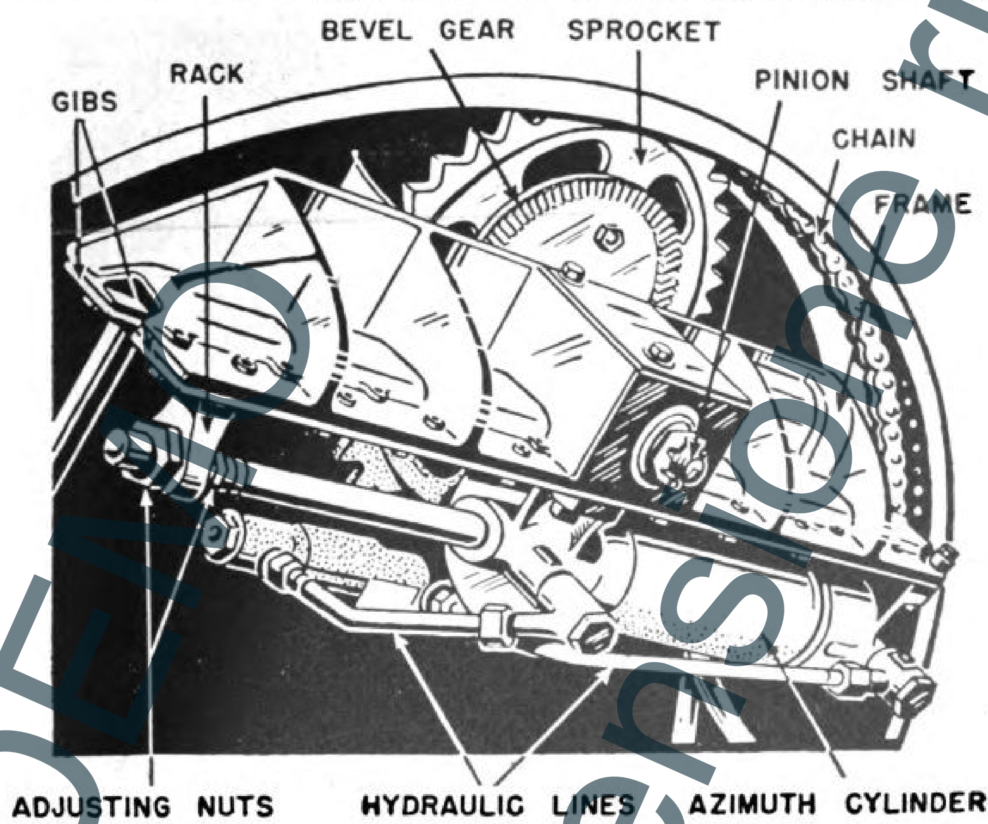

Figure 125.—Azimuth power drive.

The movement of the rack turns the PINION GEAR, which is mounted on the same shaft as two other gears, the BEVEL GEAR and the SPROCKET.

When the turret is installed in the airplane, the teeth of the sprocket mesh into a FIXED CHAIN riveted to the track. When the sprocket turns, it walks around the chain, moving the turret with it.

The assembly is such that moving the PISTON ROD out (by turning the control handle clockwise) moves the rack to the left, turning the pinion and spocket counterclockwise, and also moving the sprocket and turret clockwise along the chain. In other words, rotating the handle to the right turns the turret to the right, and vice versa.

The cylinder used for the AZIMUTH CONTROL unit is a double-acting, single-piston type. The cylinder is threaded into forged

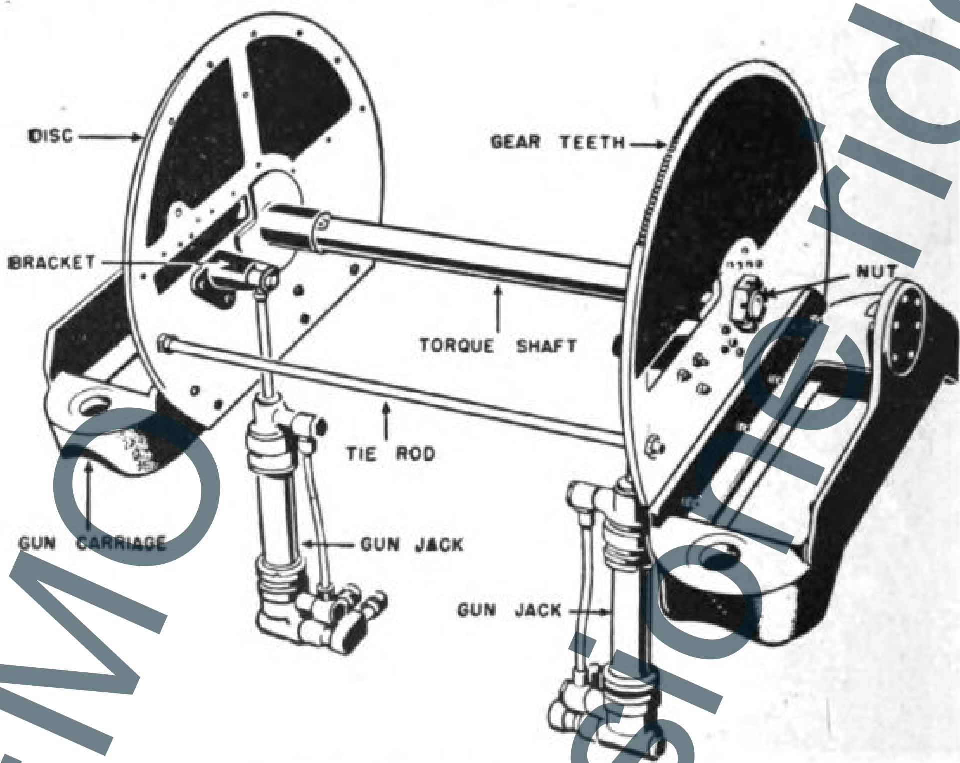

Figure 126.—Elevation control units.

aluminum caps. A neoprene doughnut packing ring in each cap prevents leaks between the caps and the barrel. A port in each cap permits the fluid to enter or leave at each end of the cylinder.

An ARM at 90 degrees to the rack itself, bored for the piston rod, is located at the outer end of the rack. The teeth of the rack are cut to mesh with the pinion gear. A channel is ground on each side of the rack to allow the rack to slide along on the gibs. The position of the rack on the piston rod can be varied by moving the adjusting nuts and washers that are installed on the piston rod on either side of the rack arm.

The two flat bronze strips on which the rack slides are fastened by means of cap screws directly to the frame, and the cylinder is bolted through them to the frame. To get a better idea of how the azimuth mechanical control works, take a look at figure 125.

How about the elevation movement? This is accomplished by two HYDRAULIC JACKS — one for each gun. Both jacks are

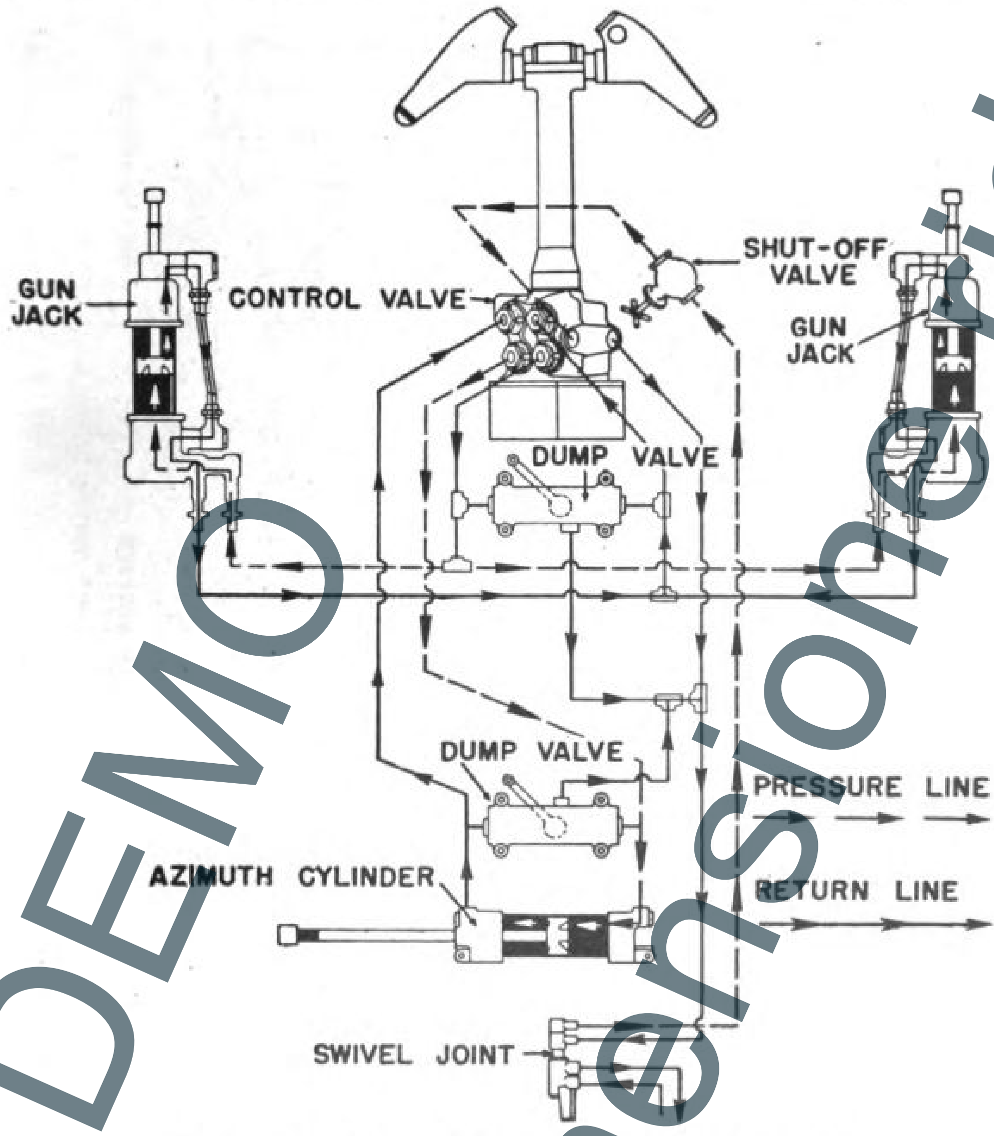

Figure 127.—Hydraulic system, MPC CH–5 and –6.

operated by the same two hydraulic lines so their action is identical.

These jacks are anchored in a vertical position by swivel joints at the bottom and outer side of the cross-beam assembly

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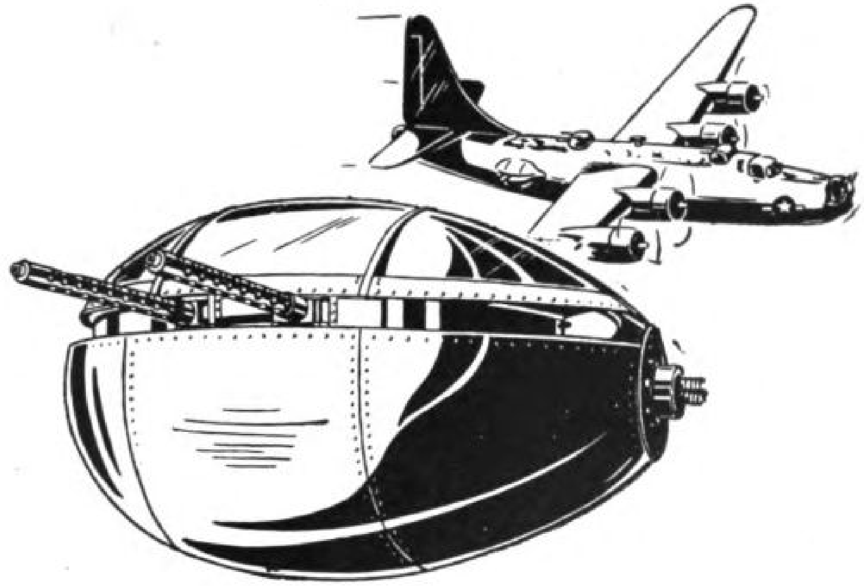

CHAPTER 9

ERCO 250 TH–1 AND TH–2 TURRETS

THE TEARDROP

Erco 250 TH turrets are streamlined to the approximate shape of a TEARDROP.

The TH–1 is installed in the STARBOARD side of a PB4Y–2, while the TH–2 matches it on the PORT side. With their wide cone of fire they protect the airplane from beam or belly attacks, besides covering a considerable area above the aircraft.

In the teardrop, you will recall, the gunner moves with his guns and sight in BOTH AZIMUTH AND ELEVATION. In azimuth, the teardrop will move the guns 55 degrees toward the bow from a beam position and 80 degrees toward the tail from beam. The guns can be elevated 55 degrees above horizontal and depressed 95 degrees below horizontal.

The main thing which distinguishes the Erco from a Martin 250 SH–2 and the CH turrets is the shape. The hydraulic system is made up of units you have already learned about.

These include a VICKERS VARIABLE DISPLACEMENT PUMP and a CLARKE CONTROL VALVE assembly with control handles, gun firing TRIGGERS, and SWITCHES.

The motivating power, both in azimuth and in elevation, is provided by hydraulic CYLINDERS mounted on PISTON RODS. The

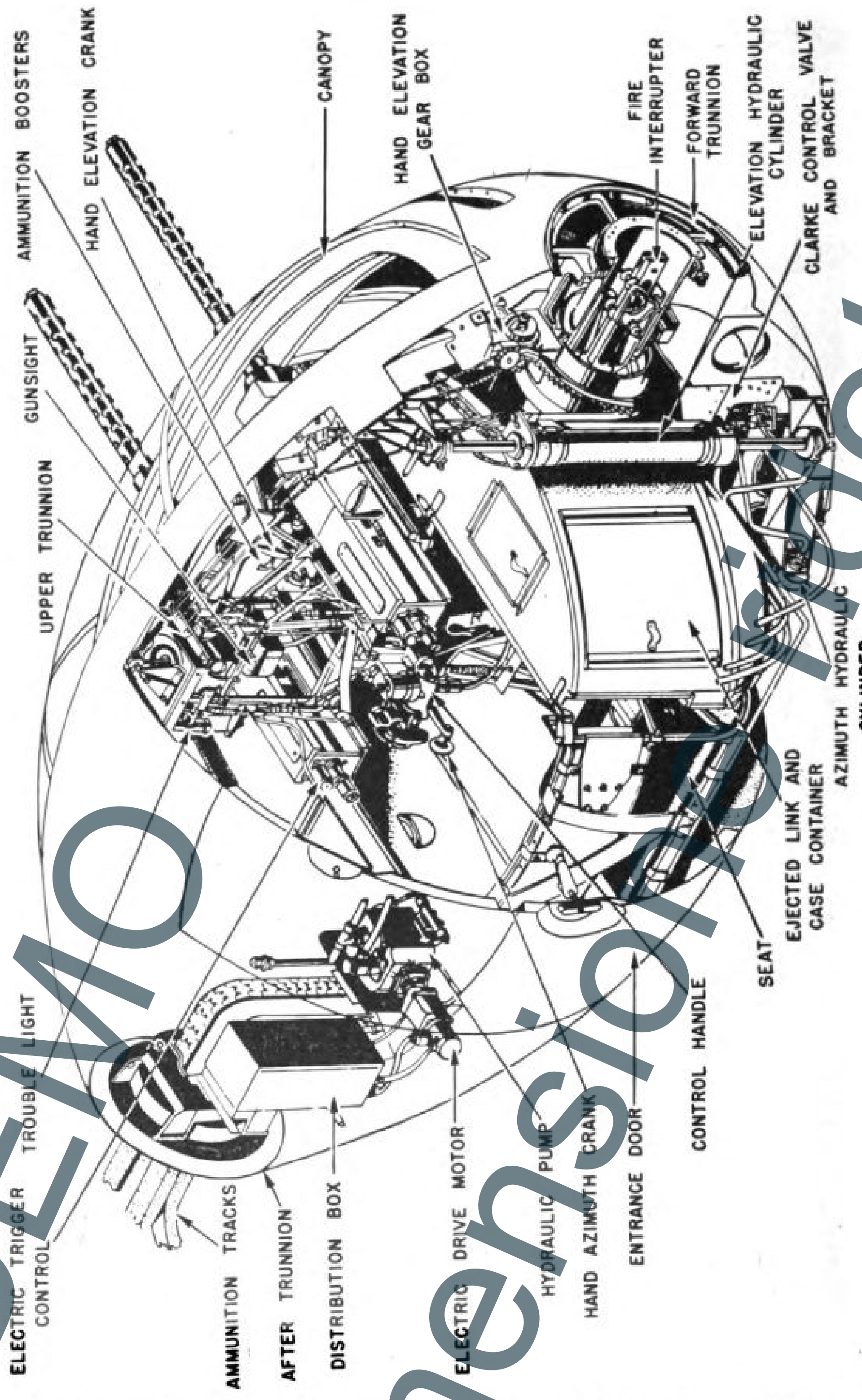

Figure 129.—Cutaway view of Erco 250 TH turret.

azimuth rotation cylinder is secured to the bottom structure of the turret. The elevation cylinder is secured to the turret structure at each end.

These cylinders are BALANCED. That is, the cylinder area is the same on each side of the piston.

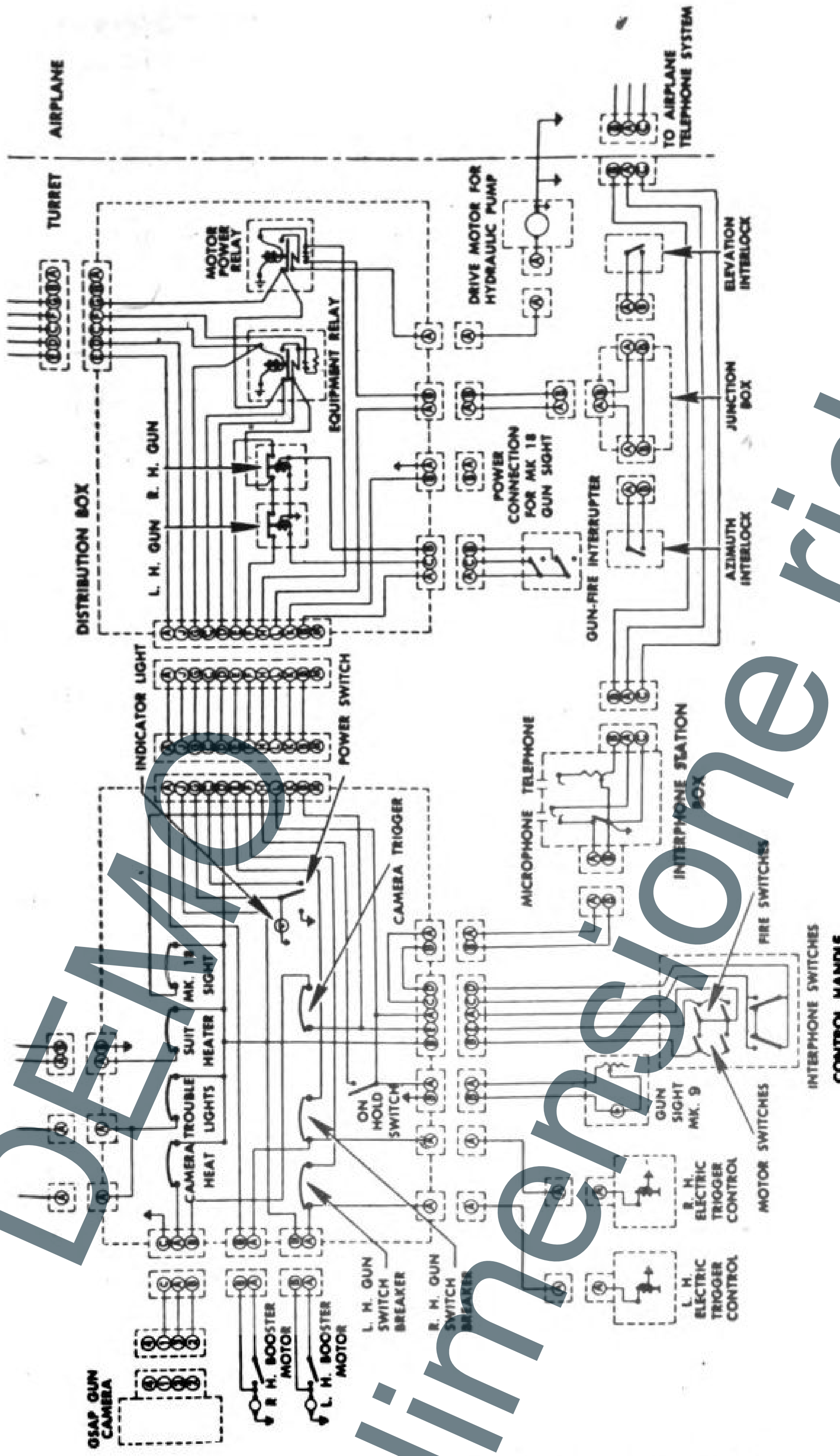

Figure 130.—Wiring diagram, Erco 250 TH-1 and TH-2.

through the reflector plate, they appear to be projected out into space. The reticel on the left which you see with your left eye is the FIXED RETICLE. The reticle on the right side of the reflector plate which you see with your right eye consists of a center

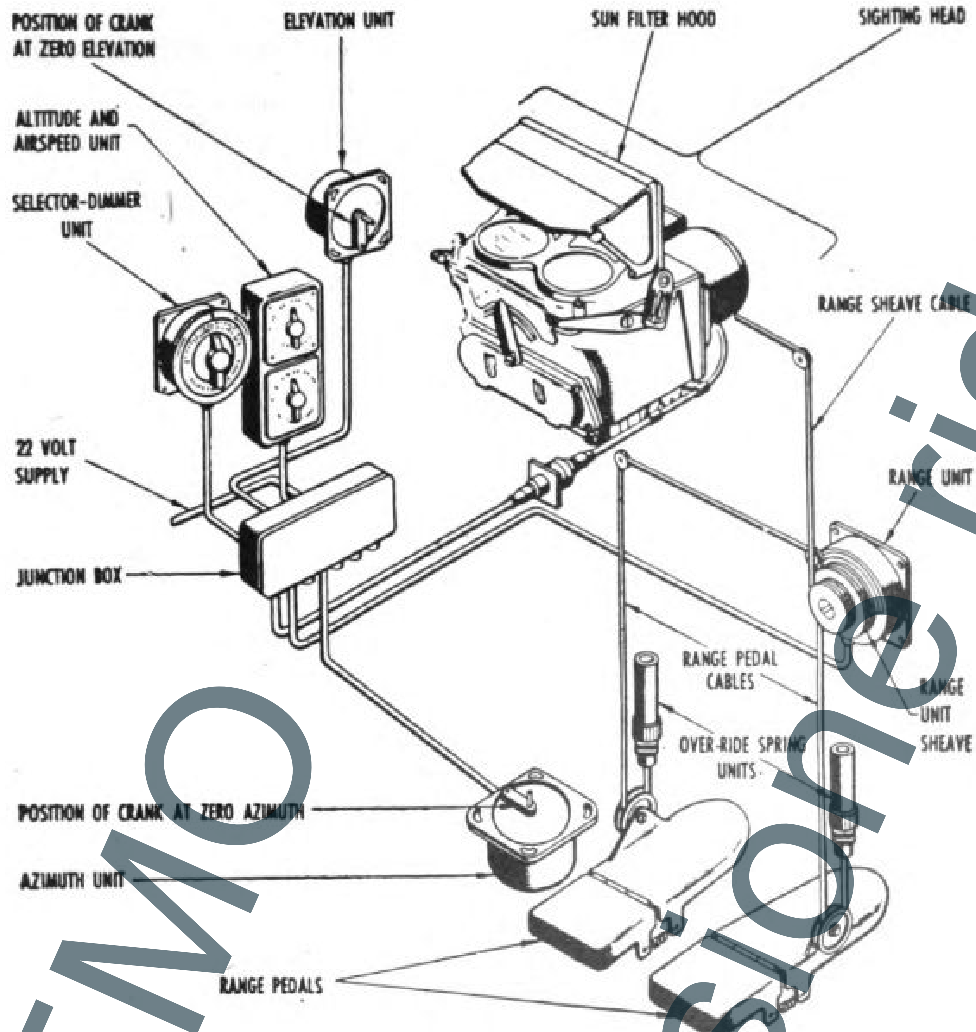

Figure 133—Mark 18 gun sight.

"pipper" which is surrounded by the six diamond-shaped pips arranged in the form of a circle. This is the GYRO RETICLE OR MOVABLE RETICLE.

The circle formed by the six diamond-shaped pips of the gyro or movable reticle can be made to spread out and close in. When the turret is operated, the gyro reticle — the center pipper and six diamonds — moves around the reflector plate. If you use the Mark 18 sight properly, the gyro reticle automatically computes the correct deflection and gets hits for you. All you

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