AIRCREWMAN'S GUNNERY MANUAL

RESTRICTED

OPNAV 33-40

NAVAER 00-80S-40

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ISSUED BY AVIATION TRAINING DIVISION, OFFICE OF THE CHIEF OF NAVAL OPERATIONS, U. S. NAVY IN COLLABORATION WITH U. S. ARMY AIR FORCES

OPNAV 33-40 1944 NAVAER 00-80S-40

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The Aircrewman's Gunnery Manual has been prepared under direction of the Deputy Chief of Naval Operations (Air) in cooperation with the Commanding General of the U. S. Army Air Forces. It is for use by all the air gunners of all our armed forces. The suggestions here offered to you have been tested in combat against all types of enemy planes, under varying conditions, in all the battle areas of the world. They will help you become a better gunner if you study them and then apply what you learn. Good luck and good hunting to you.

A. W. Radford

A. W. RADFORD
REAR ADMIRAL, USN
Acting Deputy Chief of Naval Operations (AIR)

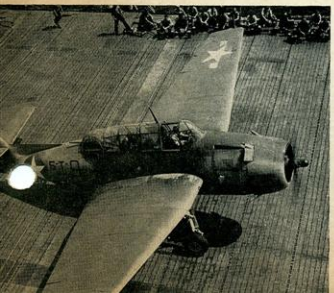
"I am a United States Naval Aircrewman, member of a combat team. My pilot and shipmates place their trust in me and my guns. I will care for my plane and guns as I care for my life. In them I hold a power of life and death—life for my countrymen, death for the enemy.

"I will uphold my trust by protecting my pilot and plane to the absolute limit of my ability. So help me God."

On the day that you utter those words, you pin on your aircrewman's wings and become officially a member of a great fighting team—a team that carries destruction to the enemy. You may be assigned to a carrier or you may be assigned to a land-based squadron. Wherever it is, your job is the same—to knock out of the sky any enemy plane that attempts to prevent your plane from going through with its mission; to add your fire power to the destruction of ships, troops, enemy installations or any target on the ground that offers you a good shot. You will teach the enemy to respect your guns.

Let's look at the routine of a standard mission from a carrier. Days before your mission, a briefing officer from the Air Combat Information Division will tell you what the target for your plane is to be. He tells you the course you are to fly, the rendezvous spot for the planes in your squadron, the nature of the target, the rendezvous for return, and the course back to

1 Revving up for the mission ahead



2 A perfect carrier take-off

3 Heading for the target

the carrier. You see photographs of the area over which you fly. You are told about the natives, the prevailing winds, currents, in short, everything you should know about the mission at hand. This briefing will usually be done in the evenings—in one-hour sessions, perhaps three or four days before the attack.

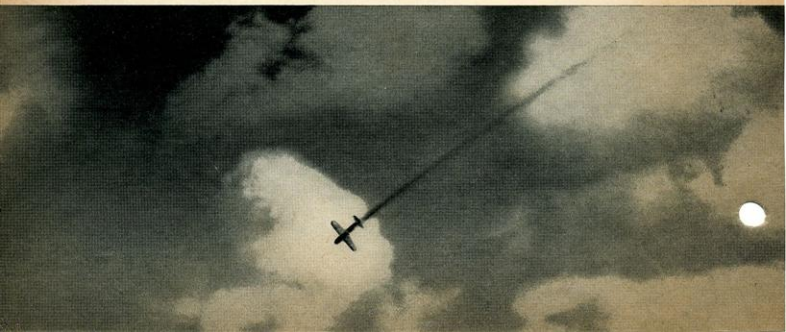
In the meantime, you check your guns and your equipment with utmost care, since your life, the lives of your fellow crew members, and the success of your mission depend on it.

Then, before dawn on the day of the attack, you hear the call to General Quarters. You go to your plane—final checks on guns are made in the dark. Your pilot arrives. In quick succession come the orders:

"Man your planes . . . Stand by to start engines . . . Start your engines."

Then—"Launch planes."

4 Another enemy plane knocked down



5 The target in flames

The fighters leave the deck first, followed by the torpedo planes and the dive bombers. These are your planes. Your pilot makes his rendezvous with the other planes in your squadron and you head toward the target in formation.

For a while you fly in formation. Suddenly, a black speck appears in the sky—"A 'bandit' at three o'clock high." This is the moment for which you have been preparing. You take aim. You open fire. In a matter of seconds, the enemy plane is in flames.

The flight continues. You are over the target. More enemy fighters. Your pilot does his job and you do yours. The mission is a success.

The rendezvous for the return is made and you fly back to your ship. After landing, you give your report to the interrogation officer. You have knocked down an enemy plane: you have done your job as an aircrewman. Those weeks of training have paid off.

6 Back to the carrier with a story to tell

7 Aerial Gunner describing the raid over the ship's loud speaker

All of the above occurs weeks after you first request to be an aircrewman, but from the time you start your instruction you are pointing toward the day of combat. A gunner's job is exciting. It requires courage, good nerves, and skill.

Bombers fly in formation for mutual protection, and you will usually have fighters along for additional help—but the last word is yours. You must be a better man than your enemy. Whether you are the better gunner is up to you and you alone.

The Aircrewman's Gunnery Manual is designed to help you become an efficient gunner. It is divided into three parts: (a) Guns; (b) Sighting and sights; (c) Turrets. In the section on guns, you will find all the necessary information about your machine gun. In the sighting section, methods are discussed from a practical point of view, just as you will see the problem. Your sights are also explained—how they work, how to maintain and boresight them. Finally, in the turret section there is a detailed discussion of ten important Navy Aerial Gun-turrets. As your training becomes more specialized, you will concentrate on one turret, but a knowledge of all turrets will make you better able to understand your own.

In brief, the Aircrewman's Gunnery Manual is designed to give you all the available useful information needed in your work as a combat Aircrewman. Study it. Become familiar with it. If you don't let it down, it won't let you down.

THIS IS YOUR GUN

THE CALIBER .50 BROWNING MACHINE GUN M2 AIRCRAFT, BASIC

With brief instructions on the caliber .30 machine gun and caliber .45 automatic pistol.

RESTRICTED

YOUR GUN AND YOUR JOB

The standard United States aerial gun—your gun—is the air-cooled caliber .50 Browning machine gun.

Your job is to become enough of a machine gun expert to use and care for the gun properly and to make emergency repairs—so that no attacking fighter will ever catch you unable to fight back. This book and your instructors will show you how to do the job.

The first dozen pages are a general introduction to the gun. They define some of the words used in describing it. They identify the major groups of parts and tell how to take them out of the gun. They show briefly how the gun works and how to load, fire, and unload it safely.

The rest of the machine gun section discusses in detail every important part of the gun and the function it performs. It explains in pictures how to take the gun completely apart, how to adjust it, clean it, and oil it, and how to mount it on the adapter that holds it while it is firing.

As a final preparation for combat, the book tells how to load the ammunition, how to check the gun regularly for wear or damage, and how to locate the cause of trouble if the gun stops firing.

Brief descriptions of the caliber .30 machine gun and the caliber .45 automatic pistol, which aerial gunners also use at times, are added.

GUN TALK

. . . terms and definitions you should know.

Your gun fires 750 to 850 shots a minute—14 shots a second. The bullets, weighing nearly two ounces each, leave the barrel at 1,977 miles an hour—2,900 feet a second. This speed is called the **muzzle velocity.** Even at a distance of four miles—the gun's **maximum range**—one of those bullets will kill a man.

At closer distances, the bullets wreck anything that gets in the way. In tests on the proving ground, the caliber .50 smashes through the metal skin and framework of an airplane, drills through a metal ammunition box, penetrates a hard pine board—and still has enough power left to pierce a plate of armor nearly a half inch thick.

Yet the gun is light—only 64 pounds—and small enough to fit into almost any airplane.

The gun is an **automatic** weapon. After the first cartridge is loaded and the gun is cocked—an operation called **charging**—it will keep firing as long as the trigger is held down. A **semi-automatic** weapon, like the caliber .45 pistol, fires only one shot each time the trigger is squeezed.

Your caliber .50 is a **free,** or **flexible** gun—mounted so that it can be swung from side to side or up and down to fire in any direction. A **fixed** gun, like the machine guns in the wings of a fighter plane, cannot be moved—the whole plane must be turned to aim the gun.

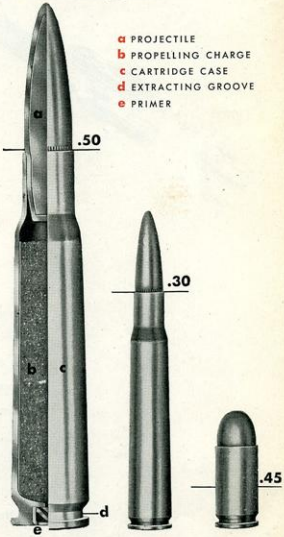
The aircraft caliber .50 gun is **air-cooled**—air, circulating through the holes in the barrel jacket, keeps the barrel from heating up too fast. This system is effective because

the air at high altitudes is very cold and the gun is sticking out into the slipstream. On the ground, the air-cooled gun heats up more rapidly and long bursts cannot be fired without damaging the barrel. Machine guns designed for ground use are water-cooled, or have a heavy barrel that can stand more heat.

Along the inside of the barrel—called the bore—are twisting **grooves.** The wide ridges between the grooves are called **lands,** and the grooves and lands together are called the **rifling.** It makes the bullet spin like a football in a good forward pass. Without it, the bullet would travel like a wobbly pass and the gun would lose most of its accuracy.

The **caliber** of any gun is the distance across the inside of the barrel, measured from land to land. Your gun is a caliber .50 because the barrel is 50/100ths of an inch wide —in other words, half an inch. The bullet is a hair's breadth wider than half an inch. This makes for a tight fit which prevents any force from escaping when the shot is fired, and also squeezes the bullet into the grooves.

The **cartridge,** or **round,** is exactly the size of the cutaway diagram. While it is being fired, it is held in an enlarged opening called the **chamber** at the rear of the barrel. The **cartridge case** is simply a metal shell. Near its base it has an **extracting groove** so that parts inside the gun can pull it out of the ammunition belt and then pull it out of the chamber after it has been fired. Inside the case are the **primer** and the **propelling charge.** The primer is a small charge of high explosive which goes off when the gun's firing pin strikes it. This sets fire to the propelling charge, which burns out in a flash and sends the bullet, or **projectile,** on its way.



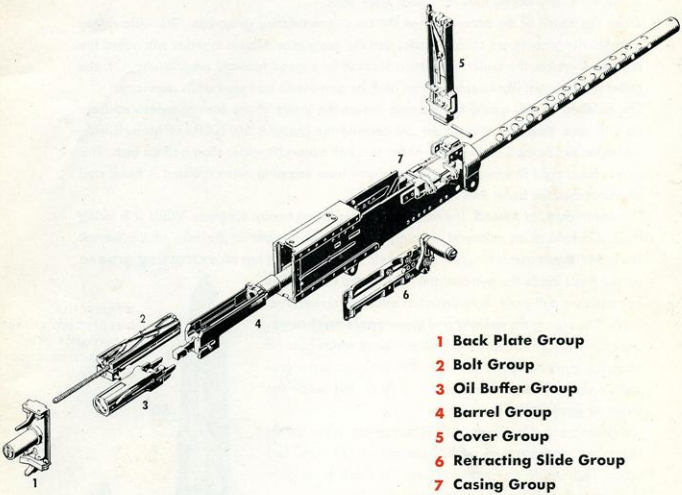
The gases created by the propelling charge set up the terrific **chamber pressure** of 50,000 pounds, or 25 tons, per square inch inside the cartridge case—as much force as a medium tank balanced on a man's thumb.

Some of this force is absorbed by the barrel. Five tons drive the bullet forward. Another five tons give a backward kick—the **recoil**—to the empty case and some of the gun parts.

After the **recoiling parts** are driven back as far as they can go, they bounce against springs and buffers that start them forward again. This forward movement is the **counter recoil.** As soon as the moving parts have returned to place, the gun is back in **battery position** and ready to fire again.

To feed into the gun, the cartridges or rounds are hooked together with **metal links** to form a long ammunition belt. By changing certain parts of the gun, you can feed the belt from either side. After each shot, the empty cartridge case is pushed out the bottom of the gun, while the used links are tossed out to one side.

THE SEVEN GROUPS



1 **Back Plate Group**
2 **Bolt Group**
3 **Oil Buffer Group**
4 **Barrel Group**
5 **Cover Group**
6 **Retracting Slide Group**
7 **Casing Group**

The explosion touched off by the pressure of your finger on the trigger sets about 150 working parts in motion. While the gun fires, parts are recoiling and counter recoiling, locking and unlocking, compressing and expanding, pivoting, sliding, pushing, pulling, opening, closing.

At first glance, the gun and its workings look as complicated and puzzling as fine clockwork. Fortunately, the parts fall naturally into seven main groups. It is easy to learn to recognize the seven groups and then learn the parts within each group.

The **bolt group** is the hardest worker of the team. Shuttling from battery position to the rear of the gun and back again about 14 times a second, the bolt group draws the live rounds from the ammunition belt, loads them into the chamber, and hits them with the firing pin. It pulls empty cases from the chamber and tosses them out the bottom of the gun.

The **barrel group** includes the barrel and the barrel extension that screws onto it. This group also recoils, but not nearly so far as the bolt group.

The **oil buffer group** is the brake that stops the recoiling barrel group. Its main part is a sealed cylinder full of oil. When the barrel and barrel extension recoil, they drive a piston into the cylinder, forcing the oil through two slots in the side of the piston head. The impact of the barrel and barrel extension is so powerful that all the oil is forced through the slots in a small fraction of a second.

The **casing group** encloses all the parts of the gun. It includes the receiver, which is a rectangular steel box holding the working mechanism, and the barrel jacket, which supports and protects the barrel.

The **retracting slide group,** which can be mounted on either side of the receiver, is used to charge the gun for the first shot.

The **cover group,** which encloses part of the top of the receiver, does most of the work of feeding the ammunition belt into the gun.

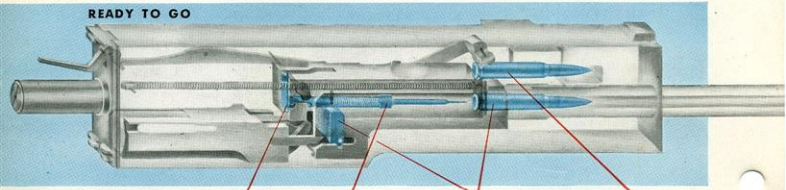
The **back plate group,** at the rear of the receiver, absorbs the force of the bolt's recoil.

This general knowledge of the seven groups is sufficient for a preliminary understanding of how the gun works. For a brief explanation of what happens inside the gun, turn the page.

THE GUN AT WORK

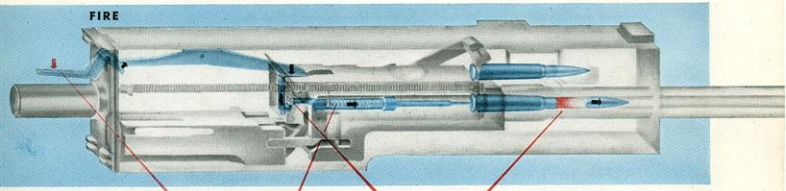
These simplified diagrams give a general picture of how the gun operates. They show the three recoiling parts—bolt, barrel, and barrel extension—going through a complete cycle from battery position through recoil and counter recoil. Many other parts not shown here are, of course, performing their jobs at the same time. The complete picture, called the cycle of operation, is described on pages G-52 to G-62.

READY TO GO



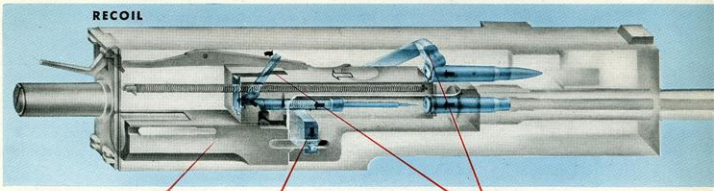
The gun is in battery position, set to fire. One round is in the chamber; the next round is in the feedway, ready to be moved into place. The firing pin, drawn back against its spring, is held back by a notch at the bottom of the sear. Bolt and barrel extension are locked together by the breech lock.

FIRE



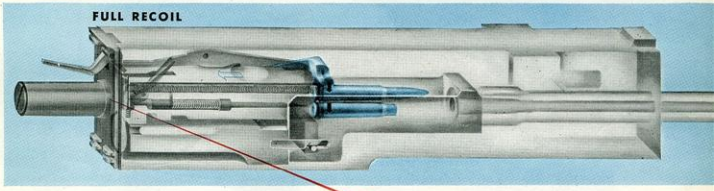
When the trigger is pressed, the front of the trigger bar presses down the sear and unlocks the notches. The firing pin, driven by its spring, snaps forward. The gun fires. The force of the explosion drives the bolt, barrel, and barrel extension backward.

RECOIL



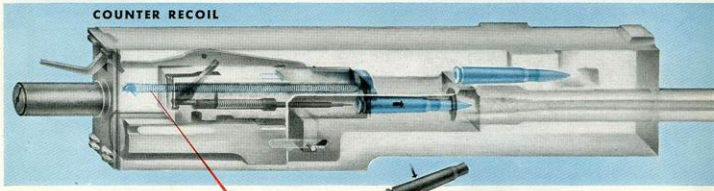
The breech lock is forced down, unlocking the bolt. The barrel extension is stopped by the oil buffer group, but the unlocked bolt keeps going back. The cocking lever pivots, pulling the firing pin back against its spring and hooking it onto the sear notch. The extractor assembly draws the next round from the feedway. The empty case, held in a slot in the front end of the bolt, is pulled from the chamber.

FULL RECOIL



The bolt travels back until it hits the back plate group. The extractor assembly carries the new round back and down toward the chamber.

COUNTER RECOIL



Aided by its driving spring, the bolt bounces forward. The extractor assembly pushes the new round farther down, forcing the empty case out of the gun, and then starts to feed the new round into the chamber. The next round moves into the feedway.

RETURN TO BATTERY POSITION As the bolt goes forward, the breech lock moves up to lock the bolt to the barrel extension, and the bolt and barrel extension return together into battery position. The extractor assembly reaches up to grab the next cartridge in the feedway. The new round is pushed into the chamber by the bolt. The gun is ready to fire again.

FIELD STRIPPING

Removing the groups from the gun, without taking the groups themselves apart, is called field stripping.

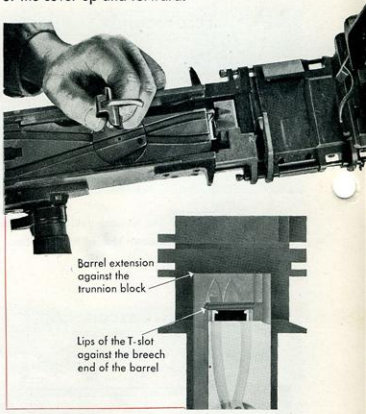
It is the first step in taking the gun completely apart to clean and oil it. If a gun stops firing, field stripping is the way to get at the working parts to see what is wrong.

A gunner in combat field strips his gun every day. These pictures show the steps.

STRIPPING

Raise the cover.

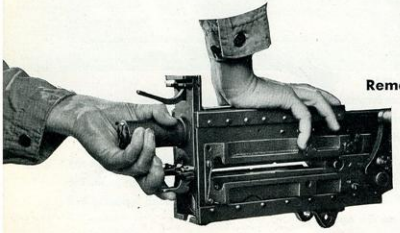
Turn the cover latch and swing the rear end of the cover up and forward.



Make sure that the gun is in battery position.

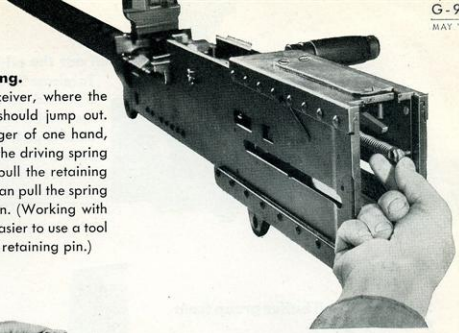
The lips of the T-slot should be against the breech end of the barrel, and the barrel extension against the trunnion block. Never remove the back plate unless the bolt is in battery position. When the bolt is back, the driving spring is compressed and might shoot out of the receiver with terrific force.

Next raise the extractor assembly with your left hand and look down the T-slot to see if there is a round in the chamber—it might be a live one. Live or dummy, remove it.

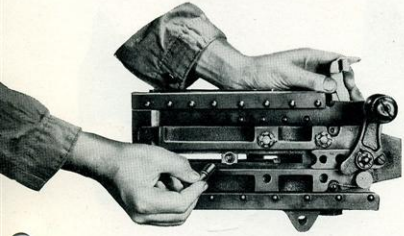


Remove the back plate.

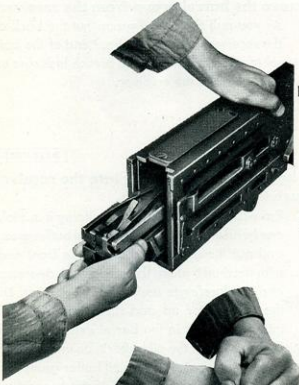
Hold down the top of the receiver with one hand and put your other hand in the position shown here. Pull the latch lock back with your middle finger, lift up the latch with your forefinger, and slide the back plate up out of the receiver.



Remove the driving spring.
Stand to the side of the receiver, where the spring cannot hit you if it should jump out. With the thumb and forefinger of one hand, push forward on the end of the driving spring rod and pry it to the left to pull the retaining pin out of its hole. Now you can pull the spring assembly back out of the gun. (Working with gloves at high altitude, it is easier to use a tool or a cartridge to release the retaining pin.)

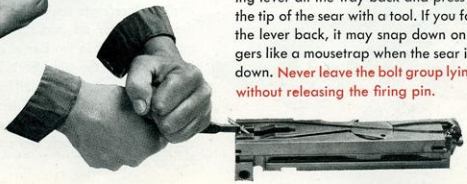


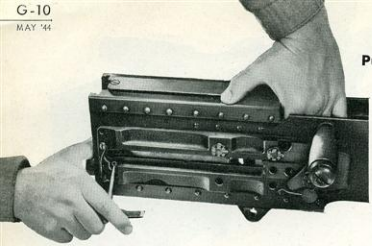
Remove the bolt stud.
Use the charging handle on the side of the gun to pull the bolt back two or three inches. Then, by raising the extractor assembly with your left hand and pulling it back, you can easily pull the bolt farther back. When the bolt stud reaches the wide place halfway back in its slot, pull out the stud. The stud may be found on either side of the gun; it is mounted on the same side as the retracting slide group.



Remove the bolt group.
With one hand, push the bolt group back until your other hand can support it and slide it out the back.

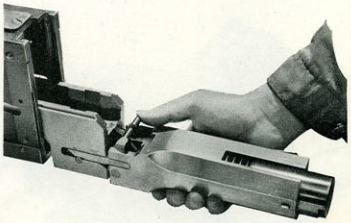
Release the firing pin.
The firing pin is cocked when you pull the bolt from the receiver. To release it, turn the cocking lever all the way back and press down on the tip of the sear with a tool. If you fail to turn the lever back, it may snap down on your fingers like a mousetrap when the sear is pressed down. Never leave the bolt group lying around without releasing the firing pin.

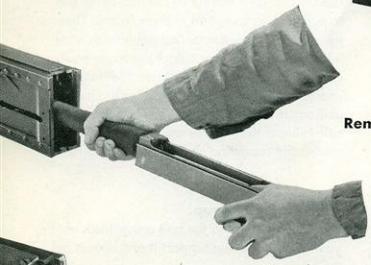




Pull out the oil buffer and barrel groups.
To release the oil buffer body spring lock, push a pointed tool into the hole in the right side of the receiver. At the same time, use your left hand to push the oil buffer and barrel groups toward the rear. Then pull them part way out of the receiver. Don't try to force these groups out until the spring lock is released.

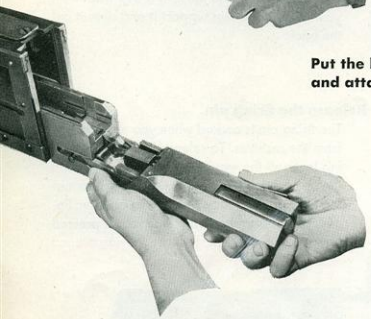
Separate the oil buffer group from the barrel group.
Grasp the oil buffer group, push the tips of the accelerator forward with your thumb, and pull to the rear.





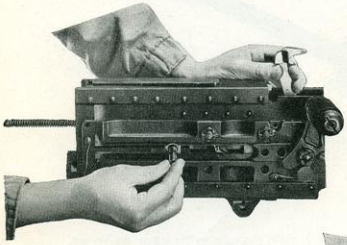
Remove the barrel group from the receiver.
As you pull the barrel group out the back of the receiver, hold up the front end of the barrel to avoid damaging the breech lock cam on the bottom of the receiver.

ASSEMBLY



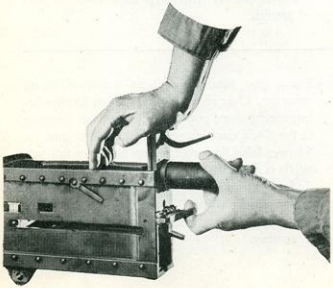
Put the barrel group part way into the receiver and attach the oil buffer group.
Raise the barrel slightly while sliding it in. Hold one hand under the back of the oil buffer group and put the other hand under the front end, with the thumb along the breech lock depressor and the forefinger under the accelerator. Lift the accelerator up and slide the depressors into their tracks in the barrel extension, holding the back of the oil buffer tube in place with your little finger. Push the oil buffer group forward until it locks in place. If the two groups are properly locked, the rear of the tube will stick out about an inch, but cannot be pulled farther out.

Replace the bolt group and push the groups into the receiver.
First make sure the cocking lever is forward. Then slide the bolt group into the barrel extension. Put the driving spring in place. Hold the top of the receiver with one hand, and with the other hand lift the end of the oil buffer group slightly and push it all the way forward. Don't use the driving spring to lift the bolt as you slide it in. Make sure the oil buffer body spring lock snaps into place.



Replace the bolt stud.
Pull the extractor assembly forward until the hole for the bolt stud lines up with the wide place in the slot. Slip the stud into place.

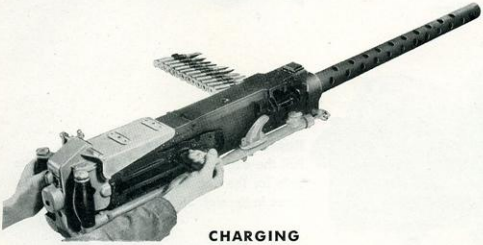
Seat the driving spring.
Hold the top of the receiver with one hand. With the other,thrust the end of the driving spring rod forward to force the bolt into battery position. Push inward on the end of the driving spring rod and slip the retaining pin into its hole.



Replace the back plate.
Hold the back plate in one hand and pull the latch lock back with your forefinger. Slide the back plate into its slot and use your other hand to push it into place. Close the cover.
Now the gun is completely assembled. For the method of using the gun—charging, loading, firing, and unloading—turn the page.

HANDLING YOUR GUN

Operating the gun, when it is properly set up and in good working order, is almost as easy as using a rifle. The methods shown here are simple, correct—and safe. They are designed to prevent accidents. Make a habit of doing the steps in this order.

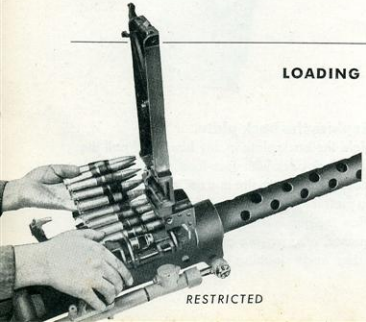


CHARGING

Charging the gun—by pulling back the charging handle—cocks the firing pin. When there is an ammunition belt in place, it also moves a round from the feedway into the chamber, and moves the next round in the belt into place against the cartridge stops. Before the gun is loaded, charge it once without any ammunition in it and press the trigger to make sure the firing mechanism works. You should hear a click as the firing pin snaps forward. There is no use loading a gun that won't fire.

The correct way to charge the gun is also the easiest way:

1 Hold the grip **with your palm up.**
2 With one smooth and rapid movement, pull back and down on the grip, draw it all the way back, and let go. Pull **hard and fast.** A strong, steady pull may not break the gun out of battery. A strong, quick pull will.
3 Don't stop pulling when the grip is all the way back. Your arm should come back with such force that it keeps traveling back after the grip is forced out of your palm. This bounces the bolt against the back plate and helps the driving spring force it fully forward into battery position. **Above all, don't hold on to the grip and ride it forward.**



LOADING

Every gun you fire will be mounted in an adapter. After charging the gun to test the firing mechanism, put the safety on the adapter in the *SAFE* position while loading the gun.

Always feed the ammunition belt into the gun **with a double link entering first.**

To load a hand-held gun, or a turret gun whose cover can be raised:

1 Raise the cover and lift up the extractor assembly.

2 Put the first round firmly against the cartridge stops, with the double loop of the link projecting beyond the stops.
3 Put the extractor assembly down, see that its hook is in the extracting groove of the round, and close the cover, making sure it is latched.
4 Charge the gun once. This will move the first round from the feedway into the chamber.

To load a gun when you cannot raise the cover:
1 Push the end of the belt into the feedway until the first round is held in place by the belt holding pawl—the little catch on the bottom of the feedway.
2 Charge the gun twice. The first charging will move the round over against the cartridge stops; the second charging will move it into the chamber.

FIRING

To fire, squeeze the trigger and hold it back as long as you want the gun to keep firing. If the adapter has two triggers, you can fire by squeezing either of them or both.
The correct position of your head, arms, and body will be demonstrated on the firing range.

UNLOADING

To unload the gun before the ammunition belt is used up:
1 Raise the cover, lift the extractor assembly, and pull out the ammunition belt. If you have trouble removing the ammunition belt, shake it.
2 Charge the gun once to eject the live round left in the chamber.
3 Pull the bolt back and look into the T-slot and chamber to make sure they are empty. To make doubly sure, charge the gun once more.
4 Pull the trigger to release the firing pin. Put the safety on the adapter in the *SAFE* position.

When you continue firing until all the ammunition is used:
1 Pull back the bolt and make sure the T-slot and chamber are empty. Charge the gun once to be doubly sure.
2 Pull the trigger to release the firing pin. Put the safety on the adapter in the *SAFE* position.

SAFETY RULES

Never forget that a caliber .50 machine gun is essentially a terrific explosion wrapped up in a metal package.

When the gun is handled properly, it controls that explosion so that nobody can be hurt but the enemy.

But one instant of carelessness may release that packaged power at the wrong time, or in the wrong direction.

Never let that happen to you. Make these safety rules your safety bible.

Before Loading the Gun

Make sure the barrel is free of obstructions and excess oil.

Make sure the cover and back plate are securely latched.

Test the operation of the gun with dummy ammunition, or by hand charging and "dry firing" without any ammunition in the gun.

Put the safety on the adapter in the *SAFE* position.

While Firing the Gun

If, while you are pulling the trigger, the gun stops firing before the ammunition is used up, beware of a delayed explosion. Wait 10 seconds before charging the gun or raising the cover.

Never use a metal tool to pry a live round or an empty case out of the gun.

After Unloading

Make sure the chamber and T-slot are empty by charging the gun twice.

Release the firing pin and put the safety on the adapter in the *SAFE* position.

In the Shop

Check the chamber and T-slot before starting to work on the gun.

Never charge the gun against the pressure of the driving spring when the back plate is off.

Keep your fingers out of the gun when charging it with the cover raised.

Never try to force the parts when stripping or assembling the gun.

Make sure the cocking lever is forward before replacing the bolt in the receiver.

Make sure the bolt is in battery position before closing the cover.

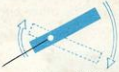
Never lay a gun down where it may fall.

DETAIL STRIPPING

The preceding pages have given about as much information on the machine gun as the average automobile driver knows about his car—enough to use it provided a mechanic is always available to take care of it and make repairs.
As a gunner, however, you must be your own mechanic. The following pages present the additional knowledge that spells the difference between amateur and expert.

Taking the gun completely apart—first removing the seven groups and then breaking each group down into its parts—is called detail stripping.
Your gun must be detail stripped after every firing mission so that you can get at every smallest part to clean it, oil it, check it for wear or damage, and replace it if necessary.
In a combat zone, you may have to do this job before dawn, in a tent without heat or light.
In school, therefore, you will learn to detail strip the most important groups—all but the back plate and retracting slide—while blindfolded and wearing gloves.
A caliber .50 combination wrench can be used for the job, although it was designed to perform some adjustments ordinarily handled only by ordnance personnel and is therefore too clumsy for general use. It is easier to use a caliber .30 combination tool, or even a screwdriver and a nail or cartridge.

These terms are used again and again in describing details of the gun:



Pivot
a pin or stud on which some other part turns.

Cam
a slanted surface which changes the direction of a moving part.

Pawl
a catch which lets a moving part go in one direction but not in the other.

Bevel
a slanted surface made by cutting off a square edge.

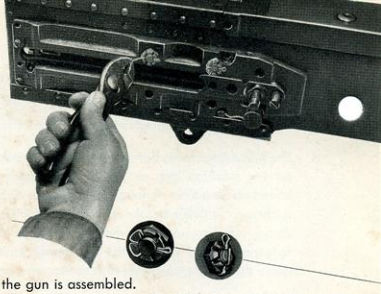
Drift
any pointed object used to push a pin out of its hole.

Cotter pins

are used in many of the gun's pins and nuts to make sure they will not loosen or fall off.

In classroom practice it is customary to use the same cotter pins again and again. In a combat zone, however, new cotter pins should be installed, if possible, while assembling the gun after stripping and cleaning it. Worn cotter pins may break or fall out.

Cotter pins are used in several sizes. Wherever you insert a cotter pin, use the largest one that will fit into that hole, but be sure it is not so long that it will interfere with working parts.



Insert cotter pins so that their heads will be up when the gun is assembled.

Bend the ends of cotter pin so that they will not interfere with working parts of the gun, or snag clothing and equipment. Separate the tips, and use pliers or some other tool to bend them around the nut or pin. If there are grooves in the side of the nut, bend the tips of the cotter pins into the nearest grooves.

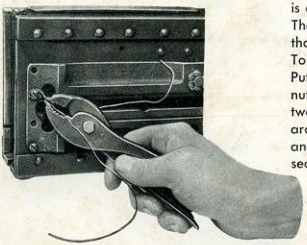
In some cases, it is more convenient to insert the cotter pin so that one end can be bent up over the end of a pin or stud, and the other end bent down into one of the grooves in the nut.

Safety Wiring

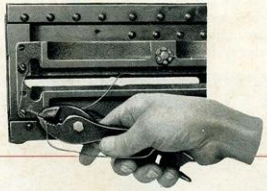
is also used to keep nuts and screws from loosening. The wire should go around the nut in such a direction that a pull on the wire will tighten the nut.

To safety wire two nuts:

Put one end of the wire through the hole in the first nut, bring it around the side of the nut, and twist the two ends of the wire together. Pull the twisted wire around the nut in the direction that tightens the nut and twist together a section long enough to reach the second nut.



Put one end of the wire through the hole in the second nut in such a direction that a pull on the twisted part of the wire would tighten the nut. Continue the other end around the nut, twist the two ends together for a short distance, cut them off, and tuck them out of the way.



Making the Job Easy

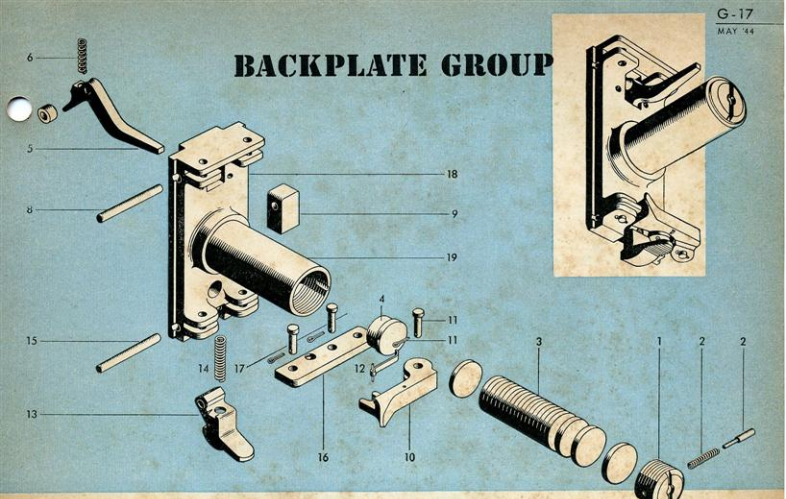
The photographs on the next 34 pages show every step of detail stripping for all seven groups. With each photograph are full instructions for performing the step. The groups are presented in the order they are normally removed from the gun:

1. Back Plate **2.** Bolt **3.** Oil Buffer **4.** Barrel **5.** Cover **6.** Retracting Slide **7.** Casing

Instructions for each group are preceded by a list of the nomenclature and functions of all its parts. The function lists are for reference: when you start to learn detail stripping, do not attempt to read and memorize them.

As each part is removed, its function is explained in more detail. In a description of the cycle of operation on pages G-52 to G-62, all the parts are shown performing their functions as the gun operates. After you know the cycle of operation, the function lists will be easy to understand and can be used for review.

BACKPLATE GROUP



Nomenclature	Function
1 BUFFER ADJUSTING SCREW	Adjusts the pressure on the buffer disks.
2 BUFFER ADJUSTING SCREW PLUNGER AND PLUNGER SPRING	Prevent the buffer adjusting screw from turning freely.
3 BUFFER DISKS	Absorb the shock of the bolt's recoil.
4 BUFFER PLATE	Passes the shock of the bolt's recoil on to the buffer disks and prevents battering of the back plate.
5 TRIGGER	Raises the rear end of the trigger bar, making the front end press down on the sear to release the firing pin and fire the gun.
6 TRIGGER SPRING	Returns the trigger to position.
7 SPACER	Keeps the trigger the proper distance from the side.
8 TRIGGER PIN	Holds the trigger and provides a pivot for it.
9 BACK PLATE FILLER PIECE	Fills the trigger hole when the trigger is not installed.
10 LATCH LOCK	Locks the latch.
11 LATCH LOCK PIN AND COTTER PIN	The pin holds the latch lock and provides a pivot for it; the cotter pin keeps the latch lock pin in place.
12 LATCH LOCK SPRING AND PIN	The spring, which is held in the latch lock by its pin, pushes against the latch lock to hold it in place.
13 LATCH	Holds the back plate down.
14 LATCH SPRING	Pushes against the latch to keep it locked.
15 LATCH PIN	Holds the latch and provides a pivot for it.
16 LOWER FILLER PIECE	Provides a mounting for the latch lock.
17 LOWER FILLER PIECE PINS (TWO) AND COTTER PINS (TWO)	Hold the lower filler piece in position.
18 BACK PLATE	Encloses the back end of the receiver, and keeps the oil buffer group from moving back.
19 BUFFER TUBE	Houses the buffer adjusting screw, buffer disks, and buffer plate.

Remove the buffer adjusting screw (1).

While unscrewing it, wrap your fingers around it to keep the plunger and plunger spring (2) from jumping out.

The buffer adjusting screw regulates the pressure on the buffer disks. The plunger and plunger spring prevent the adjusting screw from turning freely.

Remove the buffer disks (3) and buffer plate (4) by tilting the buffer tube (19) until they fall out.

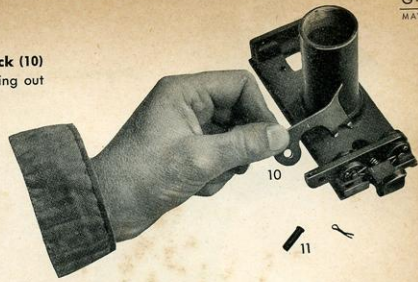
The buffer plate receives the shock of the bolt's recoil and passes it on to the buffer disks, which absorb it. The buffer plate also keeps the bolt from battering against the back plate.

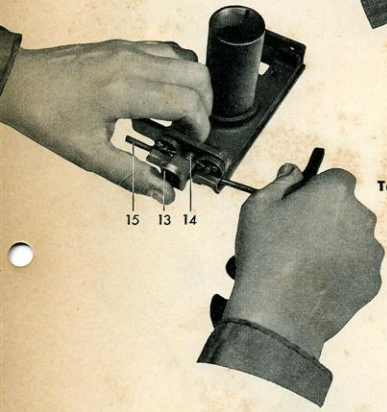
Take out the trigger (5), trigger spring (6), and spacer (7).

After you push out the trigger pin (8) they can easily be removed from the front. (There will be no trigger on the back plate unless the gun has been assembled for use in an adapter.)

The trigger lifts the rear end of the trigger bar. This forces the front end down on the sear, releasing the firing pin and firing the gun. The trigger spring then forces the trigger back into position. The spacer keeps the trigger the proper distance from the side.

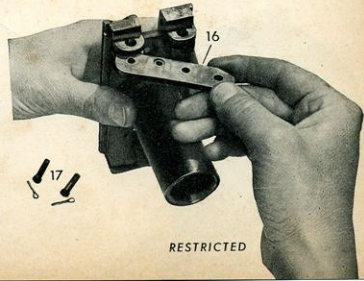
Remove the latch lock (10)
by pulling out the cotter pin and drifting out the latch lock pin (11).
The latch lock keeps the latch fastened.





Take off the latch (13) and latch spring (14)
by drifting out the latch pin (15). Press the latch with your thumb so its spring will not pop out.
The latch, forced into position by its spring, holds the back plate down.

Remove the lower filler piece (16)
by taking out the cotter pins and removing the two lower filler piece pins (17). For this step and the next two steps, it is easier to hold the back plate upside down, as shown here.
The filler piece provides a mounting for the latch lock.



Replace the lower filler piece.

Insert the filler piece pins with their heads toward the top and replace the cotter pins. If the gun is to be used in an E-11 adapter, the filler piece should stick out to the right. Otherwise it can stick out on either side.

Replace the latch, latch spring and latch pin.

Make sure the spring is seated in the holes in the latch and the lower filler piece. Press down on the latch while inserting the pin.

Put back the latch lock
and insert its pin
and cotter pin.

Replace the trigger.

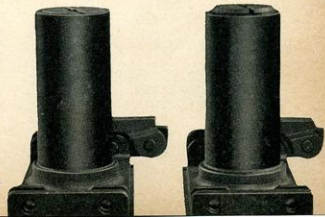
Put it through its hole, with the long handle part to the rear and the hole for the trigger spring on top. Seat the trigger spring in the hole on the trigger and push the top of the spring back into the hole in the back plate. Put the spacer to the left of the trigger (as seen from behind the gun) and push the trigger pin into place.

Replace the buffer plate and buffer disks.
Put the buffer plate into the buffer tube, small end first, and drop in the disks a few at a time...

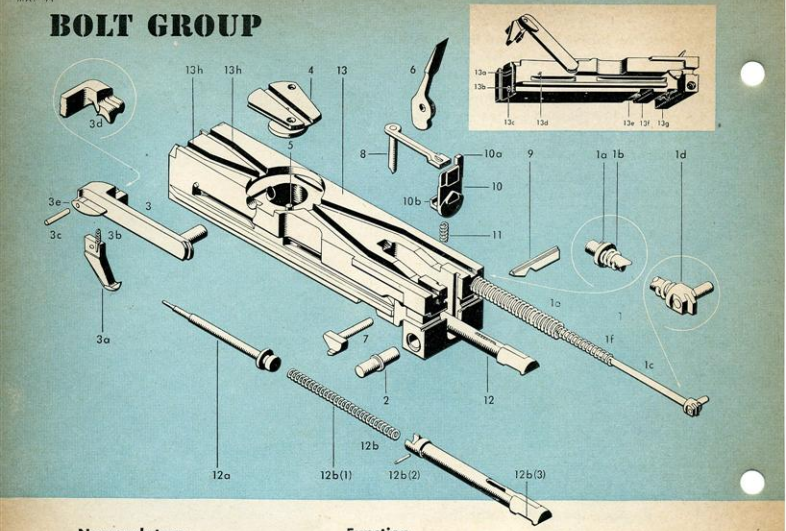
...Or, if you are working at a steady table, stack up the disks like poker chips, put the buffer plate on top with the small end up, and push the buffer tube down over the stack.

Replace the buffer adjusting screw.
Put the plunger and plunger spring into the hole in the buffer adjusting screw. Tighten the screw until the plunger hits the buffer tube, then hold the plunger down with the tip of a tool and continue to turn the screw until the plunger is held in place.

Adjust the buffer adjusting screw.
When the screw has been tightened as tight as possible—use the caliber .50 combination wrench if one is available—you should not be able to see more than one thread. If it does not go in that far, you have inserted too many buffer disks, or the disks and the buffer plate are not seated correctly. If the screw goes in so far that the end goes inside the buffer tube, the disks are too worn to be used. Have the ordnance shop make the necessary replacements.



BOLT GROUP



Nomenclature	Function
1 DRIVING SPRING ROD ASSEMBLY	Smooths out the action of the bolt in automatic fire and helps push it forward on counter recoil; returns the bolt to battery position in hand charging.
a DRIVING SPRING ROD COLLAR STOP PIN	
b DRIVING SPRING ROD COLLAR	
c DRIVING SPRING ROD	
d DRIVING SPRING ROD HEAD AND RETAINING PIN	
e OUTER DRIVING SPRING	
f INNER DRIVING SPRING	
2 BOLT STUD	Connects the bolt to the retracting slide group.
3 EXTRACTOR ASSEMBLY	Pulls the new round from the ammunition belt and helps feed it into the chamber; ejects the last empty case in the ammunition belt.
a EJECTOR	Helps support the new round for extraction from the belt and feeding into the chamber; ejects the last spent case in a belt.
b EJECTOR SPRING	Holds the ejector against the round.
c EJECTOR PIN	Holds the ejector in place and provides a pivot for it.
d EXTRACTOR HOOK	Extracts the new round from the belt by hooking into the extracting groove.
e EXTRACTOR LUG	Rides under the extractor switch and over the extractor cam to guide the extractor assembly on counter recoil.
4 BOLT SWITCH	Provides a clear track along either the right or left cam groove, depending on the direction of feed.
5 BOLT SWITCH STUD	Keeps the bolt switch from turning.
6 COCKING LEVER	Cocks the firing mechanism; keeps the gun from firing too soon.
7 COCKING LEVER PIN	Holds the cocking lever in place and provides a pivot for it.

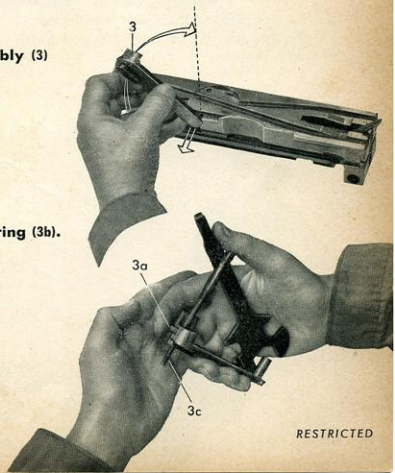
Nomenclature	Function
8 SEAR STOP ASSEMBLY	The sear stop holds the sear in place. Its pin provides a compression point for the firing pin spring.
9 SEAR SLIDE	Pushes the sear down to release the firing pin when the gun is fired from the side.
10 SEAR	Holds the firing pin back until the trigger is pressed.
a SEAR TIP	Rides under the trigger bar to cam down the sear in automatic fire.
b SEAR NOTCH	Hooks into the notch on the firing pin extension to hold the firing pin back until the trigger is pressed.
11 SEAR SPRING	Pushes the sear up into place after each round is fired.
12 FIRING PIN ASSEMBLY	
a FIRING PIN	Fires the round by hitting the primer.
b FIRING PIN EXTENSION ASSEMBLY	
(1) FIRING PIN SPRING	Forces the pin forward when the trigger is pressed.
(2) FIRING PIN SPRING STOP PIN	Holds the firing pin back until the trigger is pressed.
(3) FIRING PIN EXTENSION NOTCH	Hooks onto the sear notch to hold the firing pin back until the trigger is pressed.
13 BOLT BODY	Houses the parts of the bolt group. Its two cam grooves make it possible for ammunition to be fed into either side of the gun.
a T-SLOT	Extracts the spent case from the chamber and helps support the new round entering the chamber.
b RECOIL PLATE	Provides a shield of harder metal to receive the recoil of the primer.
c FIRING PIN PORT	Provides a hole which enables the firing pin to hit the primer.
d EXTRACTOR STOP PIN	Stops the downward motion of the extractor assembly.
e BREECH LOCK RECESS	Provides a space for the breech lock to enter the bolt to lock it to the barrel extension.
f MIDDLE PROJECTION	Turns the accelerator to the rear in hand charging.
g LOWER PROJECTION	Works with the accelerator to speed up the bolt on recoil and slow it down on counter recoil.
h CAM GROOVES	Guide the belt feed lever (of the cover group) as its lug rides in the grooves.

(Before you start on this group, make sure the firing pin has been released.)

STRIPPING

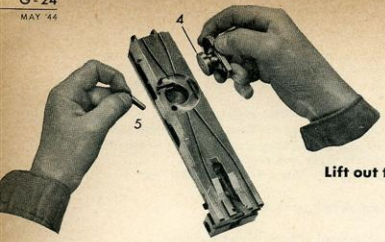
Remove the extractor assembly (3) by swinging it to the rear and pulling it off the side.

The extractor assembly pulls the new round from the ammunition belt and helps guide it into the chamber. It also ejects the last spent case in a belt.



Remove the ejector (3a) and ejector spring (3b). After you drift out the ejector pin (3c), the ejector will fall out. The spring may need a little shaking. (If the ejector pin is staked—fastened—in place, do not remove it; let ordnance make any necessary repairs.)

The ejector, held against the side of the new round by the spring, helps line up the round with the chamber. The ejector also pushes out the last empty case of the ammunition belt—a job ordinarily done by the new round as it is pushed down the T-slot.

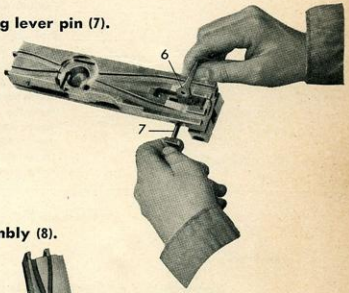


Lift out the bolt switch (4) and the bolt switch stud (5).
(In some guns the stud is staked and cannot be removed.)

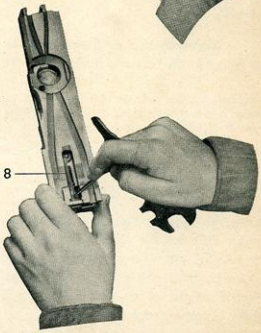
The bolt switch can be turned to provide a clear track along either the right or left cam groove. This is one of the adjustments which allows the gun to feed from either right or left. The stud keeps the bolt switch from turning.

Remove the cocking lever (6) and cocking lever pin (7).
Pull the pin out to the side with your left forefinger and thumb. At the same time lift up the cocking lever with your right hand.

The cocking lever, pivoting on its pin, cocks the firing mechanism. It also prevents the firing mechanism from acting too soon—a protection called fire control.



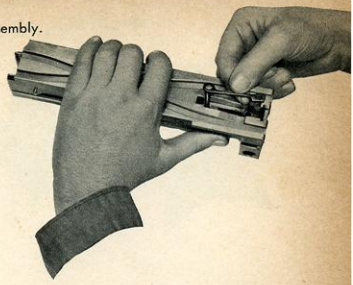
Remove the sear stop assembly (8).
Put a pointed tool in the groove at the rear of the sear stop. Pry the sear stop over to the right. Then . . .

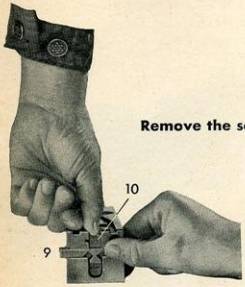


. . . Turn the bolt upside down and push the tool down against the bottom of the sear pin. Finally . . .

. . . Turn the bolt right side up and lift out the sear stop assembly.

The sear stop holds the sear in place. The sear stop pin is a compression point for the firing pin spring, which backs up against the pin when the gun is cocked.

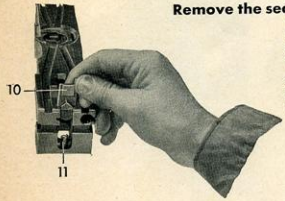




Remove the sear slide (9).

Press the sear (10) down with a tool or the thumb of one hand. With the thumb of the other hand, push the slide out sideways, square end first.

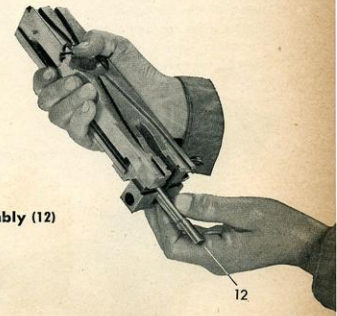
The sear slide makes it possible to fire the gun with a solenoid—an electrical attachment—mounted on the side. This is one method of firing turret guns. A plunger in the solenoid pushes in on the square end of the sear slide, camming down the sear.



Remove the sear (10) and sear spring (11).

Lift the sear up out of its slot. Turn the bolt upside down and shake out the spring.

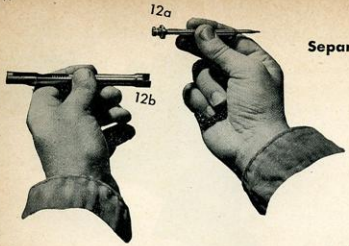
The sear holds the firing pin back when the gun is cocked. In firing, the trigger bar presses the sear down to release the firing pin. The sear spring then forces the sear back into place.



Remove the firing pin assembly (12)

by tilting up the front end of the bolt and shaking it.

The firing pin assembly fires the round by driving the pin against the primer.

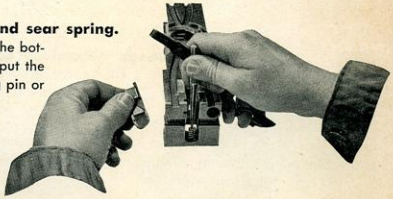


Separate the firing pin (12a) and firing pin extension assembly (12b).
Simply lift the firing pin out of the slot in the front of the extension.

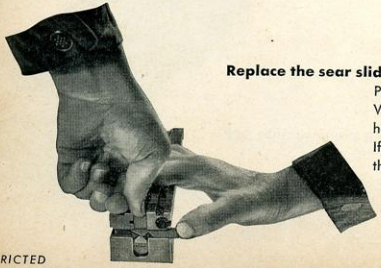
The firing pin extension notch hooks onto the sear notch. The firing pin spring drives the firing pin forward. The spring stop pin holds the spring in the firing pin extension.

ASSEMBLY

Insert the firing pin assembly.
Fit the back end of the firing pin into the notch at the front of the extension assembly. Tilt up the back end of the bolt. Slide the firing pin assembly into the bolt with the firing pin extension notch facing down.



Replace the sear and sear spring.
Seat the spring in the circular hole in the bottom of the bolt. The easiest way is to put the spring over the point of an extra firing pin or a drift, put the point into the hole, slide the spring into place, and remove the drift. Then slide the sear down into its slots with the sear notch forward. Make sure that the bottom of the spring is seated in the hole in the bolt and that the top is seated in the hole in the bottom of the sear.



Replace the sear slide.
Press the top of the sear down with one thumb. With the forefinger and thumb of the other hand, push the slide into place, notch down. If the slide fails to go in easily, check to see if the sear spring is properly seated.

Insert the sear stop assembly.

Tilt the bolt to slide the firing pin assembly all the way forward. Push the sear stop pin into place. Then . . .

. . . Put a tool in the groove at the rear of the sear stop to push it all the way down and pry it into the slot at the left.

Replace the cocking lever and cocking lever pin.

Hold the cocking lever in your right hand with the pregnant side forward. Put it all the way down into its slot with the tip pointing back. Put the pin in the left side of the bolt and push in on it. At the same time, pull the cocking lever back until the pin goes through the hole. (This is the easiest way to do it blindfolded.)

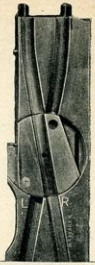
Now test the firing mechanism. Push the cocking lever all the way forward, then all the way back. (The new type cocking lever cannot be turned all the way forward unless it has been put in with the pregnant side to the front.) Press the sear tip down. You should hear a click as the firing pin snaps forward. If not, the firing mechanism has been improperly assembled.

Insert the bolt switch stud with the small end up.

Place the bolt switch over the stud.

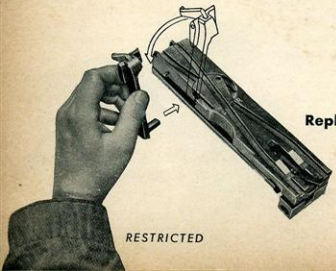
For left hand feed, the narrow end goes to the rear.

For right hand feed, the wide end goes to the rear.



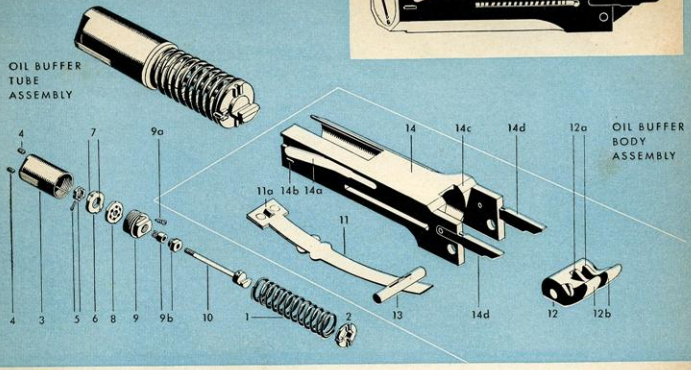
Replace the ejector and ejector spring in the extractor assembly. Slip the spring into its hole with the tail sticking up between the ejector and the side of the extractor. Insert the pin, compress the spring with a pointed tool, and push the pin in just enough to keep the spring down. Then . . .

. . . With your forefinger pressing the pin toward you, force the end of the ejector into its groove until its hole lines up with the pin. Then push the pin into place.



Replace the extractor assembly in the bolt. Hold it straight up in your left hand. Push it sideways into the bolt as far as it will go, then let it drop forward.

OIL BUFFER GROUP



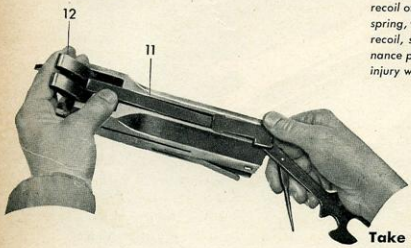
Nomenclature	Function
Oil Buffer Tube Assembly	
1 OIL BUFFER SPRING	Helps absorb the recoil of the barrel group and push it forward on counter recoil.
2 OIL BUFFER SPRING GUIDE AND SPRING GUIDE KEY	The spring guide, which is prevented from turning by the spring guide key, holds the oil buffer spring in place.
3 OIL BUFFER TUBE	Houses the oil buffer parts.
4 FILLER SCREWS (TWO)	Provide openings for filling the oil buffer tube.
5 PISTON HEAD NUT AND PIN	Hold the head and valve on the piston rod.
6 PISTON VALVE	Closes and opens the holes in the piston rod head.
7 VALVE KEYS (TWO)	Keeps the valve from turning.
8 PISTON ROD HEAD	Pushes into the oil to absorb the recoil of the barrel group.
9 TUBE CAP	Closes the front of the oil buffer tube.
a RELIEF VALVE ASSEMBLY	Lets the oil escape if the pressure gets too great.
b PACKING GLAND ASSEMBLY	Prevents oil leakage around the piston rod.
10 PISTON ROD AND HOOK	Connect the barrel extension shank with the piston rod head.
Oil Buffer Body Assembly	
11 OIL BUFFER TUBE LOCK	The front end keeps the accelerator tips from bouncing up. The protrusion keeps the oil buffer tube from turning freely.
a PROTRUSION	
12 ACCELERATOR	Serves as an energy transmitter, a locking device, and a timing device. Its functions are explained fully in the discussion of cycle of operations (page G-52).
a ACCELERATOR LOCKING LUGS	
b ACCELERATOR TIPS	
13 ACCELERATOR PIN	Holds the accelerator and provides a pivot for it.
14 OIL BUFFER BODY	Houses all parts of the oil buffer group.
a OIL BUFFER BODY SPRING LOCK	Holds the oil buffer group in place when the back plate is off.
b OIL BUFFER BODY GUIDES (TWO)	Fit into slots in the receiver to help hold the oil buffer group in its place.
c SHOULDERS	Prevent the tips of the accelerator from turning too far down.
d BREECH LOCK DEPRESSORS (TWO)	Forces the breech lock down by camming down the breech lock pin.

STRIPPING

Remove the oil buffer tube assembly

by pushing it back with one hand and pulling it out of the oil buffer body with the other.

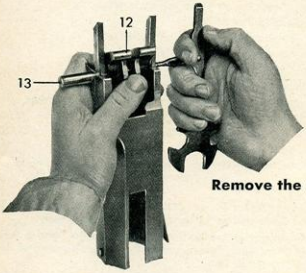
The tube assembly houses the parts which absorb the recoil of the barrel and barrel extension. The oil buffer spring, which helps take up the recoil and start counter recoil, should be removed only by experienced ordnance personnel. It is powerful enough to cause serious injury when released.



Take off the tube lock (11).

Turn the oil buffer body upside down on a table. With one hand, use a tool to pry up the rear end of the tube lock until its rear winged part clears the sides of the circular opening in the slot. With the thumb of the other hand, press down on the front of the tube lock to keep it from springing out. Turn the accelerator (12) back to push the tube lock out of its recess.

The protrusion keeps the oil buffer tube from turning freely. The other end of the tube lock keeps the accelerator from bouncing when it hits the shoulders of the oil buffer body.



Remove the accelerator (12)

by drifting out the accelerator pin (13).

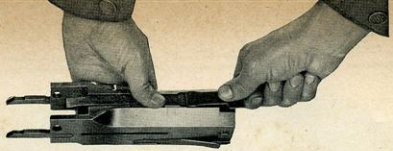
The accelerator works in three ways. It is:

An energy transmitter. It transfers energy from the barrel extension to the bolt on recoil, and from the bolt to the barrel extension on counter recoil.

A locking device. Its locking lugs hold the barrel extension back against the oil buffer body during part of the recoil and counter recoil.

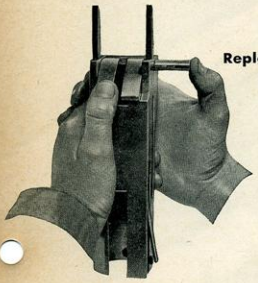
A timing device. On recoil, it slows down the barrel extension and speeds up the bolt. On counter recoil, it slows down the bolt and speeds up the barrel extension.

ASSEMBLY



Replace the tube lock.

Put the oil buffer body upside down on a table and hold the lock against it, protrusion down. With the thumb of one hand, press the forward winged part into the circular opening in the slot. With the other hand, raise the rear of the lock just enough to lift the protrusion over the buffer body. Then push the lock forward until the rear winged part snaps into the circular opening.

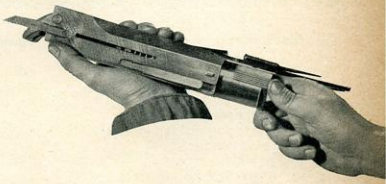


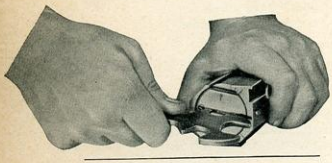
Replace the accelerator and pin.

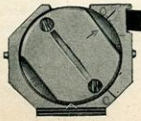
With the oil buffer body right side up, hold the accelerator with the tips up and the locking lugs to the rear. Push it down between the depressors until it hits the tube lock. Then lay the tips back against the shoulders of the oil buffer body. With one hand, press the pin through the hole. With the other hand, move the accelerator up or down until the pin slips in. (This is the easiest way to do this step blindfolded.)

Replace the oil buffer tube assembly.

Sometimes it is necessary to insert a tool under the tube lock to hold its protrusion out of the way. Push the oil buffer tube assembly into place with the piston rod hook facing up.







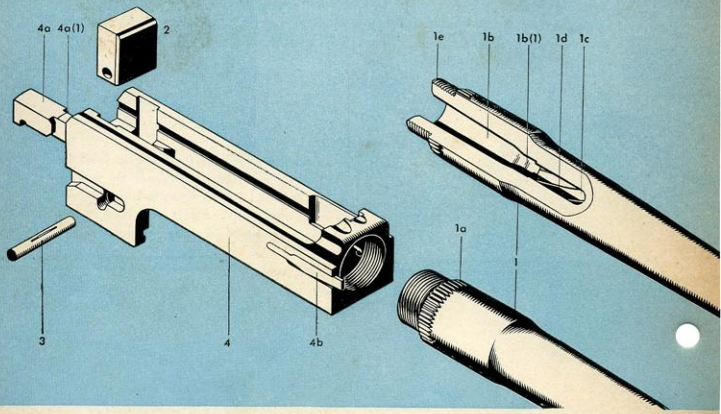
(The purpose of the oil buffer adjustment is fully explained on page G-71.)

Adjust the oil buffer.

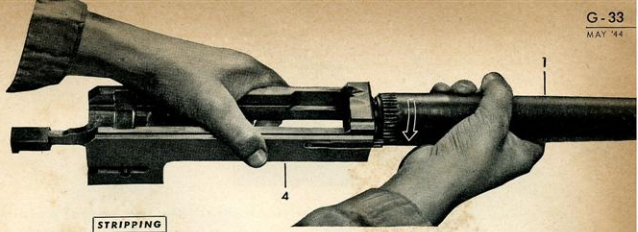
Place the oil buffer group right side up on a table. Press down on it with one hand; with the other, use a tool to turn the oil buffer tube to the left (counterclockwise) until the clicks stop. Then turn it to the right (clockwise) exactly three clicks.

The tube lock protrusion should be in the third notch from the left. Ignore the position of the arrow. It is not an accurate indication of the oil buffer setting.

BARREL GROUP



Nomenclature	Function
1 BARREL	Gives the bullet direction and spin.
a BARREL LOCKING NOTCHES	Fit against the barrel locking spring to keep the barrel from turning freely.
b CHAMBER	Houses the round while it is being fired.
(1) SHOULDERS OF CHAMBER	Support the front end of the cartridge case.
c LANDS (EIGHT) } RIFLING	Give the projectile its spin.
d GROOVES (EIGHT) } RIFLING	
e BREECH END OF BARREL	
f MUZZLE END OF BARREL	
2 BREECH LOCK	Locks the bolt to the barrel extension.
3 BREECH LOCK PIN	Holds the breech lock in the barrel extension; hits the depressors on the oil buffer body to force the breech lock down during recoil.
4 BARREL EXTENSION	Serves as a connection between the bolt, barrel, oil buffer, and receiver.
a BARREL EXTENSION SHANK AND HOOK	Connect the barrel extension to the oil buffer tube assembly.
(1) SHANK SHOULDERS	Provide a surface for the accelerator to lock the barrel extension to the oil buffer body.
b BARREL LOCKING SPRING	Fits into the barrel locking notches to keep the barrel from turning freely.



STRIPPING

Separate the barrel (1) and barrel extension (4)

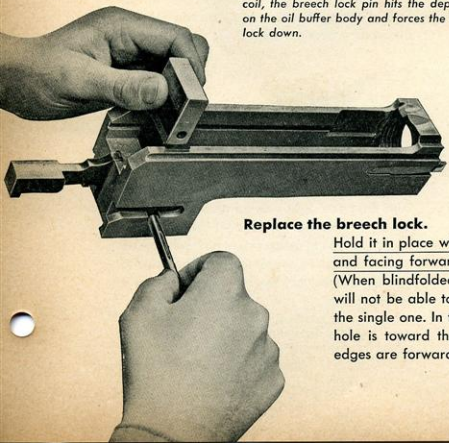
by unscrewing them.

The barrel establishes the bullet's direction of flight and gives it a right-hand spin for greater accuracy. The barrel extension serves as a connection between the bolt, barrel, oil buffer, and receiver.

Remove the breech lock (2)

by drifting out the breech lock pin (3).

The breech lock holds the bolt to the barrel extension when the gun is in battery. On recoil, the breech lock pin hits the depressors on the oil buffer body and forces the breech lock down.



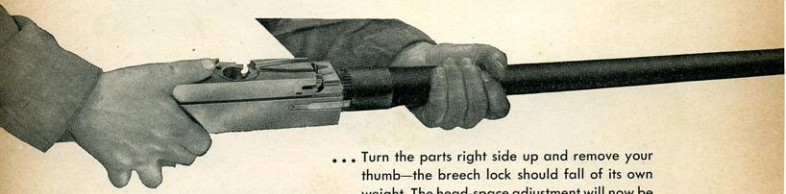
ASSEMBLY

Replace the breech lock.

Hold it in place with the double bevel on top and facing forward. Push the pin into place. (When blindfolded and wearing gloves, you will not be able to tell the double bevel from the single one. In that case just make sure the hole is toward the bottom and the beveled edges are forward.)

Screw the barrel into the barrel extension as far as it will go, then unscrew it about one-half turn. This prepares the barrel for the next step.

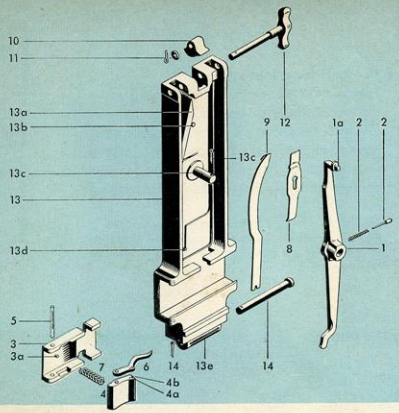
Adjust for headspace. Put the bolt, with the extractor assembly and switch removed, on the barrel extension and slide it all the way forward. Hold the gun upside down, placing one hand near the breech end of the barrel and the other hand on the barrel extension, with the thumb holding the breech lock down firmly. Do not support the barrel on a bench. With one quick movement, screw the barrel in as far as it will go. Then carefully unscrew the barrel three notches—that is, until you hear three clicks of the barrel locking spring. For this step, you can rest the barrel on a bench. Next . . .



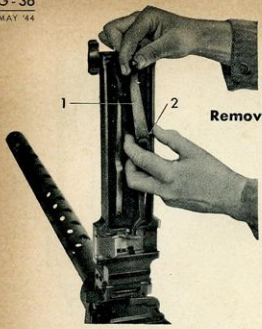
. . . Turn the parts right side up and remove your thumb—the breech lock should fall of its own weight. The head-space adjustment will now be correct enough to permit the recoiling parts to go fully into battery position when the gun is reassembled.

(This method of headspace adjustment is only approximate and must be rechecked after the gun is fully assembled. The procedure and the purpose of the adjustment are fully described on pages G-63 to G-69.)

COVER GROUP



Nomenclature	Function
1 BELT FEED LEVER	Pivots from side to side to operate the feeding mechanism.
a BELT FEED LEVER LUG	Rides in the bolt's cam grooves to move the lever from side to side.
2 BELT FEED LEVER PLUNGER AND PLUNGER SPRING	Hold the belt feed lever in position when the cover is raised.
3 BELT FEED SLIDE	Moves from side to side to feed the ammunition belt into the gun.
a BELT FEED PAWL SPRING STUD	Helps hold the pawl spring in place.
4 BELT FEED PAWL	Pushes the new round into the feedway.
a PAWL ARM LOCATING PIN b PAWL ARM PIN	Hold the pawl arm in place.
5 BELT FEED PAWL PIN	Holds the belt feed pawl and provides a pivot for it.
6 BELT FEED PAWL ARM	Prevents double feeding.
7 BELT FEED PAWL SPRING	Pushes the belt feed pawl down behind the new round.
8 COVER LATCH SPRING	Presses against the cover latch to keep it locked.
9 COVER EXTRACTOR SPRING	Holds the extractor assembly down while it is pulling a new round from the belt; cushions the shock when the extractor assembly is cammed up at the end of the counter recoil stroke.
10 COVER LATCH	Holds the cover down.
11 COTTER PIN AND WASHER	Hold the cover latch shaft in the cover.
12 COVER LATCH SHAFT AND LEVER	The shaft holds the cover latch. The lever serves as a handle to turn the shaft and unlock the latch.
13 COVER	Houses the parts of the cover group.
a COVER EXTRACTOR CAM	Cams down the extractor assembly on recoil.
b COVER LATCH SPRING STUD	Holds the cover latch spring in place.
c BELT FEED LEVER PIVOT STUD AND COTTER PIN	The stud serves as a pivot for the belt feed lever. The cotter pin holds the lever on the stud when the cover is closed.
d COVER EXTRACTOR SPRING STUD	Helps hold the cover extractor spring in place.
e DETENTS	Grooves that work with the detent pawl (on the receiver) to hold the cover in any one of three positions when it is raised.
14 COVER PIN AND COTTER PIN	Fasten the cover to the receiver.



Remove the belt feed lever (1).

Take out the cotter pin. With one hand, move the top of the lever over to line up its lower end with the slot in the cover. Use your other hand to lift the lever off its pivot stud, holding your thumb or finger over the plunger and plunger spring (2) to keep them from jumping out.

The belt feed lever, which is pivoted as its lug rides in the cam grooves in the bolt, moves the belt feed slide in and out of the gun to feed new rounds into the feedway.

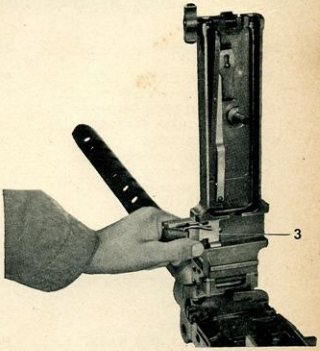
Remove the plunger and plunger spring (2) from the lever.

The plunger and plunger spring hold the belt feed lever in position when the cover is raised.

Remove the belt feed slide (3)

by pulling it out to the side.

The slide moves in and out of the gun carrying the belt feed pawl, which pushes new rounds into the feedway.



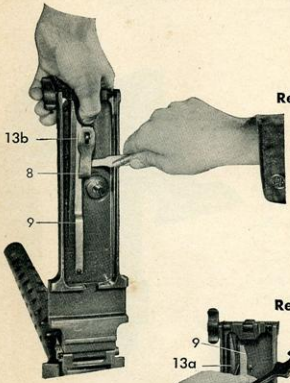
Remove the belt feed pawl (4) from the slide.

Hold the pawl down to keep its spring in place while you drift out the belt feed pawl pin (5).

The belt feed pawl slides out over the new round, is snapped down behind it by the spring, and pushes it into the feedway.

Take the pawl arm (6) off the pawl, and lift the belt feed pawl spring (7) off its stud.

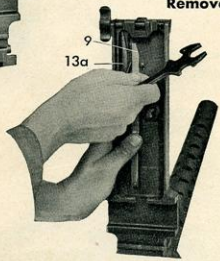
The pawl arm prevents double feeding; if a round is not extracted from the ammunition belt, the pawl arm rides over it, holds up the pawl and thus stops the feeding action.



Remove the cover latch spring (8).

Use a tool to pry out the bottom end of the cover latch spring and push it over on top of the cover extractor spring (9). With your thumb, push the top end of the latch spring down until it lifts off its stud (13b).

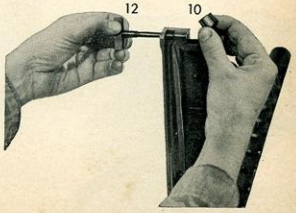
The spring presses against the cover latch to keep it locked.



Remove the cover extractor spring (9).

Use one thumb to keep the spring from popping out. With the other hand, put a pointed tool into the notch in the side of the cover extractor cam (13a) and pry the spring out.

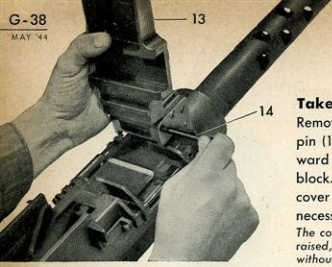
The spring holds the extractor assembly down while a new round is pulled from the ammunition belt. It also cushions the shock when the extractor assembly is cammed up at the end of the counter recoil stroke.



Take off the cover latch (10).

Remove the cotter pin, turn the latch shaft lever (12) to the latched position — parallel to the cover — and pull the shaft out the side. The washer and latch will come off.

The latch keeps the cover closed. The cover latch shaft, which holds it, can be turned with the lever to unlock the latch and raise the cover.



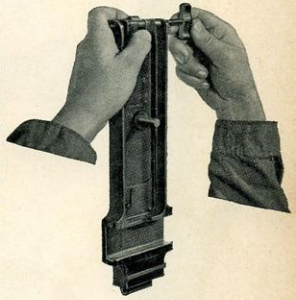
Take off the cover (13).
Remove the cotter pin and pull out the cover pin (14). Lift the rear of the cover up and forward to pry the front end out of the trunnion block. Because it is difficult to put back on, the cover should not be removed unless absolutely necessary.

The cover houses the parts of the cover group. When raised, it enables you to see the bolt and feedway without field stripping the gun.

ASSEMBLY

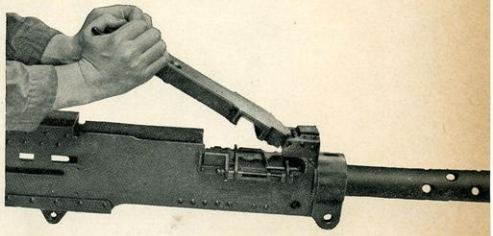
Replace the latch.

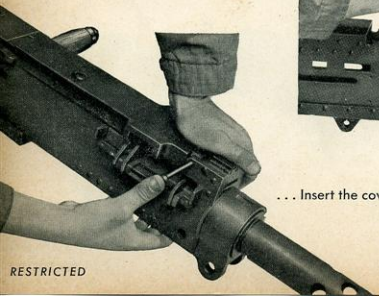
The latch shaft lever should be on the side opposite the charging handle. Put the latch into its recess with the keyway—the little slot inside the hole—toward the top of the cover and the pointed end of the latch against the under side of the cover. Insert the latch shaft with the key—the little ridge along the side of the shaft—lined up with the keyway. Put the washer on the end of the shaft. Insert the cotter pin from the bottom, and bend the ends down carefully to keep them out of the way when the cover is closed.



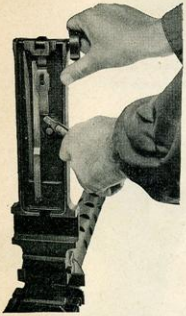
Put on the cover.

Hold the cover in a nearly closed position and push it forward into place. Put the back end all the way down, and force the front end down into position. Then . . .

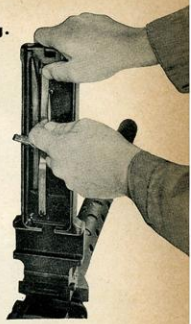




. . . Insert the cover pin and replace its cotter pin.



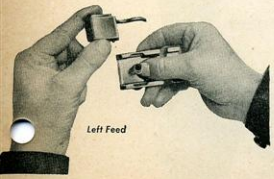
Replace the cover extractor spring.
Hook the slotted end of the spring on its stud, with the other end curving away from the cover. With one hand, press the top of the spring all the way back. With the other hand, pry it into the slot to the left by putting a tool between the spring and the cover latch spring stud.



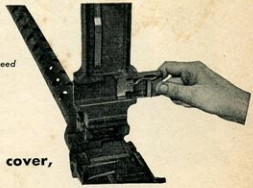
Put back the cover latch spring.
Hold the spring with its lower tip curving into the cover. Put the wide part of the slot over the latch spring stud and force the spring up just enough to hold it in place. With the thumb and forefinger of one hand, hold the top of the cover latch shaft lever toward you to make sure the latch spring rides up over the latch. With the other hand, pry the bottom of the spring up into its slot by putting a tool between the bottom of the spring and the belt feed lever pivot stud.

Replace the belt feed pawl arm
on the belt feed pawl. Hold the pawl with its smooth side toward you and its sharp end pointing in the direction of feed—to the right for right feed, to the left for left feed. Put the pawl arm on top, with the pregnant side curving away from you.

Replace the belt feed pawl
in the slide. Put down the pawl and pawl arm and pick up the slide—in your right hand if the gun is to feed from the left, or in your left hand if the gun is to feed from the right. In either case, hold it with the open side up and the rounded end toward the direction of feed. Put the small end of the pawl spring over its stud, with the oval loop on top of the spring toward you—away from the pawl arm. Hold the spring in place with the thumbnail of the hand that holds the slide. Use your other hand to place the pawl over the spring, with the pawl arm away from you. Then . . .



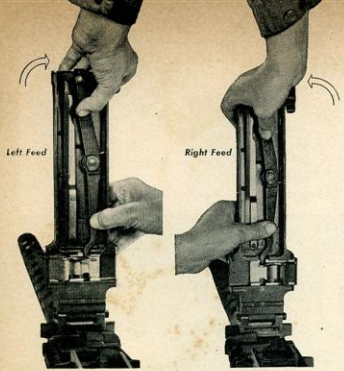
. . . Use the thumb which has been holding the pawl to press down on the pawl while you insert the belt feed pawl pin with your other hand. Start the pin in from the side with the arm.



Place the belt feed slide in the cover, with the pawl arm on top.

Replace the plunger and plunger spring.
They go in the upper hole of the belt feed lever for left hand feed, and in the lower hole for right hand feed. (The upper end of the belt feed lever can be recognized by the lug.)

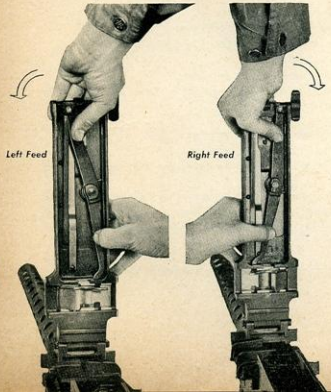
Replace the belt feed lever.
Set the lever in at an angle with the top end pointing in the direction of feed. Place the plunger against the inside of the cover. Then . . .



. . . Straighten the lever until you can put the lower end through the slots in the cover and in the belt feed slide. Push the lever down on the pivot stud as far as you can. Next . . .

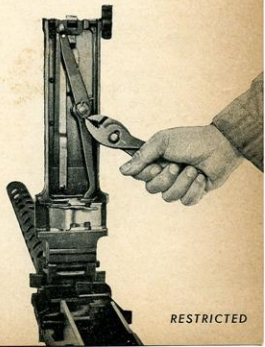
. . . To get the lever all the way down, turn it as far as you can in the direction that compresses the plunger spring. Finally . . .

. . . Pivot the lever quickly in the opposite direction while pressing down on it with both thumbs. The plunger and spring will snap down into place. This is the quickest method with most guns, but if the plunger spring is unusually stiff you may have to pry the plunger into place with a screwdriver.

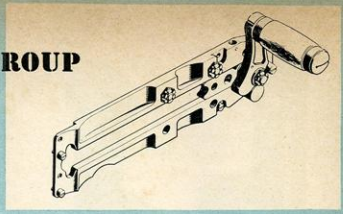


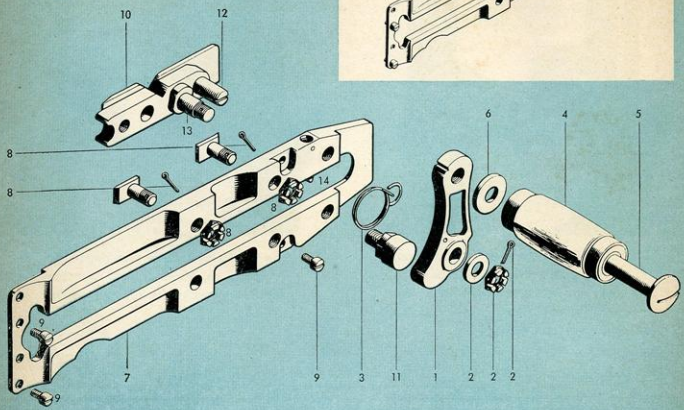
Install a cotter pin.

In combat, use a new cotter pin each time—and be sure it is the right size. An old pin may break. A thin pin may keep the gun from feeding properly by letting the belt feed lever drop down too far.



RETRACTING SLIDE GROUP

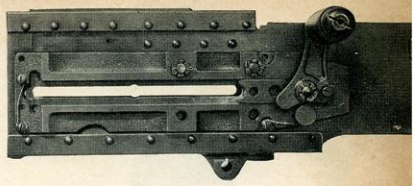


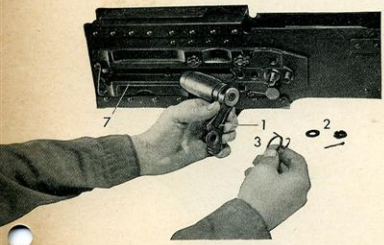


Nomenclature	Function
1 LEVER	Pulls back the retracting slide in hand charging.
2 LEVER STUD NUT, WASHER, AND COTTER PIN	Hold the lever on the lever stud.
3 LEVER SPRING	Keeps the lever forward when not in use.
4 GRIP OR CHARGING HANDLE	Is pulled back to hand charge the gun.
5 GRIP BOLT	Fastens the grip to the lever.
6 GRIP WASHER	Prevents binding between grip and lever.
7 BRACKET	Holds the retracting slide and provides a slot in which the slide moves back and forth.
8 BRACKET BOLTS, NUTS, AND COTTER PINS (TWO OF EACH)	Help fasten the bracket to the receiver.
9 BRACKET SCREWS (THREE)	Help fasten the bracket to the receiver.
10 RETRACTING SLIDE	Works against the bolt stud to move the bolt back in hand charging.
11 LEVERAGE STUD	Supports the bottom end of the lever, making it easier to pull back.
12 LEVER STOP	Stops the forward movement of the lever.
13 LEVER STUD	Fastens the retracting slide lever to the slide and provides a pivot for the lever.
14 PLUNGER AND PLUNGER SPRING	Keep the retracting slide forward when not in use.

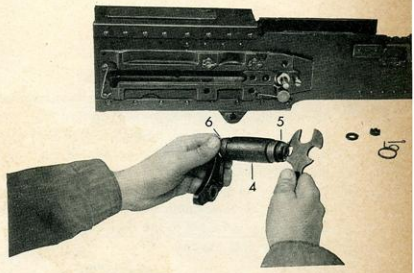
STRIPPING *from the right:*

The retracting slide can be installed on either side—whichever is convenient for the direction of feed and the place where the gun will be used. These instructions are for stripping the slide from the right and assembling it on the left. The methods can easily be reversed.



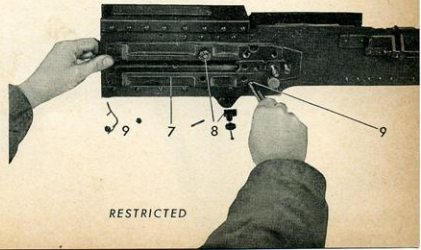


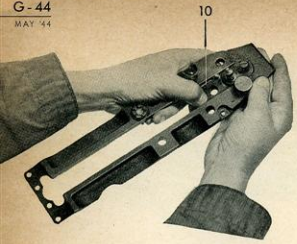
Remove the lever (1)
from the bracket (7) by taking off the cotter pin, nut, and washer (2). Remove the spring (3).
The lever pulls the retracting slide back in hand charging the gun. The spring keeps the lever forward when not in use.



Remove the grip (4)
by taking off the grip bolt (5) and washer (6).
The grip is simply a handle for operating the lever.

Take off the bracket (7).
If the bracket bolts (8) and bracket screws (9) have been safety wired, as they should be, remove the wire first. Take out both cotter pins. Unscrew the nut from the forward bolt and take the bolt out. Loosen the rear nut. Remove all three bracket screws. Slide the whole bracket forward a fraction of an inch and lift it off the side of the receiver. (Older guns have only one bracket bolt.)



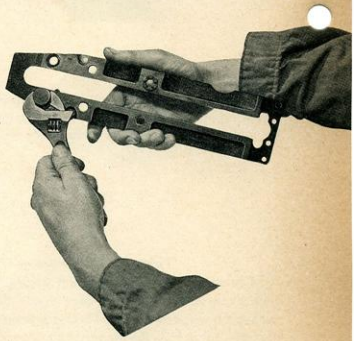


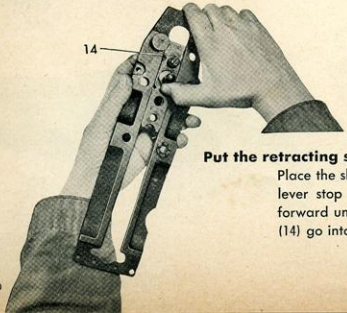
Remove the retracting slide (10)
from the bracket by pushing it out the side.
The retracting slide forces the bolt group to the rear in hand charging.

Remove the leverage stud (11)
by unscrewing it from the bracket. Take off the remaining bracket bolt.
The leverage stud gives the bottom of the lever something to work against, making it easier to pull the lever back.

ASSEMBLY *on the left:*

Replace the leverage stud.
Turn the slide over so that it will fit against the left side of the receiver, pointed end of the bracket forward. Screw the leverage stud into the lower forward hole. Then, insert the rear bracket bolt in the top rear hole, with the head of the bolt on the smooth side of the bracket and the beveled edge to the rear. Screw the nut loosely onto the bolt.

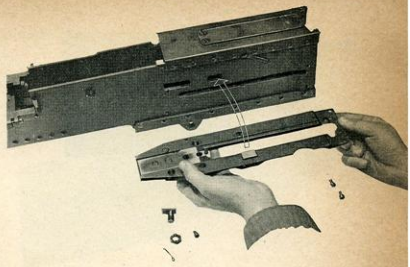


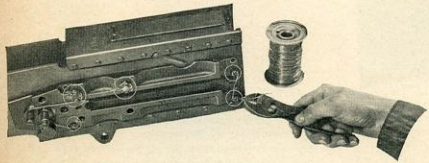


Put the retracting slide in the bracket.
Place the slide at the rear of the slot, with the lever stop toward the front. Force the slide forward until the plunger and plunger spring (14) go into the notch in the slide.

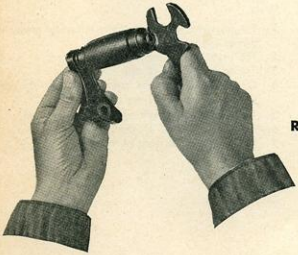
Replace the bracket.

Put the bracket against the receiver, with the head of the rear bracket bolt through the rear hole on the receiver, and slide the bracket to the rear. Then . . .





. . . Reach in under the front of the top plate to insert the front bracket bolt, its head inside the receiver with the beveled edge forward. Screw on the nut. Put the long bracket screw in the lower front hole and the two short screws in the rear—one in the bottom hole, the other in the second hole from the top. Tighten the screws. Tighten the bolts and insert their cotter pins. Safety wire the bolts and screws.

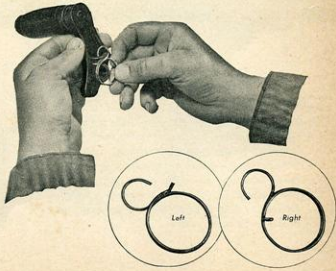


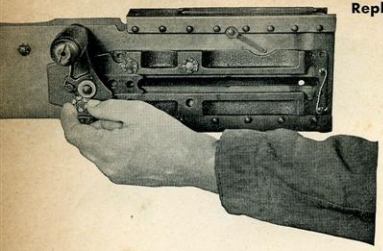
Replace the grip and grip bolt.

Attach the grip in such a way that it will be on the left side when you hold the lever with its pointed edge away from you. The washer goes between grip and lever.

Replace the lever spring.

There are two different lever springs—one for assembling the retracting slide on the right, the other for assembling the slide on the left. The difference is in the position of the bent tip. Using the proper spring, put the bent tip into the hole in the lever—on the side opposite the grip—with the big loop of the spring around the hole for the lever stud.





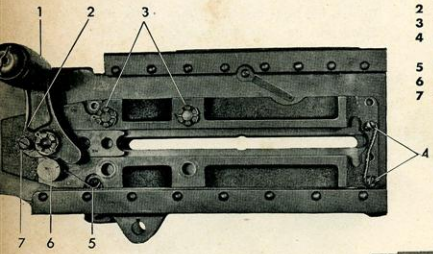
Replace the lever.

The big loop of the spring goes around the lever stud and the small loop around the lever stop. Replace the washer, tighten the lever stud nut, and replace its cotter pin. The retracting slide group is now correctly assembled on the left side of the receiver.

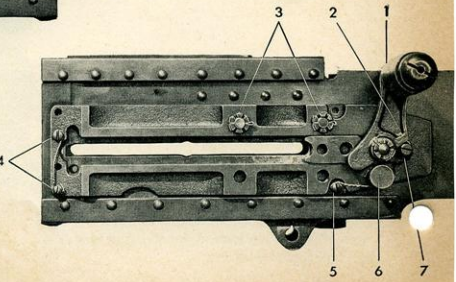
To change the retracting slide from one side to the other:

Remove the lever and put the grip on the other side.
Take the bracket off the receiver.
Take the leverage stud out of the bottom hole and screw it into the top hole. You may have to remove the retracting slide while changing the leverage stud.
Turn the bracket over and mount it on the other side of the receiver.
Replace the lever, substituting the correct lever spring.
Check to make sure these parts are in the correct position:

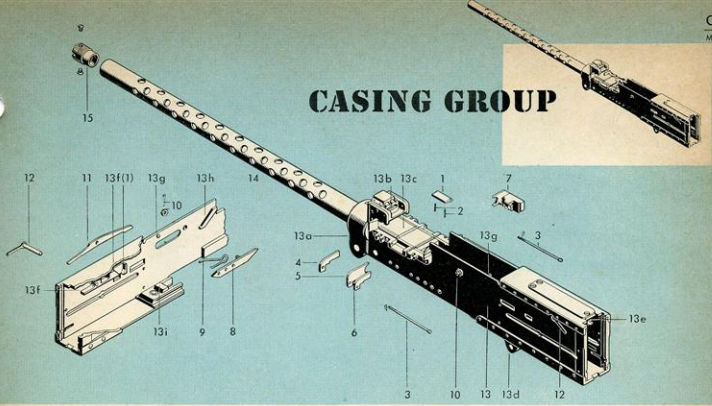
1. The grip on the outside of the lever and projecting above the bracket.
2. The pointed side of the lever forward.
3. The bracket bolts on top.
4. One rear screw in the bottom hole and the other in the second hole from the top.
5. The front bracket screw in the bottom hole.
6. The leverage stud on the bottom.
7. The lever stop in front of the lever stud.



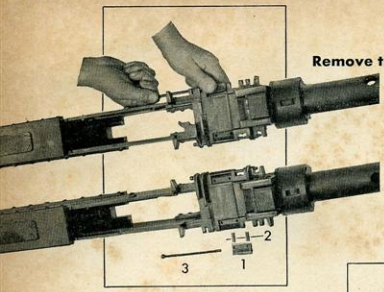
After changing the retracting slide from one side to the other, always move the cover latch lever to the side opposite the charging handle. Otherwise, the charging handle may hit the cover latch and force the cover partly open. The gun will not fire unless the cover is tightly latched to hold the belt feed lever lug down in the bolt's cam grooves.



CASING GROUP

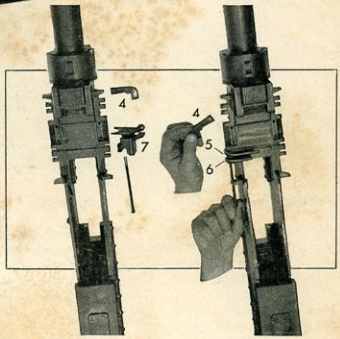


Nomenclature	Function
1 BELT HOLDING PAWL	Holds the ammunition belt in the feedway.
2 BELT HOLDING PAWL SPRINGS (two)	Force the belt holding pawl up behind the next round.
3 BELT HOLDING PAWL PINS (two)	Hold the belt holding pawl and the cartridge stops.
4 FRONT CARTRIDGE STOP	Holds the front of the cartridge in the correct position.
5 LINK STRIPPER	Strips the links off the cartridge case.
6 REAR CARTRIDGE STOP	Holds the rear of the cartridge in the correct position.
7 RIGHT-HAND REAR CARTRIDGE STOP ASSEMBLY	Serves as a combination rear cartridge stop, link stripper, and short round eliminator when the gun feeds from the left.
8 EXTRACTOR SWITCH AND SWITCH PIVOT	The switch cams the extractor assembly down at the beginning of counter recoil to aline the new round with the chamber.
9 EXTRACTOR SWITCH SPRING	Returns the switch to its original position.
10 EXTRACTOR SWITCH PIVOT NUT AND COTTER PIN	Fasten the extractor switch to the receiver.
11 TRIGGER BAR	Pushes down the sear when the trigger is pressed.
12 TRIGGER BAR PIN	Holds the trigger bar and provides a pivot for it.
13 RECEIVER	Houses the working parts of the gun.
a TRUNNION ADAPTER	Serves as a front mounting for the gun.
b DETENT PAWL	Holds the cover up by pushing into the detents in the cover.
c TRUNNION BLOCK	Provides a bearing for the breech end of the barrel; forms the bottom of the feedway; serves as a spacer for the sideplates.
d REAR MOUNTING HOLES	Serve as the rear mounting for the gun.
e REAR TRIGGER BAR STOP	Keeps the rear end of the trigger bar from going so high that the front end rides the top of the bolt.
f TOP PLATE BRACKET	Holds the trigger bar.
(1) FRONT AND REAR COCKING LEVER CAMS (OR "V-SLOT")	Cam the cocking lever backward and forward.
g BOLT STOP	Provides a means of locking the bolt to the rear.
h EXTRACTOR CAM	Cams the extractor assembly up on the last part of counter recoil.
i BREECH LOCK CAM	Cams the breech lock up on counter recoil; prevents forward movement of the oil buffer body; holds the barrel extension down.
14 BARREL JACKET	Houses the barrel and holds the front barrel bearing. Its holes insure uniform cooling of the barrel.
15 FRONT BARREL BEARING	Supports the front end of the barrel and prevents whip. In firing, the barrel slides through this bearing and the trunnion block.



Remove the belt holding pawl (1) and springs (2). Keep the pawl pressed down with one hand while you pull out the belt holding pawl pin (3) with the other.

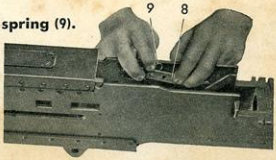
The belt holding pawl holds the ammunition belt in position while the belt feed pawl (in the cover group) moves out over the new round.

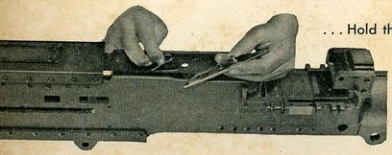


Take off the cartridge stops by pulling out the other belt holding pawl pin. On a gun feeding from the right, this will release the front cartridge stop (4), link stripper (5), and rear cartridge stop (6). On a gun feeding from the left, it will release the front cartridge stop (4) and the right-hand rear cartridge stop assembly (7).

On a gun feeding from the right, the front and rear cartridge stops are installed on the left side to hold the new rounds in position. The link stripper, between them, pulls the links from the cartridges. On a gun feeding from the left, only a front cartridge stop is installed—this time on the right side. The right-hand rear cartridge stop acts as a combination link stripper, short round eliminator, and rear cartridge stop.

Remove the extractor switch (8) and its spring (9). Take off the cotter pin and nut (10). Holding the rear of the switch against the receiver, push the switch pivot in until the looped end of the spring snaps up above the switch. Then . . .

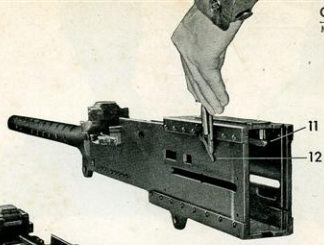




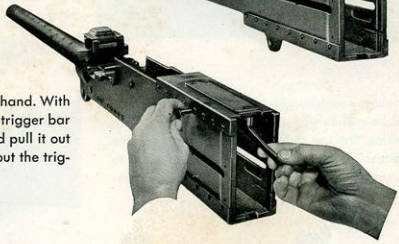
. . . Hold the looped end of the spring while you remove the switch. Lift the spring out of its recess.

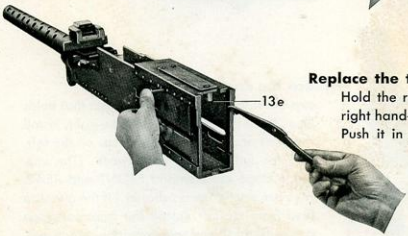
On recoil, the rear of the extractor switch is pivoted downward by the lug on the extractor assembly. The switch is then forced back into position by its spring, and on counter recoil it cams the extractor assembly down to aline the new round with the chamber.

Remove the trigger bar (11).
Use a tool to pry the stud on the rear of the trigger bar pin (12) out of the hole in the receiver. Then . . .



. . . Hold the trigger bar with your right hand. With your left hand, push the rear of the trigger bar pin down and slightly forward, and pull it out of the receiver. Now you can pull out the trigger bar.

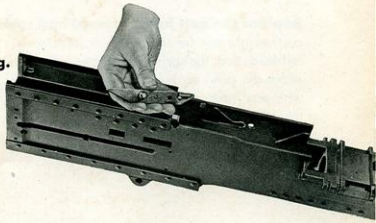




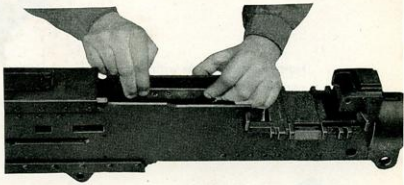
ASSEMBLY

Replace the trigger bar.
Hold the rear end of the trigger bar in your right hand—long end forward, bowed side up. Push it in place, just to the right of the top plate bracket, until the rear of the trigger bar is about a quarter inch behind the rear trigger bar stop (13e). Insert the trigger bar pin, holding the handle of the pin down and slightly forward so that the ridge along the pin fits through the keyway in the hole. Move the trigger bar backward or forward until the pin slips into its hole in the trigger. Then pivot the pin to the rear until its stud snaps into the hole in the receiver.

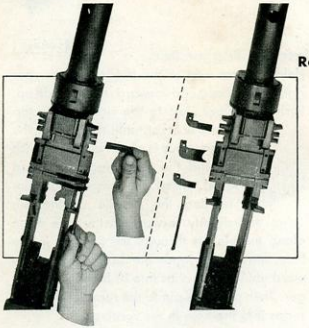
Replace the extractor switch and its spring.
First, put the switch spring into its recess in the side of the receiver, loop end forward. Put the bent tip of the spring through the little hole in the side plate, letting the long end of the spring stick above the recess. Hold the extractor switch in your right hand. Then . . .



. . . Hold the bottom half of the spring in place with one finger while you put the switch pivot through the hole in the side of the receiver. Make sure that the front end of the switch is above the extractor cam, and that the lug at the rear of the switch is resting on the spring. Finally . . .



. . . Hold the switch against the receiver with both fingers while you pivot its rear end down into place. The top of the spring will snap into the recess. Replace the nut, being careful not to screw it too tight. Make sure the switch operates properly.

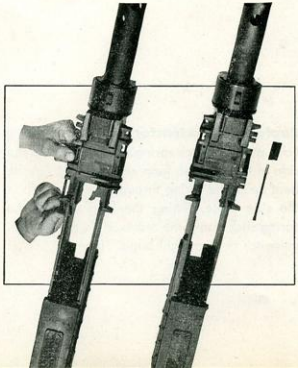


Replace the cartridge stops

and insert the belt holding pawl pin that holds them. If the gun is to feed from the right, install the front and rear cartridge stops on the left, with the link stripper in between. (The cartridge stops are stamped *FRONT* and *REAR*. The rear stop is always shorter.) If the gun is to feed from the left, install the front cartridge stop and right-hand rear cartridge stop assembly on the right.

Replace the belt holding pawl and springs

on the right side for right feed, or left side for left feed. Seat the springs in the two holes and place the pawl on top. Press the pawl down with one hand while you insert the pin with the other.



THE GUN IS ITS OWN TOOL KIT

In an emergency, the gun can be stripped with nothing but its own parts as tools.

Use the point of a cartridge or the cocking lever pin to depress the oil buffer body spring lock.

Use the cocking lever pin to drift out the sear stop pin and accelerator pin.

Use the flat tip of the cocking lever as you would use a screw driver to remove and replace the sear stop, oil buffer tube lock, the cover latch spring, and cover extractor spring.

Use the oil buffer tube lock to pry the handle of the trigger bar pin out of its hole in the side of the receiver.

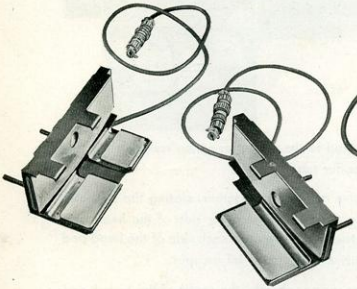
Use the sear stop pin to drift out the belt feed pawl pin.

But use these methods only when absolutely necessary and take care not to damage the parts used as tools. **Never use the driving spring rod assembly as a tool.**

HEATERS

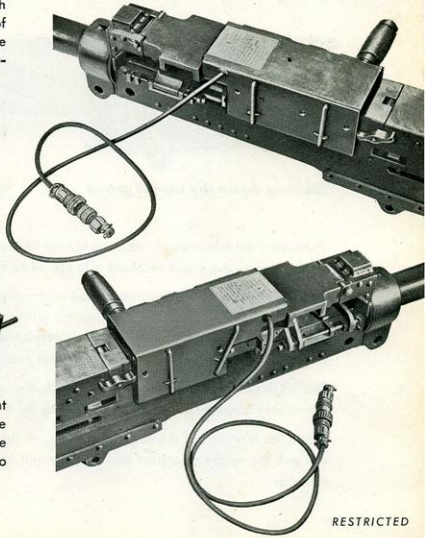
In bombing missions at high altitude, where the temperature may drop to 50 degrees below zero, an electric heater is sometimes clamped over the cover of the gun to keep the parts from "freezing" together.

There are two models of the heater—one with a side plate extending down the left side of the gun, the other with the side plate on the right. The part that extends down must be **opposite the charging handle.**



To install a heater, turn its two clamps straight up. Raise the cover of the gun, and slide the heater down on it as far as it will go. Turn the top clamp down and back until it snaps into the catch; turn the lower clamp up and back into the catch.

The heater turns on when you plug it into the bomber's electric output. Do not leave the heater connected when it is off the gun.



CYCLE OF OPERATION

As the gun operates, each part must do its job at exactly the right time. This complicated teamwork of parts, as the gun feeds, fires, and ejects each round, is called the cycle of operation.

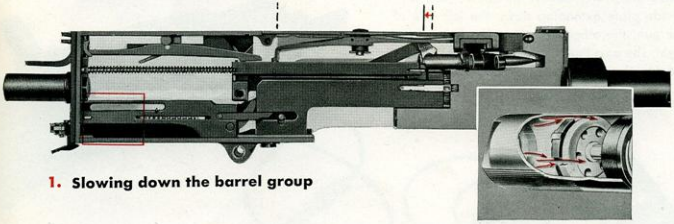
The cycle of operation is a picture of your gun in action when everything is in perfect working order. Unless you are familiar with it, you will have no way of knowing what is wrong when the gun does not work.

A gun with one whole side cut away will make it possible to watch the action of the parts as the gun recoils and counter recoils during automatic fire. Then, with this action as a background, we can follow one round through the gun and see what happens to it.

RECOIL ACTION

The force of the propelling charge, which shoots the projectile forward, also kicks the bolt backward. The bolt is locked to the barrel extension by the breech lock. So the three recoiling parts—bolt, barrel, and barrel extension—start back together.

The barrel and barrel extension speed backward with as much momentum as a small truck. The gun's first job is to stop them.



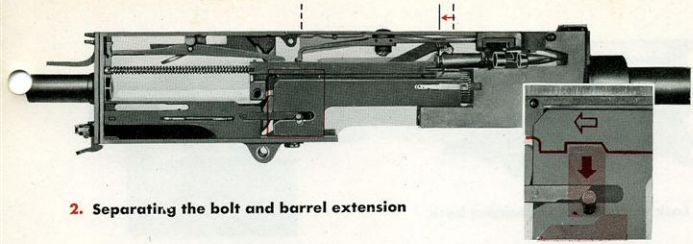
1. Slowing down the barrel group

The barrel extension shank, which is always hooked to the oil buffer piston rod, immediately begins forcing the piston rod back into the oil buffer tube.

Pushing against the oil, the piston head and valve are forced together, closing the six holes in the piston head. Now the only way the oil can escape to the other side of the head and valve is through two narrow slots, called **restricted openings,** on each side of the head and the valve—and the piston rod head can move only as fast as the oil escapes.

This **hydraulic action**, helped by the oil buffer spring, absorbs the recoil of the barrel and barrel extension. They are almost stopped by the time they hit the front of the oil buffer body.

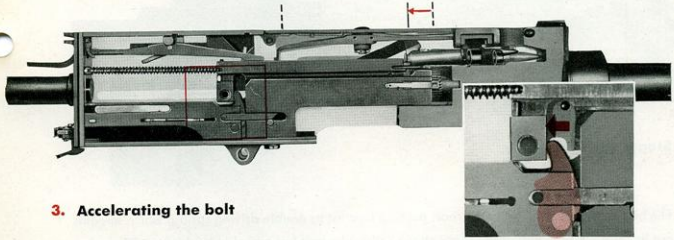
While this is going on, the next job is to unlock the bolt from the barrel extension so the bolt can pull the empty case from the chamber and leave space to feed the next round into the chamber.



2. Separating the bolt and barrel extension

As the barrel extension travels back, the breech lock pin hits the slanted surfaces of the breech lock depressors, forcing the breech lock down just as it moves off the breech lock cam. The bolt is completely unlocked from the barrel extension at about ¾ inch of recoil, and begins pulling the empty case from the chamber.

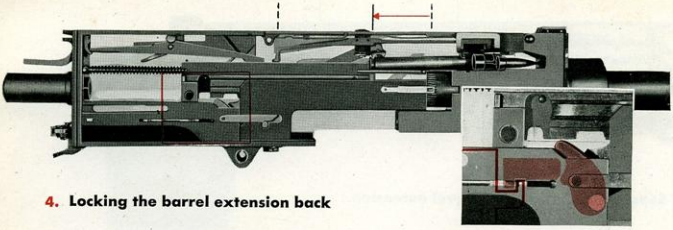
In order to complete the recoil and counter recoil action as rapidly as possible, the next job is to speed up the bolt.



3. Accelerating the bolt

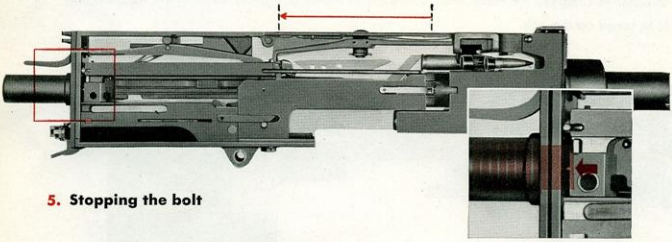
The barrel extension hits the rounded front of the accelerator, turning it backward. The accelerator tips hit the lower projection on the bolt, giving the bolt a powerful boost to the rear. In this way the accelerator serves as an **energy transmitter**. It also acts as a **timing device**, because the transfer of energy slows down the barrel extension and speeds up the bolt.

At this point the barrel and barrel extension have almost finished the 1⅛ inches of their recoil, but the bolt still has to go all the way to the back plate. The next job is to hold the barrel extension back at the end of its recoil and make it wait for the bolt, so that all the recoiling parts will return to battery position at the same time.



4. Locking the barrel extension back

As the accelerator turns backward, its locking lugs move down until the shoulders of the barrel extension shank are clamped between the locking lugs and the underside of the accelerator. The accelerator thus acts as a **locking device,** holding the barrel extension against the oil buffer body at the end of its recoil stroke. The oil buffer spring is locked back in a compressed position.

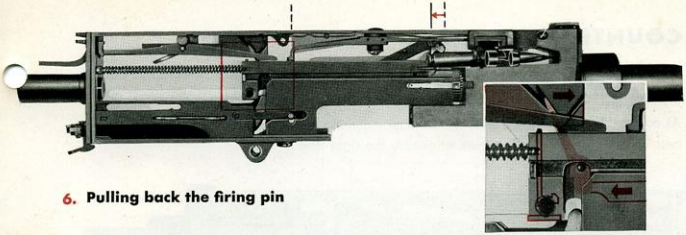


5. Stopping the bolt

The bolt continues to travel to the rear, pushing against its double driving spring, which smooths out its action. At the end of the recoil stroke—after the bolt has traveled back about 7⅛ inches—it hits the buffer plate and jams it against the buffer disks, which absorb the force of the blow.

COCKING ACTION

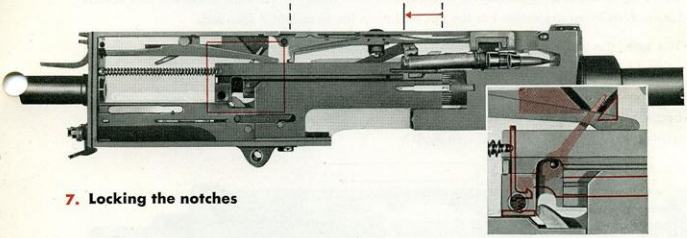
During the bolt's recoil, the gun is also being cocked. This involves two main steps: the firing pin must be drawn back against its spring, and the notch on the firing pin extension must be hooked to the sear notch to hold the firing pin back. In addition, there must be some way of preventing the gun from firing too soon if the firing pin notch should accidentally slip off the sear notch.



6. Pulling back the firing pin

When the gun is in battery position, the top of the cocking lever is resting on the rear cocking lever cam—the back half of the V-slot. As the bolt begins to move back, the top of the cocking lever is forced forward and its lower end is pivoted backward.

This lower end sticks through a slot in the firing pin extension. Its heel presses the firing pin extension backward, compressing the firing pin spring against the sear stop pin.



7. Locking the notches

A little farther back, the firing pin notch overrides the sear notch, forcing the sear down. The sear spring forces the sear back up, and the two notches are interlocked.

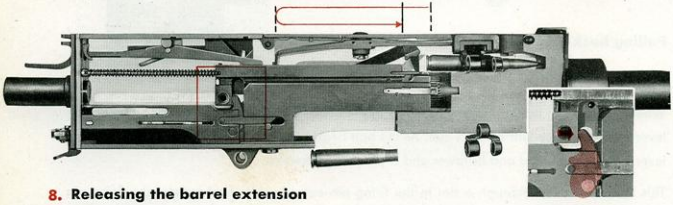
The cocking lever continues to push the firing pin extension back a little farther than is actually necessary, to make sure the two notches will engage even if the heel of the cocking lever or the camming surface of the firing pin extension is worn. This extra distance is called **overtravel.**

The cocking lever also makes it impossible for a round to be fired too soon, even if some defect in the gun should accidentally release the firing pin during recoil or counter recoil. As long as the heel of the cocking lever is in the path of the firing pin extension, the pin cannot go all the way forward even if it slips off the sear notch. This protection, called **fire control**, is in effect as soon as the bolt has moved back from battery position a short distance.

COUNTER RECOIL ACTION

At the end of recoil, the bolt hits the buffer plate hard enough to bounce forward into battery position without help. Its driving spring serves chiefly to smooth out the counter recoil action.

As counter recoil starts, the barrel and barrel extension are still locked back, waiting for the bolt. The first job is to unlock them at exactly the right time.

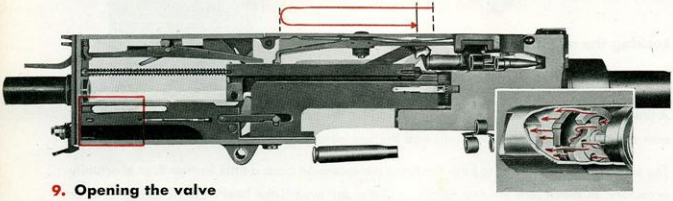


8. Releasing the barrel extension

At the start of recoil, the tube lock in the oil buffer body is keeping the accelerator tips from bouncing up too soon and catching in the breech lock recess of the bolt. But as the bolt speeds forward, its lower projection hits the tips and turns the accelerator forward.

This turns the locking lugs back out of the way and releases the barrel extension, which is pushed forward by the oil buffer spring and starts its own counter recoil.

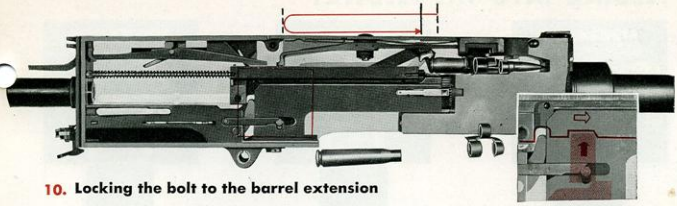
The front of the accelerator also pushes against the barrel extension and gives it an additional boost forward. This time the accelerator slows down the bolt and speeds up the barrel extension—just the opposite of its job on recoil.



9. Opening the valve

As the barrel extension starts forward, it pulls the piston rod head and valve through the oil buffer. But this time the valve drags behind the piston head. The oil can flow through the six holes—called **throttling ports**—in the piston rod head, and through the space at the center of the valve, as well as through the restricted openings at the sides. This permits faster forward movement of the barrel and barrel extension.

The bolt and barrel extension are now nearly together, with the bolt still traveling a little faster than the barrel extension. The next job is to lock them together.



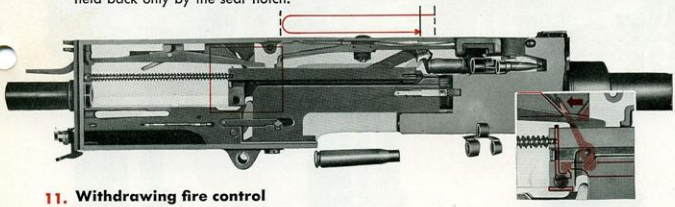
10. Locking the bolt to the barrel extension

The bottom of the breech lock hits the breech lock cam on the bottom of the receiver and is forced up into the breech lock recess of the bolt, which has moved over it just in time.

The bolt, barrel extension, and barrel are now locked together. They are approximately ¾ inch away from battery position, and they travel the rest of the way together.

COCKING ACTION

Cocking action continues all through counter recoil. The tip of the cocking lever hits the front cocking lever cam—the forward half of the V-slot—and starts pivoting backward. This moves the heel of the cocking lever forward until overtravel is eliminated and the firing pin notch is held back only by the sear notch.



11. Withdrawing fire control

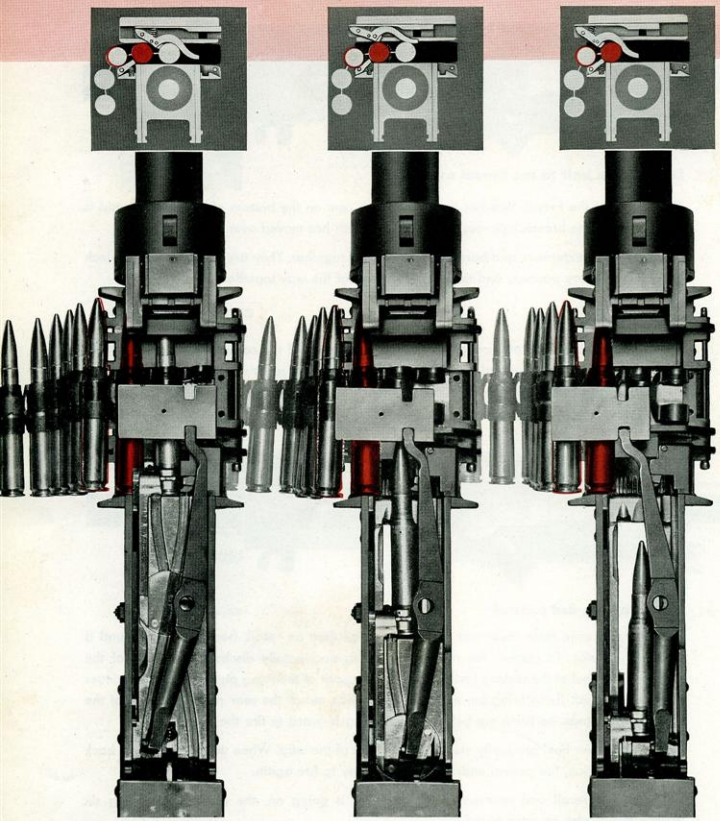
Fire control is even more important on counter recoil than on recoil, because a live round is now in the T-slot. To prevent the round from being accidentally discharged outside of the chamber, the heel of the cocking lever remains in the path of the firing pin as the bolt continues to travel forward. If the firing pin notch somehow slips out of the sear notch, the heel of the cocking lever stops the firing pin before it can spring forward to fire the round.

The cocking lever heel gradually moves forward out of the way. When the bolt is almost back in battery position, fire control ends. The gun is ready to fire again.

While all this recoil and counter recoil movement is going on, the gun is performing six **major functions** on each round:

1. Feeding it into the feedway.
2. Extracting it from the belt.
3. Feeding it into the chamber.
4. Firing it.
5. Extracting it from the chamber.
6. Ejecting it.

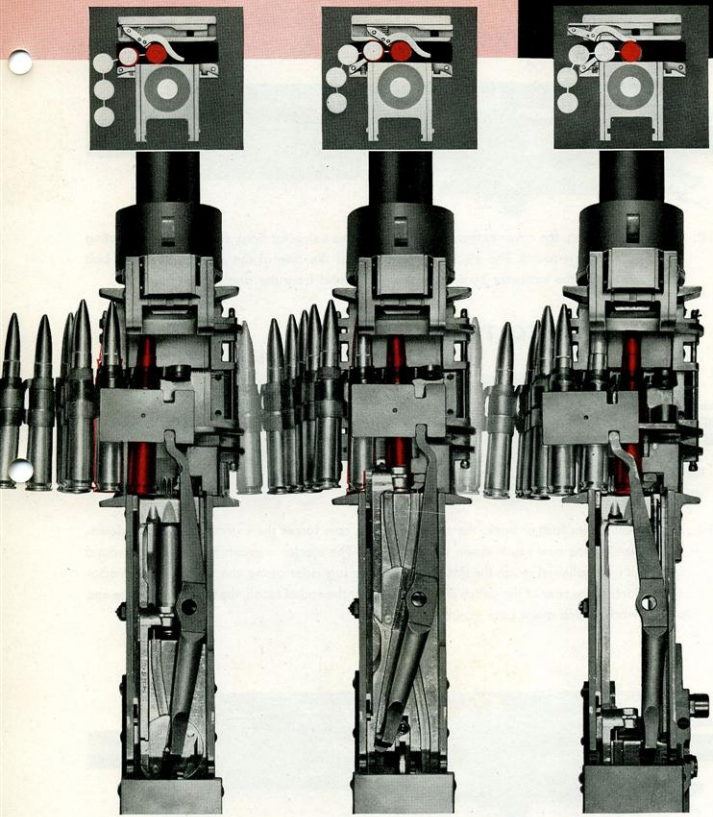
FEEDING INTO THE FEEDWAY



12. When the bolt is forward in battery position, the belt feed slide is in the cover; the ammunition belt is held by the belt feed pawl and belt holding pawl.

13. As the bolt recoils, its cam grooves guide the belt feed lever lug, pivoting the lever and moving the slide out the side of cover. The belt is held stationary by the belt holding pawl while the belt feed pawl pivots, compressing its spring, and rides up over the link holding the next round.

14. At full recoil, the belt feed slide moves out enough to permit the belt feed pawl spring to snap the pawl down behind the new round.

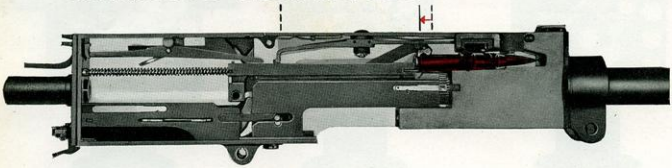


15. As counter recoil starts, the belt feed lever begins moving the slide back into the receiver. The belt is pushed in by the belt feed pawl. The next round rides over the belt holding pawl, forcing it down and compressing its spring.

16. When the bolt is back in battery position, the slide is all the way back in the gun. The belt holding pawl is snapped up behind the second round by its spring.

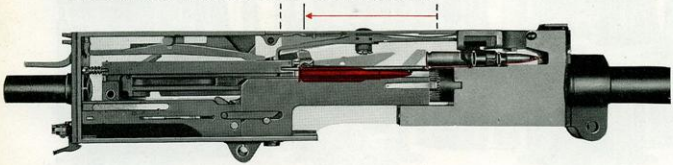
17. If for any reason the round that was in the feedway was not extracted from the belt, the belt feed pawl arm rides over it, holding up the belt feed pawl to prevent double feeding.

EXTRACTING FROM THE BELT

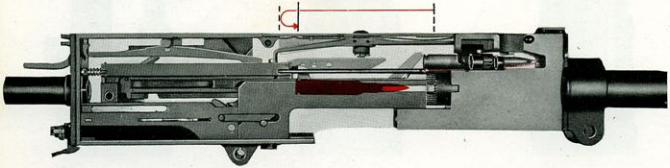


18. In battery position, the cover extractor spring holds the extractor hook firmly in the extracting groove of the new round. The ejector presses against the side of the round. When the bolt begins to recoil, the extractor hook pulls the new round from the ammunition belt.

FEEDING INTO THE CHAMBER

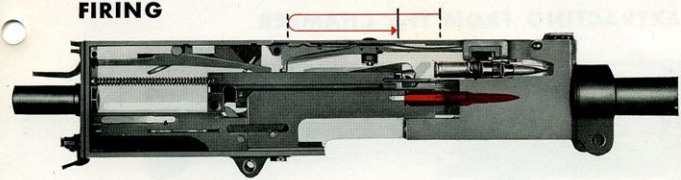


19. As the bolt moves farther back, the cover extractor cam forces the extractor assembly downward, pushing the new round down into the T-slot. The ejector supports the side of the round to keep it from falling through the slot. The extractor lug rides along the top of the extractor switch, forcing the rear of the switch downward. Near the end of recoil, the lug moves off the end of the switch, which snaps back up into position.

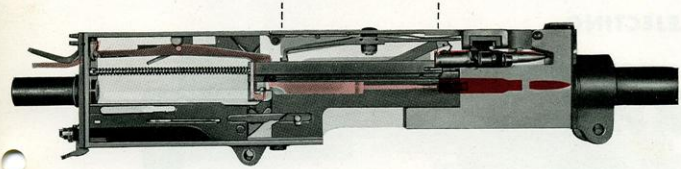


20. At the start of counter recoil, the camming surface on the bottom of the extractor switch forces the extractor assembly farther down. The extractor stop pin on the left side of the bolt keeps the assembly from going too far down, and the new round thus is lined up with the chamber.

FIRING

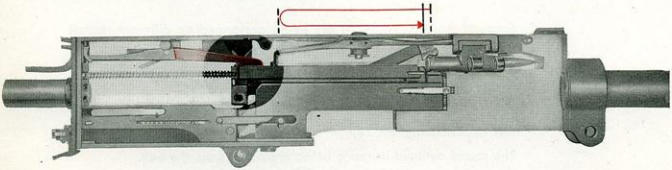


21. When the new round is part way in the chamber, the extractor lug hits the extractor cam, forcing the extractor assembly up over the next round in the feedway. The face of the bolt, ending its counter recoil stroke, pushes the round all the way into the chamber.



22. When the trigger is pressed, it raises the rear of the trigger bar, pivoting the front end down against the sear tip.

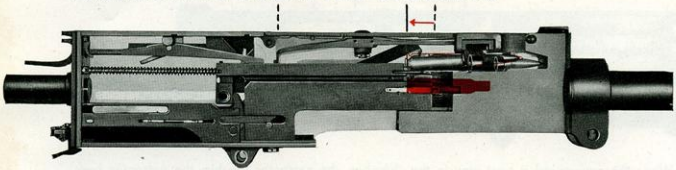
The sear notch releases the firing pin notch and the firing pin snaps forward. The sear spring forces the sear back up into position.



23. The front end of the trigger bar remains down as long as the trigger is pressed. In automatic fire, when the bolt is almost back in battery position, the sear tip rides under the forward tip of the trigger bar and is cammed down to fire the gun.

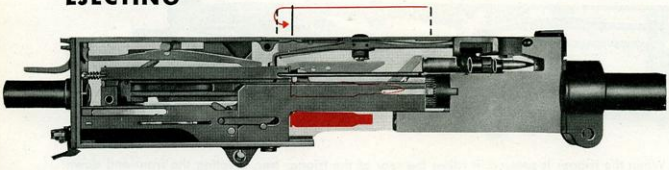
Automatic firing continues as long as the trigger is held down, and stops when the trigger is released. Any number of rounds, from one shot up to long bursts, can be fired.

EXTRACTING FROM THE CHAMBER



24. As soon as the bolt is unlocked from the barrel extension on recoil, the T-slot begins pulling the empty case out of the chamber. The case is free of the chamber before the end of recoil.

EJECTING



25. As the new round is forced down toward the center of the T-slot at the start of counter recoil, it pushes the empty case out the bottom of the gun. The last empty case in an ammunition belt is pushed out by the ejector.

Some of these six functions are being performed on different rounds during each recoil and counter recoil stroke.

In battery position (Diagram 22, Page G-61):

The red round is fired.

On recoil (Diagram 24):

The round outlined in red is being extracted from the belt.
The empty case of the red round is being extracted from the chamber.

On counter recoil (Diagram 25):

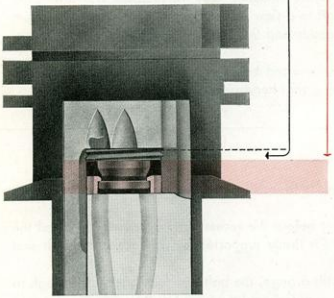
The empty case of the red round is being ejected.
The round outlined in red is being fed into the chamber.
The gray round is being fed into the feedway, against the cartridge stops.

ADJUSTMENTS

To keep the caliber .50 working properly, four adjustments must be kept accurate. The gun must be adjusted for **headspace** and **timing.** The **oil buffer** and the **buffer adjusting screw** must be set properly.
The purpose and method of these adjustments are described in the next ten pages. Also shown here is another set of adjustments which must be made in **changing the direction of feed.** In most cases, diagrams in this section are exaggerated for the sake of clarity.

HEADSPACE ADJUSTMENT

Although there are other more technical definitions of headspace, for all practical purposes it is simplest to think of the headspace of the caliber .50 machine gun as **the distance between the face of the bolt and the breech end of the barrel, when the bolt has been pulled back enough to prevent any play at the breech lock.**
This distance, which can be measured with a headspace gage, **is regulated by the distance the barrel is screwed through the barrel extension.**



When headspace is too tight, the bolt cannot operate efficiently, the action becomes sluggish, and the gun may stop—or it may not even go into battery position at all.

When headspace is correct, the gun can go into battery, the round is properly supported in the chamber, and the bolt operates efficiently.

When headspace is too loose, the parts are battered and the round is so improperly supported in the chamber that the case may be blown apart when the gun is fired.

Your machine gun is such a precision-built instrument that it cannot work properly unless headspace is correct to within thousandths of an inch. The next six diagrams, showing top and side views of the gun with varying headspace adjustments, explain why.

RESULTS OF HEADSPACE ADJUSTMENT

Excessively tight headspace

occurs when the breech end of the barrel projects so far back that the bolt's forward movement is stopped before its breech lock recess has moved over the breech lock. As a result, the breech lock cannot move up all the way into its recess, and the bottom of the breech lock cannot get up over the breech lock cam. This prevents the barrel extension from going forward into battery—when the cover is raised, you will see a space between the front of the barrel extension and the trunnion block.

The bolt may be so far back that the gun will not fire at all. At best, the gun will fire one shot and stop, because the extractor assembly cannot reach the ammunition belt to pull out a new round.

Tight headspace

occurs when the bolt goes forward barely enough to permit the breech lock to enter the recess.

The front of the breech lock is held tightly against the front of the breech lock recess. The bolt, which can operate smoothly only when there is a little play between lock and recess, gets off to a slow start on recoil. The action of the gun is sluggish; it may fire a few rounds and then stop. It is unable to pull a heavy ammunition belt.

The headspace gage cannot be inserted between the face of the bolt and the breech end of the barrel, showing that headspace is too tight.

Correct headspace

allows just a little play between the breech lock and the front of the breech lock recess.

The bolt gets off to a head start before the recess hits the breech lock, and the gun works efficiently. The round is firmly supported by the face of the bolt and the shoulders of the chamber.

Before measuring headspace with a gage, the bolt is drawn back just enough to take up the play between the breech lock and the breech lock recess. The distance between the face of the bolt and the breech of the barrel is then just large enough for the headspace gage to enter, showing that headspace is correct.

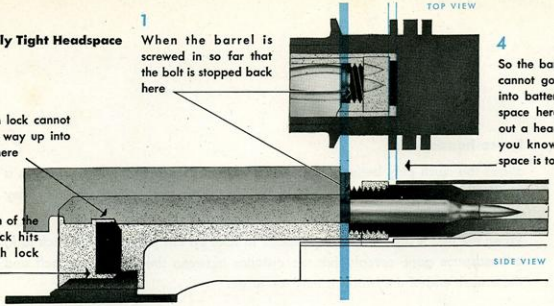
Excessively Tight Headspace

1 When the barrel is screwed in so far that the bolt is stopped back here

2 The breech lock cannot go all the way up into its recess here

3 The bottom of the breech lock hits the breech lock cam here

4 So the barrel extension cannot go all the way into battery—there is a space here. Even without a headspace gage, you know that headspace is too tight.

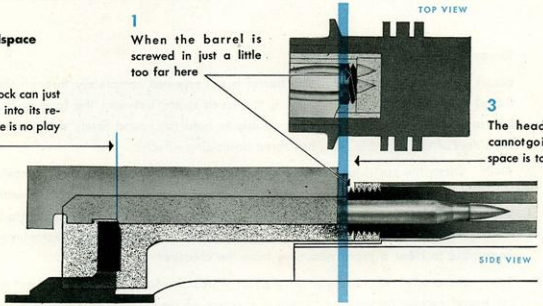


Tight Headspace

1 When the barrel is screwed in just a little too far here

2 The breech lock can just barely move into its recess and there is no play here

3 The headspace gage cannot go in here—headspace is too tight.

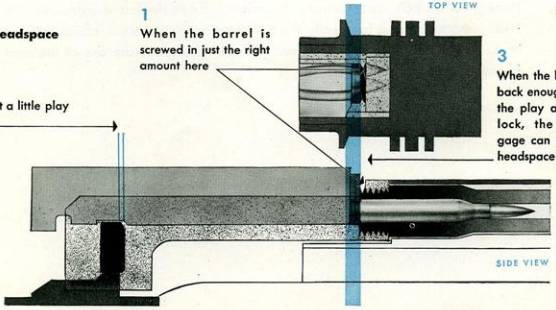


Correct Headspace

1 When the barrel is screwed in just the right amount here

2 There is just a little play here

3 When the bolt is drawn back enough to take up the play at the breech lock, the headspace gage can go in here—headspace is correct.



Loose headspace

allows too much play between the breech lock and the breech lock recess. As a result, these two parts and the breech lock cam take such a battering that they are soon unfit for service.

When the bolt is drawn back far enough to take up this play at the breech lock, a headspace gage reveals that the distance between the face of the bolt and the breech end of the barrel is now too large.

Excessively loose headspace

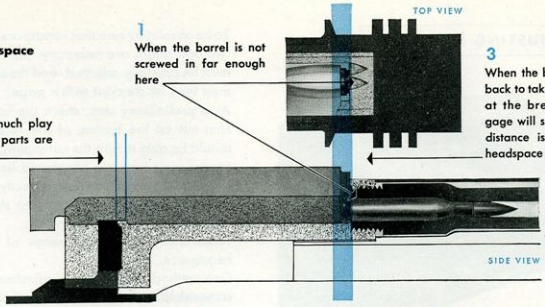
occurs when the breech end of the barrel is not screwed completely through the barrel extension. As a result, there is too much space between the face of the bolt and the barrel, and the bolt is unable to hold the round firmly against the shoulders of the chamber. This has three damaging effects:

One: Often the cartridge case, unsupported by the shoulders of the chamber, is blown apart by the exploding charge. This may result in a separated case, with the tip blown off and left in the chamber after the rest of the case is extracted, or a split case, cracked along the sides. In combat it is difficult and sometimes impossible to clear a separated case from the chamber.

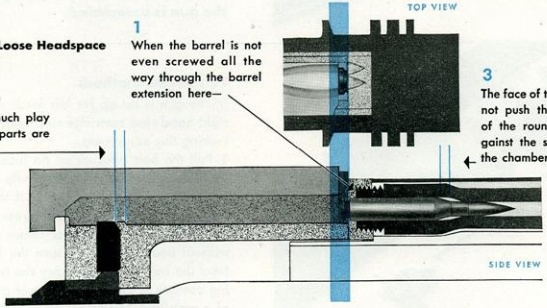
Two: Since some of the expanding gases which should drive the bullet out of the barrel escape around the breech, the range of the gun is cut down and the flight of the bullet becomes inaccurate, resulting in a less concentrated shot pattern.

Three: As the bolt slams forward into battery, it hits the barrel extension. The T-slot is battered, and frequently the barrel extension is broken about halfway back. Broken barrel extensions caused by loose headspace are one of the most frequent combat breakdowns.

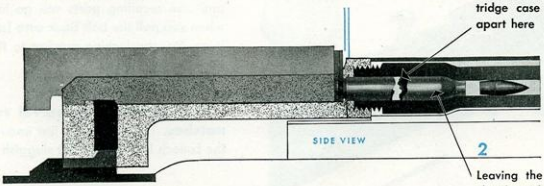
Loose Headspace



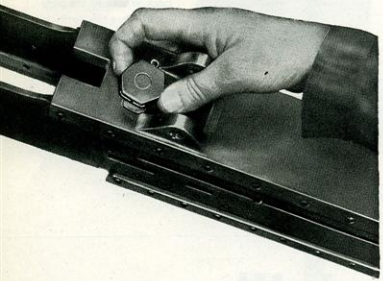
Excessively Loose Headspace



Results of Excessively Loose Headspace



ADJUSTING HEADSPACE



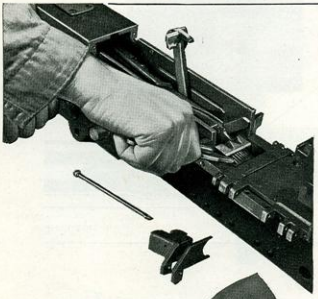
To be absolutely sure that headspace is correct, two operations are necessary: the headspace must be carefully adjusted, and the adjustment must then be checked with a gage.

As a preliminary step, check the breech lock cam nut on the bottom of the receiver. You should be able to turn the nut slightly with your fingers, and its cotter pin should be in place. If the breech lock cam is not correctly installed, have the ordnance or armament shop check it at once.

There are two different ways of adjusting headspace.

One method of making the adjustment **while assembling the gun** was described on page G-34.

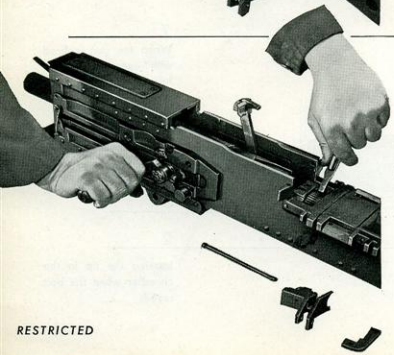
It is also possible to adjust headspace **after the gun is assembled.**



To use this method:

(If the gun is set up for left feed, remove the right-hand rear cartridge stop assembly while making this adjustment.)

1 Pull the bolt back about an inch and let it go. If the parts do not return fully to battery position, proceed with Step 2. If they do return fully to battery position, screw the barrel in until the parts no longer return to battery without being forced. To turn the barrel, retract the bolt slightly and pry the barrel locking notches to the left with a tool or the point of a cartridge. Then . . .



2 Unscrew the barrel **one notch at a time** until the recoiling parts will go into battery when you pull the bolt back **one inch** and let it go. Pry the locking notches to the right to unscrew the barrel.

3 Then **unscrew the barrel two more notches.** This will allow just enough play at the breech lock to prevent sluggish action.

CHECKING HEADSPACE

After adjusting headspace by either of the two methods, check the adjustment with a gage before firing the gun. Two gages for checking headspace are now in use:

The old gage (A196228) is a one-piece combination headspace and timing gage. The end marked *HEADSPACE—.200* is a GO gage for checking headspace. The end marked *TIMING —.116* is a *NO FIRE* gage for checking timing. The new gage (A351211) is a double-ended GO—NO GO headspace gage. It comes attached to two timing gages, *FIRE* (A351214) and *NO FIRE* (A351213), to make up headspace and timing gage assembly A351217. One advantage of the new gage is that it can be inserted through the bottom of the receiver to check headspace in turrets where the cover of the gun cannot be raised all the way.

Never release the firing pin with the headspace gage in place; the firing pin will be damaged.

To check headspace with a gage:

1 Cock the firing pin by charging the gun and letting the parts go fully into battery.

2 Back off the bolt slightly—not more than 1/16th of an inch—to relieve the pressure of the driving spring and take up play between the breech lock and breech lock recess. Then...

WITH THE OLD GAGE

3 Check for tight headspace by inserting the headspace end of the gage into the T-slot, between the face of the bolt and the breech end of the barrel.

4 If the gage does **not** go in, headspace is too tight; unscrew the barrel one notch at a time until the gage just goes in without being forced.

5 If the gage **does** go in easily the first time, **check for loose headspace** by screwing the barrel in, one notch at a time, until the gage will not enter. Then unscrew the barrel **one** notch so the gage can enter.

6 Remove the gage and release the firing pin.

WITH THE NEW GAGE

3 Check for tight headspace by inserting the GO end of the headspace gage into the T-slot, between the face of the bolt and the breech end of the barrel.

4 If the gage does **not** go in, headspace is too tight; unscrew the barrel one notch at a time until the gage just goes in without being forced.

5 If the gage **does** go in easily the first time, **check for loose headspace** by trying to insert the *NO GO* end of the gage into the T-slot. If this end of the gage does **not** go in, headspace is correct. If it **does** go in, tighten the barrel one notch at a time until the *NO GO* end will not enter. When headspace is correct the GO end of the gage must **just** go in and the NO GO end of the gage must **not** go in.

6 Remove the gage and release the firing pin.

WITHOUT A GAGE

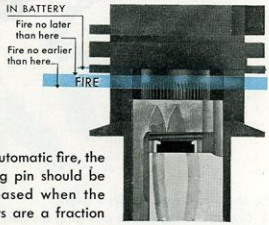
No method of setting headspace will always give correct headspace adjustment. The adjustment should always be checked. A fairly accurate check can be made without a gage.

1 Charge a dummy round into the chamber. Raise extractor and pull back on it. There should be an extremely small amount of rearward motion of the bolt before the barrel extension starts rearward. This independent rearward movement of the bolt should not be more than the slightest possible movement.

2 If no dummy is available follow the same procedure. The independent rearward movement of the bolt should be slightly greater than when a dummy is used but it should be very slight.

3 With practice these methods of checking headspace are very accurate.

TIMING ADJUSTMENT



In automatic fire, the firing pin should be released when the parts are a fraction of an inch out of battery position. To be exact, the gun should be less than 0.116 ($\frac{116}{1000}$) of an inch out of battery, but not less than 0.020 ($\frac{20}{1000}$) of an inch out of battery, when it fires.

Results of incorrect adjustment

If the gun is 0.116 of an inch or more out of battery when it fires, it fires too early. It will fire two shots and then stop, because the recoil from the second shot starts before the extractor hook can reach the cartridge in the feedway. If the gun is less than 0.020 of an inch out of battery when it fires, it fires too late. The rate of fire is slowed down. The barrel extension batters the trunnion block as the parts slam into battery position.

Checking the timing

1 Adjust and check headspace.
2 Cock the firing pin by charging the gun and letting the parts go fully into battery.
3 Retract the recoiling parts about a quarter inch. Then . . .

With the Old Gage

4 Check for early timing by inserting the timing end between the front of the barrel extension and the trunnion block, with the curved part of the gage resting over the barrel. Let the barrel extension close slowly on the gage. Then press the trigger. If the firing pin is released, firing is too early.

5 If the firing pin is not released, **check for late timing** by obtaining a 0.020-inch feeler gage and inserting it between the barrel extension and trunnion block. If the firing pin does not release, firing is too late.

With the New Gage

4 Check for early timing by inserting the *NO FIRE* leaf of the gage assembly between the front of the barrel extension and the trunnion block. Let the barrel extension close slowly on the gage. Then press the trigger. If the firing pin is released, firing is too early.

5 If the firing pin is not released, **check for late timing** by inserting the *FIRE* leaf between the barrel extension and trunnion block. If the firing pin does not release, firing is too late.

If you find that the timing is too early or too late, try installing different trigger bars until you find the one that works. If you are unable to obtain the correct timing this way, don't try to file or bend a trigger bar—take the gun to ordnance for the necessary repairs.

OIL BUFFER ADJUSTMENT

When you turn the oil buffer tube, the valve inside the tube also turns because the valve key is held in a slot in the side of the tube. Turning the valve changes the size of the restricted openings. Increasing the size of the openings lets the piston push back through the oil more rapidly on recoil. Decreasing them slows up the piston.

The openings are largest, and the rate of fire is most rapid, when the slots in the side of the valve are in line with the slots in the side of the piston head. This is the proper adjustment for aircraft machine guns, regardless of temperature and altitude, in all cases where the buffer tube has been filled with the correct oil (Recoil Oil 2-36, latest issue).

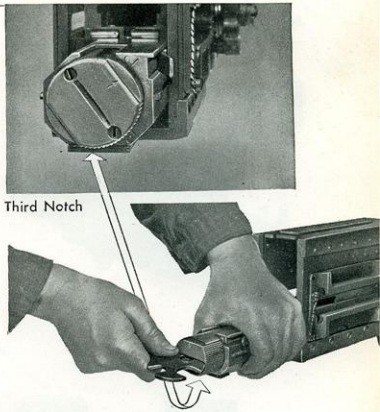
Results of improper adjustment

If the restricted openings are too small, the rate of fire will be too slow. The gun's action may stop part way back on recoil.

Making the adjustment

Because of differences in the manufacture of machine guns, the openings are not necessarily at their widest when the arrow on the buffer tube points to the O (for *OPEN*). The only way to be sure the adjustment is correct is to see that the tube lock protrusion is in the **third notch from the left** at the bottom of the tube.

Because it is difficult, if not impossible, to make this adjustment when the gun is assembled, remove the oil buffer group and put it on the table. Then, even if you are blindfolded or working in the dark, it is easy to turn the tube to the left (counterclockwise) until the clicking stops, then turn it to the right (clockwise) until you hear three clicks.



Emergency check

The oil buffer can be roughly checked in combat without removing the back plate of the gun or its adapter. Simply squint through the hole in the back plate and check the angle of the slot on the rear of the oil buffer tube. If the slot is in the same position as the two hands of a clock at 5 minutes to 5, the setting is approximately correct.

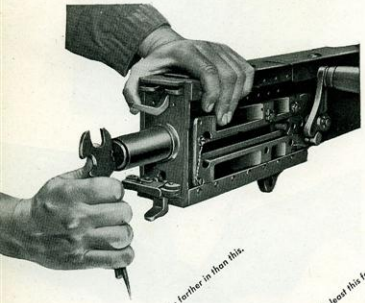
BUFFER ADJUSTING SCREW ADJUSTMENT

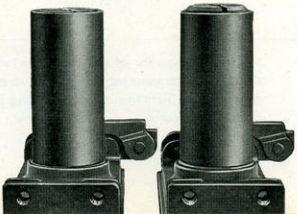
Tightening the buffer adjusting screw increases the pressure on the buffer disks; loosening the screw decreases the pressure.
There are usually 22 disks in the tube. If they are too worn, or if there are too few of them, the adjusting screw will go in too far. If there are too many disks, or if they are not seated properly, the screw will not go in far enough.

Results of improper adjustment

If the screw is too tight, or if the disks are too worn, they are unable to cushion the shock of the recoiling bolt. The pounding of the bolt may strip the threads off the adjusting screw and drive it out the rear of the buffer tube, or shear off the sides of the back plate and force it off the back of the receiver.
If the adjusting screw is too loose, or if there are too few disks, the bolt will batter against the back plate instead of the buffer plate, and may break the back plate and drive it off the receiver.

Making the adjustment





Tighten the buffer adjusting screw as tight as you can, using a caliber .50 combination wrench if one is available. Remove the back plate and press on the buffer plate to make sure it is held firmly in position.

The adjustment is correct when the end of the screw does not go inside the tube, nor stick out more than one thread.

If the adjusting screw goes in so far that its end is inside the buffer tube, the disks have become worn and flattened, or too few disks have been inserted. Instead of adding one new disk yourself, have ordnance check the condition of the disks and replace them all if necessary.

If, after the screw is tightened as much as possible, you can see more than one thread, make sure that the disks and buffer plate are properly seated, and that you have not inserted too many disks. If the screw still sticks out too far, have ordnance make the necessary repairs.

CHANGING THE DIRECTION OF FEED

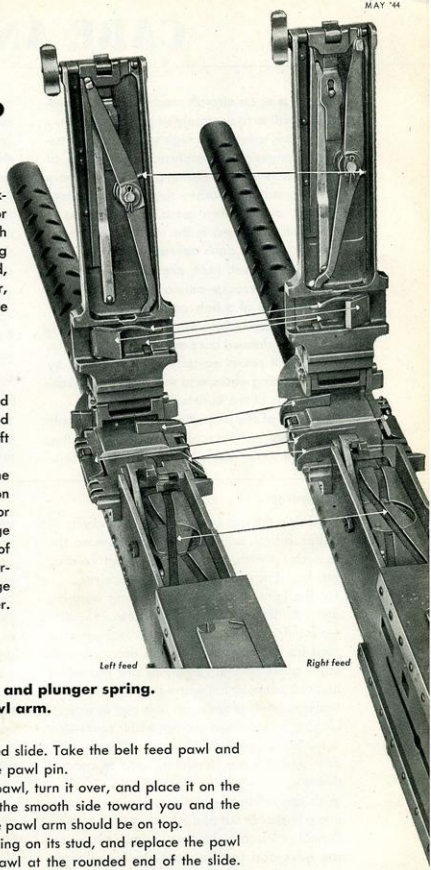
IN THE BOLT GROUP

Change the bolt switch. Lift out the extractor assembly and turn the bolt switch. For left hand feed, the narrow end of the switch goes to the rear, providing a clear track along the cam groove marked *L*. For right hand feed, the wide end of the switch goes to the rear, providing a clear track along the groove marked *R*.

IN THE RECEIVER

Change the belt holding pawl. It should go on the same side as the direction of feed —right side of the receiver for right feed, left side for left feed.

Change the cartridge stops. Since the rounds are fed in against them, they go on the side opposite the direction of feed. For right feed, put the front and rear cartridge stops and the link stripper on the left side of the receiver. For left feed, put the front cartridge stop and the right-hand rear cartridge stop assembly on the right side of the receiver.



Left feed *Right feed*

IN THE COVER GROUP

Change the { **belt feed lever plunger and plunger spring.**
belt feed pawl and pawl arm.
belt feed slide.

1. Remove the belt feed lever and belt feed slide. Take the belt feed pawl and pawl spring off the slide by drifting out the pawl pin.

2. Take the pawl arm off one side of the pawl, turn it over, and place it on the other side. When you hold the pawl with the smooth side toward you and the pointed end facing the direction of feed, the pawl arm should be on top.

3. Turn the pawl around, put the pawl spring on its stud, and replace the pawl in the slide, with the pointed end of the pawl at the rounded end of the slide. Insert the slide in the cover with the pawl arm on top.

4. Replace the belt feed lever plunger and plunger spring—in the upper hole for left hand feed, or lower hole for right hand feed. Replace the belt feed lever on its stud, and make sure the plunger and spring hold the slide in the cover.

CARE AND CLEANING

The parts of an aircraft machine gun are precision built to fit as closely as possible, yet they must work together at high speeds and in extreme ranges of temperature. Dirt, moisture, or grease between the moving parts—even in very small quantities—causes sluggish guns, stoppages, and broken parts. Small burrs — scratches or gouges in the metal—also can interfere with the gun's operation.

Inside the barrel, heat, pressure, and friction produce tiny cracks—only a twelfth as deep as the thickness of a hair and almost impossible to see—in the surface of the bore. Although a carelessly cleaned bore may look all right, the cracks will retain moisture, the waste left by the exploding gases, and smears of metal from the jackets of the bullets. The result: rust.

Explosion of the propelling charge leaves only an almost harmless ash. But the exploding primer mixture leaves a salt—potassium chloride—similar to ordinary table salt. This primer salt, which quickly absorbs moisture from the air, is deposited in the chamber and bore, in the recesses of the bolt, and around the front part of the receiver.

These parts will rust very quickly if primer salt is left on them. The salt is not affected by oil; if a gun is oiled without being carefully cleaned, the salt continues to absorb moisture even when covered with oil.

Therefore the gun must be cleaned, and cleaned thoroughly, immediately after every mission.

Since aircraft guns are only lightly oiled, condensation of moisture will cause rusting even of a perfectly clean gun.

Therefore every gun of every aircraft should be cleaned every day, whether it has been used or not.

Cleaning

Field strip the gun and detail strip the bolt, oil buffer, barrel, and cover groups. Remove the extractor switch, switch spring, belt holding pawl, and pawl springs from the receiver.

For the bore of the barrel, the best cleaning agent is rifle bore cleaner (Spec. No. RIXS205) —a combination solvent and preservative issued for combat use. If that is not available, other good cleaning solutions are hot water and G.I. soap, or hot water and soda ash (1½ tablespoonfuls of soda ash to a pint of water). Lacking any of these, use hot water alone—or, if necessary, even cold water. "White spirits" and kerosene are frequently used in combat theaters.

With any of these solutions, put the muzzle into a bucket or vat of the fluid. Attach a clean flannel patch to a cleaning rod and move the rod back and forth through the barrel from the breech end for about a minute, pumping the cleaner in and out.

If a brass or bronze wire brush is available, run it through the barrel three or four times while the bore is still wet. Pump the cleaning fluid through the barrel again to clean it. Dry the cleaning rod and use clean, dry flannel patches to swab the bore until it is perfectly dry and clean. Dry and clean the chamber, using a patch on a pointed stick if necessary. Finally, pull a clean patch smoothly through the bore and chamber, letting the cleaning rod and patch turn with the rifling.

The bearing surface of the barrel—the flat part that slides in the front barrel bearing—should be cleaned and shined with crocus cloth to remove deposits and prevent binding. In an emergency, a fine oil stone can be used instead of crocus cloth.

Clean other parts of the gun with rifle bore cleaner, dry cleaning solvent (Spec. No. RIAES12), "white spirits" or kerosene. Thoroughly clean every part with a brush or rag to remove all dirt, moisture, and primer salts.

Clean and flush the recesses in the bolt, using a long brush or a rag on a pointed stick. Dirt, moisture, or primer salts left in the firing pin

Cleaning rod

O.S. 1361

Oil can

Oil can with flexible nozzle

Crocus cloth

Oil stone

Cleaning brush

Wire brush

Cleaning rod kit

Cleaning patches

port will result in "light struck primers"—the firing pin will be slowed down and will not dent the primers enough to fire.

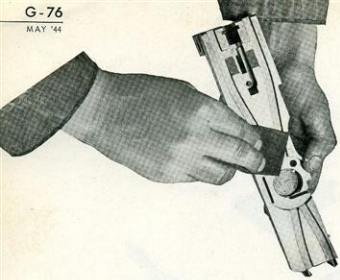
Other parts of the bolt requiring special attention are the hole for the driving spring, the T-slot, the breech lock recess, and the recesses at the rear of the bolt.

Wash the back plate group and oil buffer tube assembly with the cleaning solution but do not soak them, since the fluid will damage the buffer disks and the oil buffer packing.

Wipe off the casing, being careful to remove all deposits from the extractor switch recess, the area around the breech lock cam, and the front barrel bearing.

After the parts have been cleaned, dry them with a clean, lintless rag. Don't touch them with your bare hands until they have been oiled—fingerprints contain an acid which causes corrosion. If cloth gloves are available, wear them while oiling the gun. If gloves are not available, keep your hands covered with oil while handling the parts.

When a new part is issued, examine it carefully for any traces of cosmoline, a heavy grayish-brown rust-preventive compound occasionally used in shipping guns and parts. Have ordnance remove any cosmoline you find.

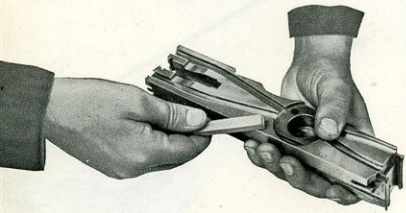


Removing rust

Any rust, especially at points where metal parts rub against each other, will prevent smooth operation. Remove it with crocus cloth or similar material. If the rust is pitted, remove it with a fine oil stone obtained from your crew chief or from armament or ordnance. Don't use sandpaper, carborundum, or a coarse stone.

Removing burrs

Any burrs or scratches must be polished off, especially where metal surfaces are in contact. First use a medium oil stone to remove the burr. Always rub in the direction the part has been worn, instead of working crosswise. Then use a finer stone to smooth out the surface and give it a polish.



Oiling

Oil must be applied carefully to avoid any "freezing" in the extremely cold temperatures of high altitudes.

If the gun is assembled dry, sub-zero temperatures will produce a metal-to-metal freeze almost impossible to break apart. Too much oil is just as bad, for it picks up moisture which freezes inside the oil and locks the moving parts together.

When oil is applied properly, there is just a film over each part. Even if particles of moisture freeze inside the gun, the oiled parts will slide over the ice like skates.

Regardless of weather conditions at ground level, **oil the gun with O.S. 1361,** a special lubricating oil for aircraft instruments and machine guns. To get the right amount of oil on the gun, wipe each part with a rag that has been well-oiled with O.S. 1361. Oil the barrel bore and chamber by swabbing them with a well-oiled patch.

If the gun is to be out of service for a few days, use engine oil SAE 30 to protect the barrel. For longer storage, use a light rust preventive compound instead of oil. The gun must be thoroughly cleaned and re-oiled with O.S. 1361 before being used again.

Desert Precautions

In theaters where airfields are dusty and sandy, special care must be taken to keep sand and dirt out of the cleaned guns.

Your gun should never be left in the bomber between missions. If it is necessary to leave it in, be sure it is well covered.

As soon as the gun is mounted in the plane, put tape over the muzzle end of the barrel and leave it there until after the take-off; the first shot will get rid of it. If possible, take a little kerosene along on a mission. If your gun gets so dusty during the take-off that it will not operate correctly, pour a little kerosene on the working parts to clean them. This method must not be used, however, in any theater where extremely cold temperatures may be encountered.

Filling the Oil Buffer Tube

Although ordnance is responsible for the maintenance of oil buffers in most combat theaters, refilling is a simple operation if you should ever have to do it yourself.

The only correct oil is A/C Spec. Recoil Oil 2-36, latest issue. In an emergency use hydraulic fluid (A/C Spec. 3580), but don't take chances with O.S. 1361 or any other oil. Remove both filler screws. If they are tight, insert a screwdriver in the slot and tap it with a mallet.

Two methods can be used for filling the tube.

1. Use a small oil can filled with 2-36 oil. To avoid getting air bubbles in the buffer tube, turn the can upside down and press the bottom to start the oil flowing before you insert the nozzle. Remove the nozzle before you release the bottom of the can, then press it again to start the oil flowing and reinsert the nozzle in the tube. Repeat the operation until the buffer tube overflows.

or

2. Insert a clean wire through one of the holes and let oil run down the wire from a container until the tube overflows.

In either case, tap the side of the oil buffer tube with a screwdriver several times to dislodge any air bubbles.

Before you replace the filler screws, look at the tips of the screws to see if they have been grooved all the way around where they press against the oil buffer tube. If the groove is not worn completely around the screw, it will allow oil to leak—replace the screw.

GUN MOUNT ADAPTERS

An adapter is a framework or cradle that holds a hand-held gun. When attached to a gun mount by means of a yoke, the adapter permits the gun to be swung from side to side and up and down.

Most gun mount adapters act as shock absorbers. The entire gun recoils a short distance inside the framework of the adapter against a cushion of springs and fluid or compressed air. This shock absorber keeps the gun steadier and makes it possible to fire it more accurately. Also, the cushioning effect of the adapter increases the life of the gun and mount by softening the shock of the explosions when the gun fires.

There are various gun mount adapters used in the Navy. Three adapters commonly used at present will be discussed in the following pages.

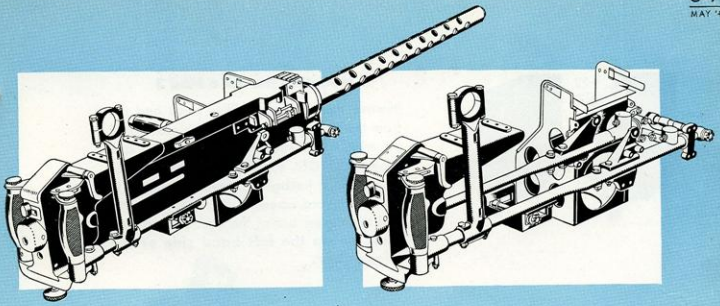
Parts of the Mark 6 Mod 3

1 FRONT MOUNTING BOLT
2 PISTON RODS AND EYELETS
3 SPACERS
4 WASHER, NUT AND COTTER PIN
5 HYDRAULIC SHOCK ABSORBER UNITS
6 FILLER PLUGS
7 FRONT FRAME SEPARATORS
8 FRONT FRAME SEPARATOR BOLTS
9 BEARER BARS
10 YOKE FITTINGS
11 REAR MOUNTING BOLT
12 REAR MOUNTING SLIDES
13 REAR MOUNTING BRACKET
14 NUT AND COTTER PIN
15 SPADE GRIPS
16 KNURLED SCREWS
17 SIGHT MOUNTING HOLES
18 SIGHT MOUNTING BRACKET
19 BACK GUARD ASSEMBLY
20 TRIGGER
21 SAFETY
22 TRIGGER BAR
23 TRIGGER BAR SPACER AND SPRING

General Description of the Mk 6 Mod 3 Gun Mount Adapter

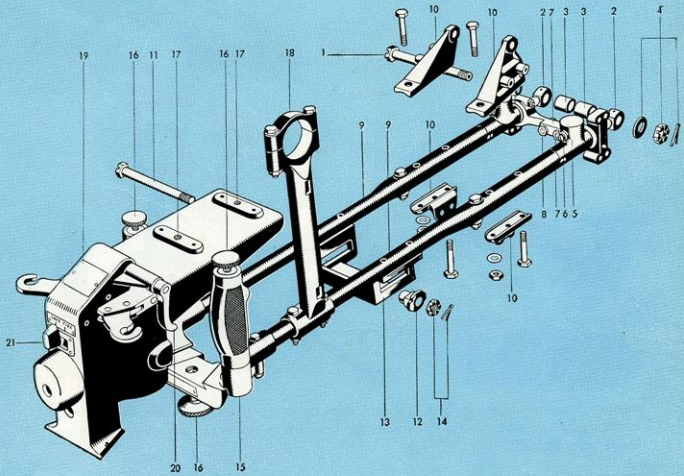
This adapter is designed to hold a single caliber .50 BAM gun. The frame assembly has two built-in hydraulic shock absorber units that work somewhat like the oil buffer in the gun. A removable back guard assembly houses the trigger and trigger safety mechanism. Only the pistons and rear mounting slides recoil with the gun. The bearer bars and back guard assembly do not recoil. A bracket is provided for mounting the Mk 9 or the Mk 9 Mod 1 reflector sight.

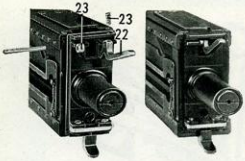
The yoke for this adapter is supplied by the airplane manufacturer in order that the required angles of fire may be obtained in each particular installation.



GUN MOUNT ADAPTER

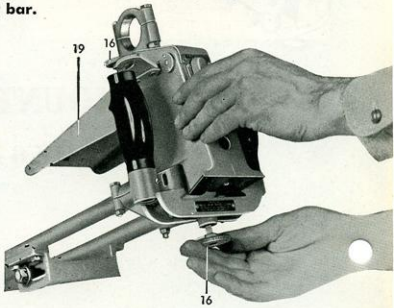
MARK 6 MOD 3



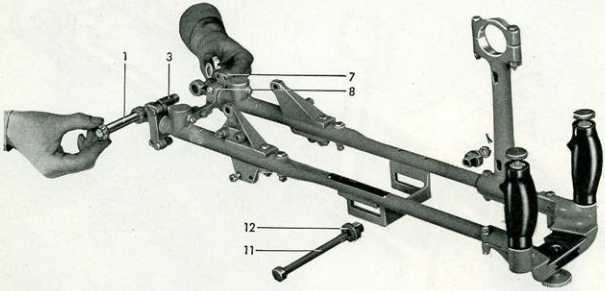


Mounting the Mk 6 Mod 3

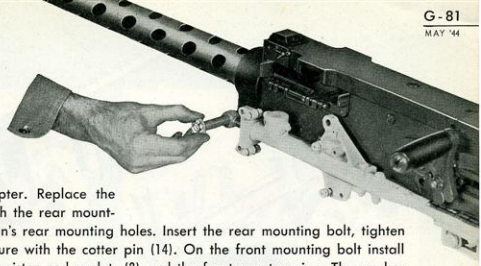
Remove the back plate filler piece and pin from the back plate group of the gun. Install the trigger bar spacer and spring (23) and trigger bar (22), supplied with the adapter to provide a linkage between the trigger in the back guard assembly (19) of the adapter and the trigger bar of the gun. **The spacer must be on the left hand side of the trigger bar.**



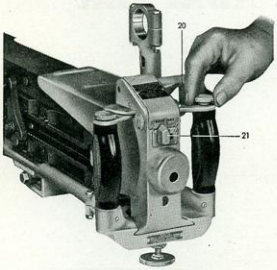
Remove the back guard assembly (19) by unscrewing the three knurled screws (16). The easiest way is to loosen the lower screw first; then, remove the back guard assembly.



Remove the rear mounting bolt (11) and rear mounting slides (12). Remove the front mounting bolt (1) and spacers (3). Loosen the front frame separator bolts (8) on the front frame separators (7).

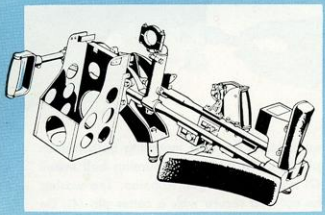


Place the gun in the adapter. Replace the rear mounting slides through the rear mounting bracket (13) and the gun's rear mounting holes. Insert the rear mounting bolt, tighten the castellated nut, and secure with the cotter pin (14). On the front mounting bolt install the spacers (3) between the piston rod eyelets (2) and the front gun trunnion. The washer goes between the nut and the eyelet. Tighten the nut and secure with a cotter pin (4). Do not tighten the two nuts mentioned enough to hamper the recoil characteristics of the adapter. Tighten the front frame separator bolts (8).



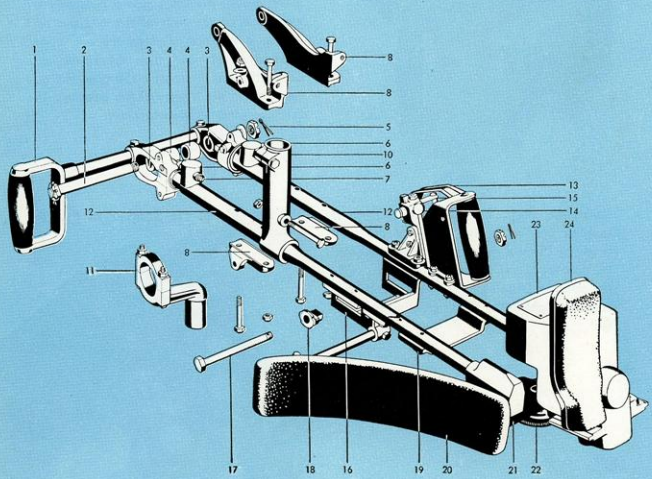
Place the back guard trigger (20) in the forward position and put safety (21) on SAFE. Install the back guard assembly by placing it on the rear of the adapter and sliding it forward. Tighten the two upper knurled screws and then the lower one. Check the installation by charging the gun and pulling the trigger of the adapter. The firing pin should snap forward.

Install the magazine holder by placing it on the left side of the adapter so that the tongues are inside the guides of the gun feedway. Secure the magazine holder with the four bolts and three nuts supplied with the adapter. Install the Mk 9 or Mk 9 Mod 1 reflector sight in the sight mounting bracket (18).



GUN MOUNT ADAPTER

MARK 10 MOD 3



Parts of the Mark 10 Mod 3

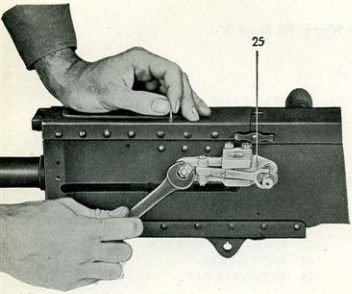
1 FRONT HAND GRIP
2 FRONT MOUNTING BOLT
3 PISTON RODS AND EYELETS
4 SPACERS
5 WASHER, NUT AND COTTER PIN
6 HYDRAULIC SHOCK ABSORBER UNITS
7 FILLER PLUGS
8 YOKE FITTINGS
9 YOKE
10 SIGHT MOUNTING BRACKET POST
11 SIGHT MOUNTING BRACKET
12 BEARER BARS
13 REAR HAND GRIP ASSEMBLY
14 TRIGGER ASSEMBLY
15 TRIGGER
16 REAR MOUNTING BRACKET
17 REAR MOUNTING BOLT
18 REAR MOUNTING SLIDES
19 BEARER BAR SEPARATOR
20 CHEST PAD
21 BACK GUARD SUPPORT
22 KNURLED SET SCREW
23 BACK GUARD
24 SHOULDER PAD

General Description of the Mk 10 Series Gun Mount Adapters

All Mk 10 adapters are basically the same and, with a few exceptions, parts may be interchanged. The Mk 10 is designed for the gunner to stand on the right side of the adapter; with the Mk 10 Mod 1 the gunner stands on the left side. Telescopic sight brackets were provided for these two adapters. The Mk 10 Mod 2 is designed for the gunner to stand on the right side of the adapter; with the Mk 10 Mod 3 the gunner stands on the left side. The Mk 10 Mod 2 and Mod 3 have a sight mounting bracket for mounting the Mk 9 or Mk 9 Mod 1 reflector sight.

The Mk 10 type adapter is for a single caliber .50, handheld gun. This is a side firing mount equipped with a spring and hydraulic shock absorbing device. The gun recoils within the mount which has necessitated the design of a sliding trigger in the housing plate assembly and special feed tongues on the magazine holder. This adapter has shoulder and chest pads designed to give maximum control and leverage. Since the gunner moves with the adapter as the gun is trained, the tendency of the eye to move away from the sight is reduced to a minimum.

The following text and illustrations show the assembly of a caliber .50 BAM gun to a Mk 10 Mod 3 gun mount adapter. These instructions will serve as a general guide for the Mk 10 series.

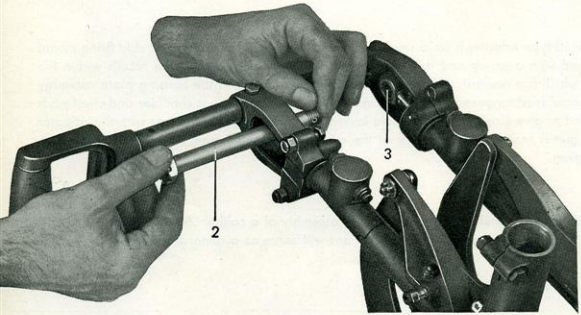


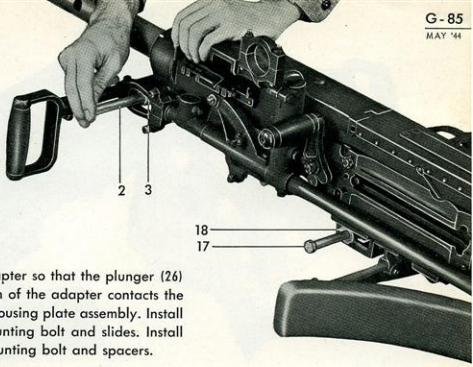
Mounting the Mk 10 Mod 3

Install the housing plate assembly (25) on the right side plate of the gun. Install the retracting slide assembly of the gun on the left side plate. (Reverse this procedure if the Mk 10 Mod 2 is used.)

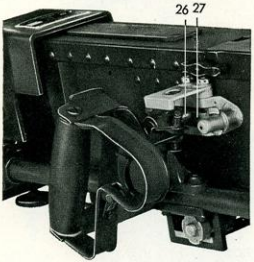
Loosen the knurled set screw (22) and remove the back guard (23) from the adapter.

Remove the front mounting bolt (2) and spacers (4) from the piston rod eyelets (3) of the hydraulic shock absorber units (6). Remove the rear mounting bolt (17) and rear mounting slides (18) from the rear mounting bracket (16).

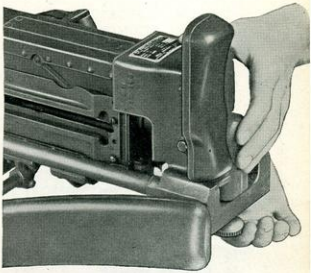




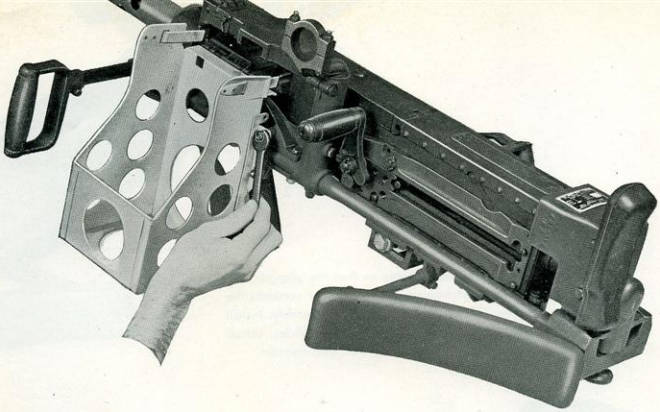
Place the gun in the adapter so that the plunger (26) of the trigger mechanism of the adapter contacts the spring lever (27) of the housing plate assembly. Install and secure the rear mounting bolt and slides. Install and secure the front mounting bolt and spacers.



Install the back guard by sliding it all the way forward in the grooves at the rear of the mount. Screw the knurled set screw located under the mount to lock the back guard in place.



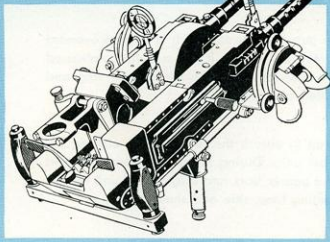
Install the magazine holder by placing it on the mount so that the feed tongues are inside the feedway guides of the gun feedway. Secure the magazine holder to the adapter with the three bolts and four nuts supplied with the adapter.

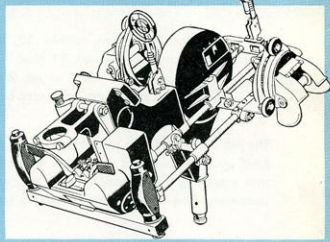


Install the Mk 9 or Mk 9 Mod 1 reflector sight in the sight mounting bracket (11).

Parts of the Mark 11 Mod 3

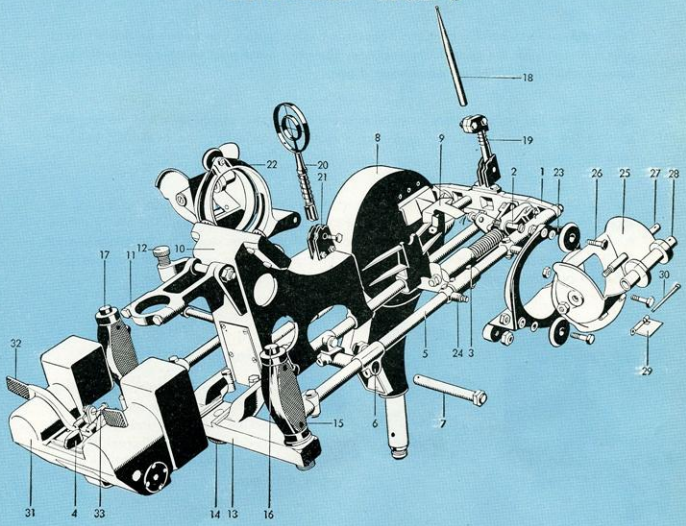
1 FRONT SUPPORT
2 FRONT MOUNTING BOLT
3 PNEUMATIC SHOCK ABSORBER UNITS
4 PISTON RODS
5 BEARER BARS
6 REAR MOUNTING SLIDE
7 REAR MOUNTING BOLT
8 LINK EJECTION CHUTE
9 LINK DEFLECTORS
10 ARMOR PLATE BRACKET
11 REFLECTOR SIGHT BRACKET
12 REFLECTOR SIGHT SUPPORT ADJUSTMENT ASSEMBLY
13 BACK GUARD SUPPORT
14 KNURLED SET SCREW
15 HAND GRIPS
16 CAMERA SWITCH
17 MICROPHONE SWITCH
18 FORE POST
19 FORE POST BRACKET ASSEMBLY
20 RINGSIGHT
21 RINGSIGHT BRACKET ASSEMBLY
22 CONTINUOUS FEED UNIT
23 CONTINUOUS FEED UNIT GUIDE
24 CONTINUOUS FEED UNIT MOUNTING STUD
25 CHUTE AND ROLLER UNIT
26 ECCENTRIC BOLT
27 AMMUNITION ROLLER SHAFT
28 AMMUNITION ROLLER
29 CONTINUOUS FEED PAWL
30 CONTINUOUS FEED PAWL PIN
31 BACK GUARD
32 TRIGGER
33 TRIGGER ADJUSTING SCREW
34 SAFETY





GUN MOUNT ADAPTER

MARK 11 MOD 3



General Description of the Mk 11 Mod 3 Gun Mount Adapter

The Mk 11 Mod 3 is a twin, caliber .30, flexible gun mount adapter. It is an improvement over its predecessors—the Mk 11 Mod 1 and Mod 2—in that it has a better positioned bracket for mounting the Mk 9 or Mk 9 Mod 1 reflector sight. The Mk 11 rear ring and Mk 1 Mod 1 front post sights may also be installed as standby sights.

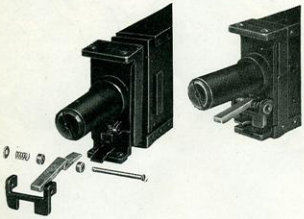
The Mk 11 Mod 3 gun mount adapter is designed to absorb the recoil of two caliber .30, BAM guns by means of pneumatic shock absorber units. During firing the piston rods and rear mounting slides recoil with the gun while the bearer bars and back guard unit remain stationary. This adapter has provisions for mounting face, side and shoulder armor.

A continuous feed unit on the outboard side of each gun insures the straight feeding of the ammunition belt into the gun feedway at all angles of fire. Each continuous feed unit is equipped with a continuous feed pawl, which prevents the ammunition belt from sliding out of the feedway when the cover of the gun is raised. The guns are assembled so that feeding is from the left side for the port gun, and from the right for the starboard gun. The retracting slide assembly must be installed on the feeding side of each gun.

On the top of each hand grip of the adapter is a push button. The button on the left hand grip is a switch for the gunner's microphone. The right hand grip switch operates the gun camera which is installed on the starboard gun.

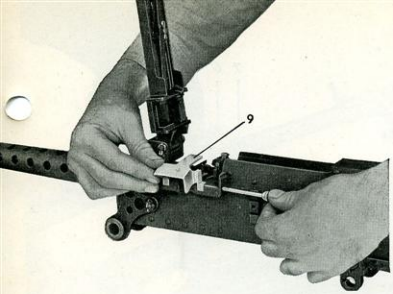
Right and left link deflectors are installed to cause the ejection of belt links into the centrally located link ejection chute. No provision is made for collecting the expended links or cartridge cases.

The Mk 14 is another twin, caliber .30 gun mount adapter. It is very similar to the Mk 11 Mod 3. It was developed to fit in the nose of PBY-5 and PBY-5a airplanes. The Mk 14 differs from the Mk 11 Mod 3 in that the continuous feed units are closer to the centerline to fulfill clearance requirements. The face armor bracket has been removed and a somewhat different bracket provided to mount a Mk 9 or Mk 9 Mod 1 reflector sight.



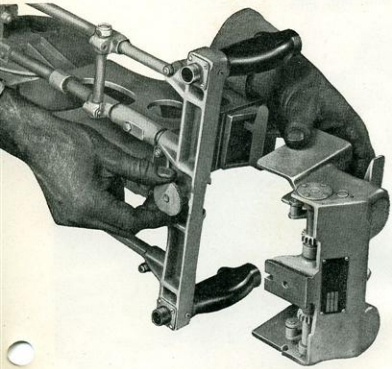
Mounting the Mk 11 Mod 3

Remove the latch lock pin, latch lock spring, and latch lock from the back plate group of the gun. Insert the bell crank and spacers supplied with the adapter. The bell crank fits over the latch spring. Reassemble the back plate group of the gun.

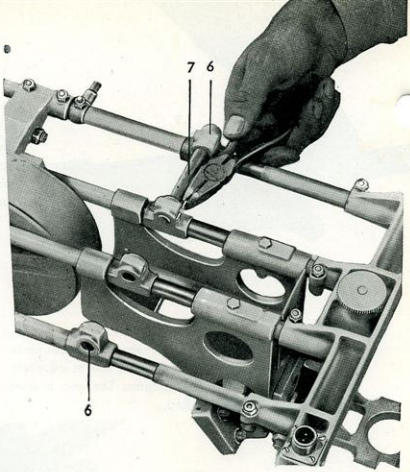


Remove the belt holding pawl pin from the gun and install the link deflectors (9) which are provided with the adapter. Replace the belt holding pawl pin.

Remove the front and rear mount adapters from the gun. Install the rear mount adapters provided with the adapter. The gun is now ready to be installed.

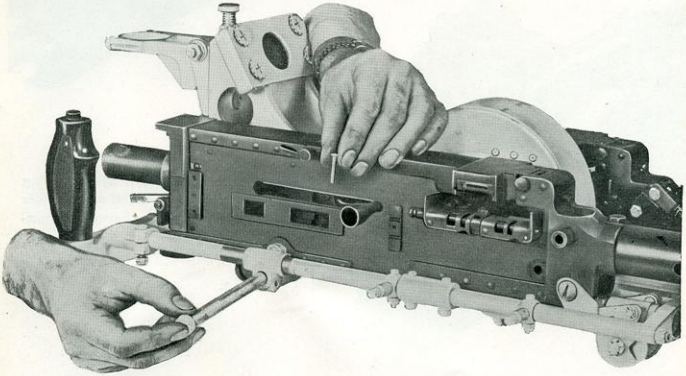


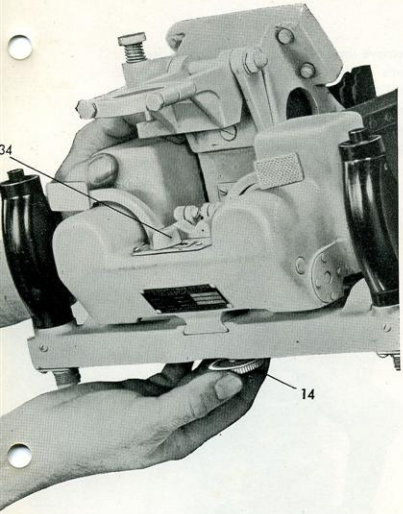
Remove the back guard (31) by unscrewing the large knurled set screw (14) on the under side of the back guard and sliding the assembly rearward until free.



Remove the front mounting bolt (2). Remove the rear mounting bolt (7) by removing the cotter pin and clevis pin from the inboard end of the bolt and withdrawing it from the rear mounting slides (6). The adapter is now ready to receive the guns.

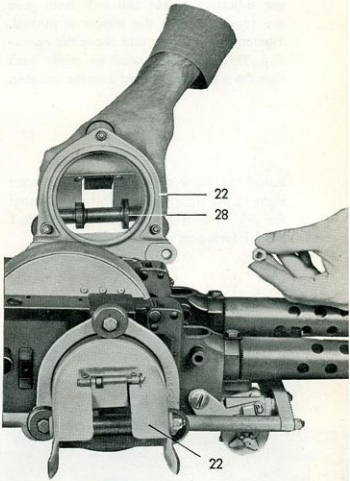
Place the guns in the mount adapter making certain that the link deflectors enter the centrally located link ejection chute (8). Insert the rear mounting bolt from the outboard side of the adapter and secure it with the clevis and cotter pins.

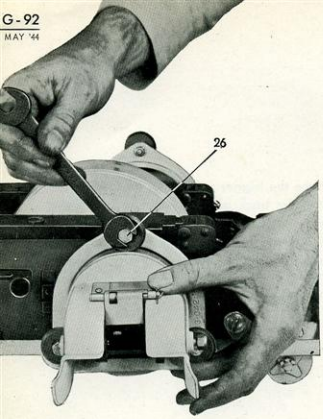




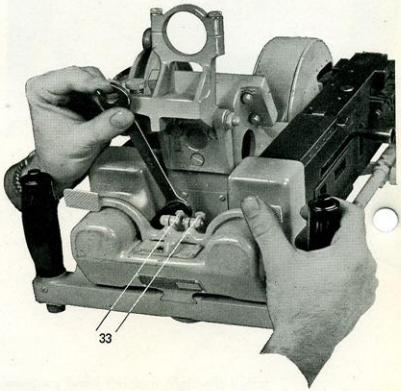
Place the trigger safety (34) on "SAFE." Install the back guard by sliding it into the grooves at the rear end of the adapter. Screw the knurled screw underneath the adapter to lock the back guard in place. Check to be sure that the rollers are below the trigger bell cranks.

Install the right and left hand continuous feed units (22) and secure them to the mount adapter by means of the two fiber lock nuts supplied for each unit. The large diameter of the ammunition roller (28) in the continuous feed unit must always be forward.





Remove the slack from the continuous feed units by loosening the eccentric bolt nut and rotating the eccentric bolt (26). Hold this bolt with a wrench and tighten the nut again. The continuous feed units should rotate smoothly and easily.



Loosen the lock nuts and adjust the trigger adjusting screws (33) until both guns fire together when the trigger is pushed. Tighten the lock nuts and check the operation. This adjustment must be made each time the guns are removed from the adapter.

Install the Mk 9 or Mk 9 Mod 1 reflector sight in the sight bracket (11). Also install the Mk 11 rear ring sight and the Mk 1 Mod 1 fore post as standby sights.

G-93
MAY '44

AMMUNITION & LOADING

PRE-FLIGHT CHECKS

POST-FLIGHT CHECKS

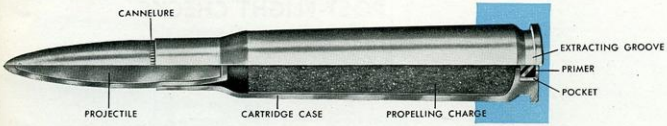
TROUBLE SHOOTING

CAL. .45 AUTOMATIC PISTOL

CAL. .30 MACHINE GUN

YOUR AMMUNITION

Depending on the job to be done, several types of projectiles can be fired from the caliber .50 machine gun. But the method of firing the round is the same in all cases.

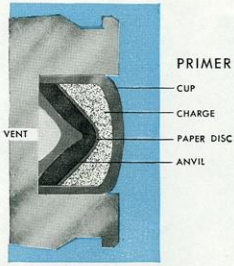


The **primer** consists of a brass **cup,** a highly explosive **primer charge,** a shellacked **paper disk** to keep out moisture, and a brass **anvil** with a pointed end.

The primer fits into a circular **primer pocket** in the base of the cartridge case. The front edge of the case is bent into a groove, or **cannelure,** in the side of the bullet to hold it in place.

When the gun's firing pin dents the primer cup, the primer charge, squeezed between the cup and anvil, explodes.

Flame flashes around the anvil and through a **vent** in the cartridge case, setting fire to the **propelling charge,** a quantity of black, smokeless powder loosely packed in the case. The propelling charge does not explode all at once, but burns steadily from back to front in a fraction of a second. Gases given off by this burning create the chamber pressure of about 50,000 pounds to a square inch.

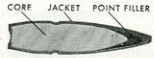
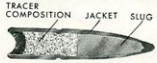


The case is forced against the sides of the chamber, and the projectile is blown forward out of the case and through the barrel.

Types of Ammunition

The types of ammunition used by aerial gunners can be identified by colors painted on the tips of the bullets.

The chart on the next page shows the kinds of ammunition, and the use, identification, and construction of each type.

TYPE	USE	COLOR OF TIPS	HOW IT WORKS
Ball (Cartridge, ball, caliber .50, M2)	Used against personnel and light material targets.	Unpainted; plain copper color	 A **jacket** of copper-colored gilding metal encloses the steel **core.** A lead and antimony **point filler** fills up the space between the point of the core and the jacket. When the projectile hits a target, the soft jacket smears, giving the steel core a grip. The core penetrates the surface instead of being turned aside.
Armor-piercing (Cartridge, armor-piercing, caliber .50, M2)	Used against armored aircraft and vehicles, concrete shelters, and other bullet-resisting targets.	Black	The projectile is the same as a ball cartridge, except that the core is made of a very hard tungsten chrome steel to give it greater penetrating power.
Tracer Cartridge, tracer, caliber .50, M2 or M10	Used for observing fire—it makes a streak of light easily seen at night, and usually visible in daylight.	Red	 Inside the gilding metal jacket is a **slug** of lead and antimony. Behind it is a pocket of **tracer composition** which is set afire by the propelling charge as the projectile leaves the cartridge case.
Incendiary (Cartridge, incendiary, caliber .50, M1)	Used to set fire to explosive or very inflammable targets, like gasoline tanks and balloons.	Light blue	In the front of the jacket is an **incendiary composition.** It is sealed by **plugs** of an alloy which melts easily. As the bullet goes through the barrel, the heat melts the plugs. The incendiary composition is set on fire when the air touches it.
Dummy (Cartridge, dummy, caliber .50, M1 or M2)	Used in training.	Unpainted (Hole in side of case)	A round with no priming charge and no propelling charge. A hole is drilled in the side of the case.
Armor-piercing Incendiary (Cartridge, armor-piercing incendiary, cal. .50, M8)	To set fire to armor-plated inflammable objects, such as the gas tanks of fighter planes.	Black, with a small blue tip on the nose.	Similar in construction to armor-piercing projectile, except that there is incendiary compound behind the steel core.

Colored ink marking

Another kind of marking sometimes is used in target practice. The tips of the bullets are painted in lithographic ink, which leaves colored smears when the bullet hits the target.

When several gunners fire at the same target, a different color is assigned to each gunner. The scores can be determined by counting the colored smears on the target.

Care and Handling

Ammunition which is carelessly stored or handled soon develops defects which may stop your gun in the midst of an attack. These tips are worth remembering:

Since small arms ammunition deteriorates quickly when exposed to the direct rays of the sun, it should be stored indoors whenever possible.

If it must be stored in the open, the boxes should be raised on blocks at least six inches above the ground, and covered with a double thickness of tarpaulin draped in such a manner that air can circulate freely through the pile. Dig a trench around the pile to keep water out.

Don't remove ammunition from its air-tight packing boxes until it is needed—it corrodes rapidly, especially in damp climates.

These storage precautions apply especially to tracer ammunition, which deteriorates quickly when it becomes damp, and may go off spontaneously if it gets too warm. Tracer should be stored separately from other ammunition if possible.

Keep the cartridges free of mud, sand, dirt, and water. If they do get dirty, wipe them off at once.

Never use grease or oil on ammunition.

Small arms ammunition will not explode violently if it is in a fire. But each cartridge will explode individually, sending the case flying in one direction and the projectile in another. Unless you are engaged in fighting the fire, don't stand near it.

Checking Ammunition

To avoid stoppages in combat, check your ammunition carefully before loading it into the ammunition can of your bomber, unless you are absolutely sure it has already been checked by ordnance.

If a clean, dry floor is available, lay the belt out in a long row and examine it carefully. If the only space available is muddy or greasy, check your ammunition by loading it, double-end first, into a box. Then load it into your ammunition can, single-end first, watching for defective rounds as you pull the belt toward you. You will probably never see a belt of ammunition this bad, but the picture shows what you should watch for while checking ammunition. Remove any defective rounds.

LOOSE PROJECTILE

BENT ROUND

UNEVEN LINKING

The base of these rounds are out of line with the others, and the extractor hook might not reach them.

SHORT ROUND

As the belt feeds into the gun, this round might be pushed forward so far that the extractor hook could not reach it.

DENTED CASE

CORRODED CASE

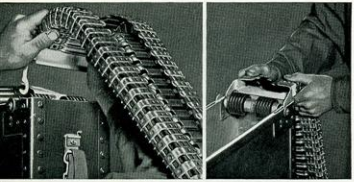
CORRODED LINKS

LOADING YOUR AMMUNITION

In the bomber, ammunition for hand-held guns is carried in steel or wooden containers, usually mounted above or to the side of the gun position. The ammunition belt feeds out the top of the container, over a roller, and through a flexible feed chute attached to the gun.

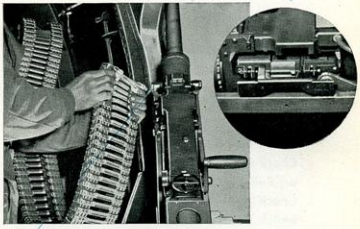
Load the ammunition into the container with the single end of the links going in first, so that the double end will go into the gun. Put the rounds in the container in even layers, checking for defective cartridges as you go.

Mount the container in the bomber, with its roller toward the gun. Methods of mounting the container vary in different planes and different combat theaters—it may sit on the floor, or be fastened into a rack with clamps, pins, or straps.

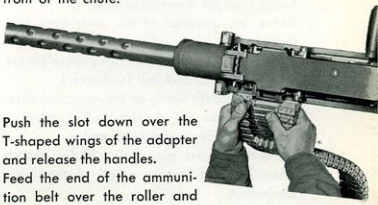


Attach the feed chute to the container, open side up, by pushing its two hooks into the slots in the sides of the container and pulling them under the pin that holds the roller. (In some cases, pins or clamps are used to fasten the chute.)

Mount a feed chute adapter on the gun on the same side as the belt holding pawl. Remove the belt holding pawl pin, straddle the belt holding pawl with the projections of the feed chute adapter, and replace the pin.



Attach the feed chute to the adapter. Squeeze the two handles on the bottom of the flexible feed chute—this will open a slot in the front of the chute.



Push the slot down over the T-shaped wings of the adapter and release the handles.

Feed the end of the ammunition belt over the roller and into the top of the chute, and pull it down to the gun. Load the end of the belt into the feedway in the usual manner.

PRE-FLIGHT AND POST-FLIGHT CHECKS

Thorough care and inspection of your gun before and after every mission are your insurance that the gun will always start firing when you want it to, and keep on firing.

The inspections take time, and they are worth every minute of it. Gunnery officers in some theaters, for example, try to allow a full hour for the pre-flight check and two hours for post-flight.

Follow this check list. Never omit a single step. Leaving out a single check, just one time, may cause the loss of an airplane—plus the crew.

PRE-FLIGHT CHECK LIST

Before assembling the gun . . .

1 Check the T-slot for burrs.

2 Check the recesses in back of the bolt, firing pin port, and driving spring hole for dirt, excessive oil, or fouling.

3 Check the oil level in the oil buffer tube.

4 Check the bore and chamber for dirt or excess oil. Pull a clean, dry rag through the barrel.

5 Check the receiver to see that the extractor switch and its spring, the belt holding pawl, and cartridge stops are clean and correctly assembled.

After assembling the gun . . .

6 Check the bolt switch, belt feed slide, and cartridge stops for direction of feed.

7 Check the operation of the cover latch and detent pawl.

8 Check all cotter pins (especially those on the extractor switch and belt feed lever).

9 Check the safety wiring on the retracting slide.

10 Check the four adjustments: buffer adjusting screw, oil buffer, headspace, timing.

11 Hand-charge the gun, testing it for smooth operation and correct action of the firing mechanism.

On the adapter . . .

12 For the Mk 6 Mod 3 and the Mk 10 adapters check the oil level in the hydraulic units.

13 Mount the gun in the adapter and check for proper mounting and safety wiring.

14 Before loading the gun, hand-charge the gun in the adapter, testing for smooth operation and firing.

15 Charge three or four rounds through the gun to check the feeding mechanism. *(Be sure the safety is in the SAFE position.* Don't feed ammunition into the gun while it is in stowed position, pointed at any part of the ship, or aimed in any direction that might endanger personnel or equipment on the field.)

16 Clear the gun, raising the cover to make sure the feedway and chamber are empty.

17 Check the sights to make sure they are not loose or damaged. (The pre-flight checks for optical and computing sights are listed in the sights section.)

18 If ordnance does not do it, check your ammunition for corroded, dented, or bulged cases; short rounds; incorrect linking, and bent or rusty links.

And finally . . .

19 If operating policy permits, take along a screwdriver and combination tool, one complete spare bolt group, and as many other spare parts as possible.

20 When a new gun is issued to you, test-fire at least 75 rounds before using it on a mission.

POST-FLIGHT CHECK LIST

1 First, make sure the chamber is empty.
2 Before leaving the ship, check for any damage to the feed chute or ammunition box.
3 Report all malfunctions, give the cause if possible, and make sure they are corrected.
4 Thoroughly clean and oil the gun. As you reassemble the gun, check it part by part, group by group, always in the same order. Usually there will be a spring chart available. Compare the springs with the chart. If you find a spring shorter than the chart shows, it is weak —replace it. To check parts such as the sear notch for wear, compare them with new parts. After cleaning, as you assemble the gun, make the following checks:

In the receiver . . .

5 Check for adjustment of the breech lock cam, burrs on the cam, or dirt under the cam.
6 Check for burrs at the rear end of the extractor switch, rust or primer salts on the switch spring, dirt or deposits in the switch recess in the side plate, new cotter pin, operation of the switch after installing it.
7 Check for weak belt holding pawl spring and worn belt holding pawl.
8 Check for condition of the cartridge stops.

In the barrel group . . .

9 Check bearing surface for dirt or corrosion.
10 Check the bore and chamber for wear or damage.
11 Check for burrs on the barrel extension shank.
12 Check for burrs or wear at the top and bottom front edges of the breech lock.

In the oil buffer group . . .

13 Check for burrs where the front end of the oil buffer body hits the breech lock cam.
14 Check for looseness or wear of the breech lock depressors.
15 Check action of the tube lock on accelerator.
16 Check for wear of the accelerator tips.
17 Refill oil buffer tube. If it takes a large amount of oil, have ordnance check it for leakage.
18 Check for adjustment of the oil buffer.
19 At regular intervals, as specified by your group ordnance officer, have ordnance change the oil in the oil buffer tube and check the oil buffer spring, relief valve, and packing gland.

In the bolt group . . .

20 Check for scoring or burring of the bottom of the bolt body caused by a jittery accelerator.
21 Check for burrs on the T-slot.
22 Check for burrs at the front of the breech lock recess.
23 Check for wear on the guides that run in the slots inside the barrel extension.
24 Check for burred or worn cam grooves or bolt switch grooves.
25 Check the extractor stop pin for wear and looseness.
26 Check for dirt or primer salts in the T-slot, firing pin port, driving spring hole, breech lock recess and the recesses in back of the bolt.
27 Check for worn or burred notches on firing pin and sear.
28 Check for weak sear spring.
29 Check for bent, worn, or broken cocking lever.
30 Check for worn hook or lug on the extractor and bent or broken extractor or ejector.
31 Check for weak ejector spring. (If the ejector pin is staked, test the operation of the ejector with your fingers without stripping it.)
32 Check for worn or bent bolt stud.
33 At regular intervals, as specified by your group ordnance officer, have ordnance replace the driving spring and firing pin spring. Manufacturers suggest this be done every 1,000 rounds.

In the cover group . . .

34 Check for burred extractor cam.
35 Check for weak belt feed pawl spring.
36 Check for burred or worn belt feed pawl, pawl arm, or belt feed slide.
37 Check for bent or worn belt feed lever, especially the lug, and for worn pivot stud.
38 Check operation of the lever plunger spring.
39 Check operation of the cover latch and detent pawl.

In the back plate group . . .

40 Check the buffer adjusting screw adjustment.
41 Check operation of the latch and latch lock.

With the gun assembled . . .

42 Check the headspace and timing.

TROUBLE SHOOTING

If a gun is carefully cleaned, inspected, and oiled every day, there is hardly one chance in a thousand that anything will go wrong with it in combat.

Reports on gun breakdowns in combat theaters show that nine-tenths are caused by dirty guns, bad adjustments, or other varieties of pure carelessness. Most of the remaining one-tenth could have been prevented by a good pre-flight check.

But if something should go wrong with your gun, the trouble-shooting charts on these two pages show the most practical way of finding out what is wrong and the possible causes of the trouble.

To complete your working knowledge of malfunctions—failures—the charts on the following two pages tell exactly what happens inside the gun in each case.

If the Rate of Fire is **too rapid**
And there is excessive vibration
the trouble probably is:
Insufficient oil in the oil buffer.

If the Rate of Fire is **too slow**
Or if the gun fires a few rounds and stops, the trouble probably is:
Tight headspace
Oil buffer adjustment too far toward the closed position, or
Too much weight on the ammunition belt.

If the gun **won't start**
firing in extremely cold temperatures, pull the charging handle back, **hold the trigger down,** and release the charging handle.

If your gun won't stop firing

Symptoms:
The gun may start firing as soon as the first round is chambered, or once the gun is firing it may fail to stop when you release the trigger.

Malfunction:
Runaway gun

Probable causes:
Worn notch on the sear or firing pin extension.
A defective solenoid.
Trigger on adapter sticking.

What to do:

On a hand-held gun, pull the charging handle down but not all the way back to hold the action out of battery. On a turret gun, pull the charging cable a short distance. To start firing again, simply charge the gun.

Do not lift the cover—this will stop the runaway firing, but will make it difficult to reload the gun.

If your gun stops firing

In battery position:

1. Hand charge twice, keeping your eye on the ammunition belt, and try to fire after each charging.
2. If the gun still does not fire, raise the cover; make sure the extractor hook is engaged in the extracting groove of the round, and that the round is against the cartridge stops.
3. Charge again and try to fire. By now you will have eliminated any defective cartridge or short round. If the gun still does not fire, look through the slot in the side of the receiver, if possible, and see if the sear goes down when you pull the trigger.

Out of battery position:

1. Try to charge it and see if the parts will return to battery position.
2. If not, raise the cover and see if you can pull the belt over against the cartridge stops. If the belt is stuck, check for binding in the container or chute.
3. If the belt is free, retract the bolt and see if a live round or empty case in the T-slot is holding the bolt out of battery.

Symptoms:
You could not move the next round over to the cartridge stops easily
Malfunction:
Binding of the belt
Probable causes:
Improperly linked belt,
Belt out of position,
Belt incorrectly loaded into the container,
Burrs or binding in the feed chute.

Symptoms:
The belt moved against the stops easily
A live round was in the T-slot
Malfunction:
Failure to feed into the chamber
Probable causes:
Separated case in the chamber,
Worn or broken extractor switch spring,
Broken ejector,
Weak ejector spring,
Weak driving spring.

Symptoms:
There was no more ammunition in the feedway and an empty case was in the T-slot
Malfunction:
Failure to eject (the last empty case)
Probable causes:
Broken ejector,
Weak ejector spring.

Symptoms:
The belt did not feed when you charged the gun, and The next round was **not** against the cartridge stops
Malfunction:
Failure to feed into the feedway
Probable causes:
Worn or broken belt feed lever lug,
Weak or broken belt holding pawl spring,
Weak or broken belt feed pawl spring.

Symptoms:
The belt did not feed when you charged the gun, and The next round was against the cartridge stops
Malfunction:
Failure to extract from the belt
Probable causes:
Worn or broken extractor hook,
Weak or broken cover extractor spring.

Symptoms:
The belt fed correctly when you charged, but the gun still would not fire
Malfunction: **Failure to fire**

Probable causes:

Sear does **not** go down:
Defective solenoid,
Defective trigger mechanism on the adapter,
Bent or worn trigger bar,
Weak or broken sear spring.

Sear **does** go down:
Dirt, cosmoline, or moisture in the firing pin port,
Broken notch on the sear or firing pin extension,
Weak or broken firing pin spring,
Broken firing pin.

Symptoms
that tell you what the malfunction is:
a. Gun stops in battery position
b. Ammunition belt does not feed into the gun when you hand charge it
c. Next round is not against the cartridge stops

The malfunction is:

FAILURE TO FEED INTO THE FEEDWAY

POSSIBLE CAUSES	WHAT HAPPENS
Broken belt feed lever lug	**If the slide does not move at all when you hand charge the gun, this additional symptom tells you immediately that the belt feed lever lug is broken.** The lever is not pivoted by the cam grooves, so there is nothing to move the belt feed slide in and out.
Worn belt feed lever lug	The slide is not pushed out far enough to engage firmly behind the next round—it may pull a short, light belt but cannot pull a long, heavy belt.
Weak or broken belt holding pawl spring	**If the belt moves in and out of the feedway on hand charging, this additional symptom tells you immediately that the belt holding pawl spring is weak or broken.** The spring fails to force the belt holding pawl up behind the next round to hold it in place while the belt feed pawl moves out over the belt.
Weak or broken belt feed pawl spring	The belt feed pawl is not snapped down firmly behind the next round. The belt will usually feed on hand charging, but may not always feed in automatic fire.

Symptoms
that tell you what the malfunction is:
a. Gun stops in battery position
b. Belt does not feed into the gun when you hand charge it
c. Next round is against the cartridge stops

The malfunction is:

FAILURE TO EXTRACT FROM THE BELT

POSSIBLE CAUSES	WHAT HAPPENS
Broken or worn extractor hook	The extractor hook slips out of the extracting groove of the round.
Broken or weak cover extractor spring	The spring does not hold the extractor hook firmly in the extracting groove of the cartridge.

Symptoms
that tell you what the malfunction is:
a. Gun stops out of battery
b. There is ammunition left in the feedway

The malfunction is:

FAILURE TO FEED INTO THE CHAMBER

POSSIBLE CAUSES	WHAT HAPPENS
Separated case	The tip of the case breaks off (usually the result of loose headspace) and remains in the chamber, preventing the next round from entering all the way.
Weak or broken extractor switch spring	The switch does not return to its horizontal position at the end of recoil, and fails to guide the extractor assembly downward on counter recoil.
Broken ejector	The round is not supported and does not line up with the chamber. (On hand charging, the round may fall through the T-slot; the bolt will return to battery without feeding a round into the chamber. If the gun is hand charged rapidly enough, the round may be fed into the chamber.)
Weak ejector spring	The round is not supported and does not line up with the chamber.
Weak driving spring	The bolt action becomes rough and sluggish; the gun's action may slow down, or may actually stop out of battery when pulling a long ammunition belt.

Symptoms
that tell you what the malfunction is:
a. Gun stops in battery position
b. Belt feeds into the feedway on hand charging
c. Gun does not fire when you pull the trigger

The malfunction is:

FAILURE TO FIRE*

POSSIBLE CAUSES	WHAT HAPPENS
Dirt, cosmoline, or moisture in the firing pin port	The firing pin does not go forward hard enough to fire the round.
Defective solenoid	The solenoid does not operate the gun's firing mechanism.
Defective trigger mechanism on the adapter	The trigger on the adapter fails to operate the trigger on the gun.
Bent or worn trigger bar	The front of the trigger bar does not push the sear tip down.
Weak or broken sear spring	The sear notch does not hold the firing pin to the rear; the firing pin rides the cocking lever forward.
Broken notch on the sear or firing pin extension	There is nothing to hold the firing pin to the rear, and it rides the cocking lever forward.
Weak or broken firing pin spring	The firing pin is not forced forward at all, or else is not forced forward hard enough to fire the round.
Broken firing pin	The firing pin is too short to hit the round.

- In cases of Failure to Fire, there are certain additional symptoms which help locate the cause of the trouble when you are on a malfunction range, although they usually cannot be observed in combat. By examining the primers of the ejected live rounds, you can tell whether they have been dented only slightly—called "light struck primers"—or not at all. You can also listen closely when you pull the trigger and hear whether the firing mechanism makes a loud click, a faint click, or no click at all.

Symptoms
that tell you what the malfunction is:
a. Gun starts firing as soon as the first round is chambered, or
b. Once the gun is firing it may fail to stop when you release the trigger

The malfunction is:

RUNAWAY GUN

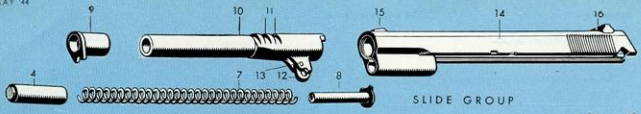
POSSIBLE CAUSES	WHAT HAPPENS
Worn notch on the sear or firing pin extension	After the firing pin is cocked, the jar of the bolt going into battery releases it.
Defective solenoid	The solenoid jams in the fire position.
Defective adapter trigger	The trigger sticks in the fire position.

Symptoms
that tell you what the malfunction is:
a. Gun stops out of battery
b. There is no more ammunition in the feedway
c. The last spent case is still in the T-slot

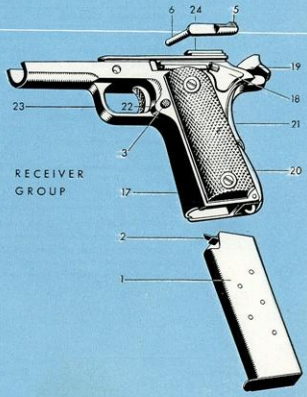
The malfunction is:

FAILURE TO EJECT
THE LAST EMPTY CASE

POSSIBLE CAUSES	WHAT HAPPENS
Broken ejector	Since there is no new round coming down the T-slot to push the last case out, it is not ejected; the case jams partly in the chamber, or against the breech end of the barrel or the barrel extension.
Weak ejector spring	Instead of ejecting the last case, the ejector pivots around it and tries to aline it with the chamber again but is too weak to do it. As a result, the case jams partly in the chamber, or against the breech end of the barrel or the barrel extension.



CALIBER .45 AUTOMATIC PISTOL



Nomenclature

1 MAGAZINE
2 MAGAZINE FOLLOWER
3 MAGAZINE CATCH
4 RECOIL SPRING PLUG
5 SLIDE STOP
6 SLIDE STOP PIN
7 RECOIL SPRING
8 RECOIL SPRING GUIDE
9 BARREL BUSHING
10 BARREL
11 BARREL LOCKING NOTCHES
12 BARREL LINK
13 BARREL LINK PIN
14 SLIDE
15 FRONT SIGHT
16 REAR SIGHT
17 RECEIVER
18 SAFETY LOCK
19 HAMMER
20 MAINSPRING HOUSING
21 GRIP SAFETY
22 TRIGGER
23 TRIGGER GUARD
24 EJECTOR

The caliber .45 automatic pistol is a sidearm often issued to Navy aircrewmen. It is actually a semi-automatic weapon; it loads and cocks itself, but the trigger must be squeezed for each shot. It is simply constructed and light in weight; it can be stripped very quickly without a tool under combat conditions. Yet it will drop a man if the bullet hits any part of his body. At 250 yards, it will penetrate four inches of white pine—and a one-inch penetration is equivalent to a dangerous wound. Its maximum range is about 1,600 yards, its muzzle velocity about 800 feet a second. However, its maximum accurate range is within 100 yards; hits beyond that range are usually more luck than skill.

There are two models, the M1911 and M1911A1. On the M1911A1, which is newer, there are slight changes in the shape of the grip safety, trigger, mainspring housing, front sight, and hammer tip.

STRIPPING

Remove the magazine (1)
by pressing the magazine catch (3) just behind the trigger on the left side.

Fig. 1

Remove the recoil spring plug (4).
Push in the checkered front of the plug. Then, holding your thumb in front of the plug to keep it from springing out, give the barrel bushing (9) a quarter turn in a clockwise direction. Let the plug come out slowly against your thumb.

Fig. 2

Take plug off recoil spring (7),
turning it slightly in a clockwise direction if it sticks.

Fig. 3

Remove the slide stop (5).
Cock the hammer and hold the gun with the left side up. Press in on the slide stop pin (6) with your right forefinger and pull the slide back with your left hand. The slide stop will disengage as the small notch on the slide passes over it. Lift it out the left side of the gun.

Fig. 4

Remove the slide group
by turning the pistol upside down and pulling the slide forward off receiver.


Fig. 5

Remove recoil spring (7) and spring guide (8).
Hold the slide upside down and pull the spring back and out.

Fig. 6

Fig. 7

Remove the barrel bushing (9).
Turn it in a counterclockwise direction and pull it out the front.

Fig. 8

Remove the barrel (10) and barrel link (12)
by pulling them forward out of the slide after turning the link forward. The barrel link can be separated from the barrel by drifting out the barrel link pin.

ASSEMBLY

Replace the barrel. Hold the slide upside down. Insert the barrel from the front with the barrel link going in first. The link must be turned forward. (See fig. 8)

Replace the barrel bushing. Line up the ridge on the side of the bushing with the space between the barrel and recoil spring housing. Push the bushing all the way in and turn it clockwise as far as it will go. (See fig. 7)

Replace the recoil spring and spring guide. Keeping the slide upside down, push the spring into its housing from the rear. The spring guide goes toward the rear with the rounded slot resting over the barrel. (See fig. 6)

Assemble the slide and the receiver. With the slide still upside down, cock the hammer of the receiver, then turn the receiver upside down and push it forward on the slide as far as it will go. Make such the barrel link is tilted forward. (See fig. 5)

Insert the slide stop pin. Hold the gun with the muzzle end of the barrel tilted up and push the slide back until its rear end is just over the hammer. Move the barrel in or out until the hole in the barrel link lines up with the hole for the slide stop pin. Push in the pin as far as it will go. Move the slide farther back, pushing the rear of the slide stop inward and upward to force it in place.

Insert the recoil spring plug. Move the slide all the way forward, leaving the hammer cocked and locking the safety lock. Set the recoil spring plug over the end of the spring (see fig. 3) and push the plug in until it is flush with the slide. Then turn the barrel bushing down until the plug snaps forward between the lips of the barrel bushing. (See fig. 2)

Insert the magazine and push it in until it catches. (See fig. 1)

LOADING THE MAGAZINE

To load the first round into the magazine, press the rear of the round down against the front of the magazine follower—the flat metal surface under spring tension—and push the round all the way to the rear.

To load the remaining rounds, hold one thumb beside the magazine as a guide. With your other thumb, press the base of the next round down against the front of the cartridge case of the round already in the magazine and slide it all the way back.

LOADING THE PISTOL

After seven cartridges have been placed in the magazine, insert the magazine in the receiver. Pull the slide to the rear and let it go forward. (If the slide was already at the rear when the magazine was inserted, press down the slide stop to let it snap forward.)

The pistol is now cocked. Unless you plan to start firing immediately, **put the safety lock in safety position** as far up as it can be moved.

Eight cartridges can be loaded in the pistol when desired.

Before inserting the magazine draw back the slide, place an extra round in the chamber, release the slide, and **put the safety lock on safety.** Then insert the loaded magazine.

SAFETY DEVICES

Four safety devices prevent accidental discharge of the pistol.

1 The safety lock. The trigger cannot be pulled when the safety lock is in safety position. Before firing, the safety lock must be moved down.

2 The grip safety. The trigger cannot be pulled unless the grip safety is squeezed forward.

3 The disconnector. This is a moving part inside the receiver that prevents the pistol from firing unless the slide is fully forward in battery position.

4 The half-cock notch. If the hammer is not forced back far enough to engage its firing notch, it is stopped by the half-cock notch, which prevents it from slipping forward and firing the round. The trigger cannot be pulled when the hammer is on half-cock. To release the hammer without firing the round, pull it all the way back and allow it to go slowly forward to the uncocked position while squeezing the trigger and grip safety.

1

2

HOW IT WORKS

RECOIL

1. When the pistol is in battery, the slide and barrel are locked together by the locking notches. As the round is fired, the explosion drives the bullet forward, and also starts recoil. Shortly after recoil starts, the barrel link pivots downward around the slide stop pin. This pulls the rear of the barrel down, separating the locking notches and leaving the slide free to travel farther back. The barrel cannot travel farther back because the barrel link is held by the slide stop pin. As the slide moves back, the extractor—near the rear of the slide group—pulls the empty case from the chamber. The case hits the fixed ejector on the upper left side of the receiver, which flips the case up and out to the right.

2. As the chamber moves over the magazine, the magazine follower, pressed upward by the magazine spring, forces the next round partly up into the chamber. (If the magazine is empty, the magazine follower forces the slide stop upward, locking the slide back at full recoil.) The recoiling slide turns the hammer backward, forcing the hammer strut down and compressing the mainspring. Since the bottom of the sear is always being pressed forward by the long leaf of the sear spring, the upper tip is pivoted backward and sticks into the firing notch on the hammer. This locks the hammer back in cocked position against the pressure of the mainspring.

3

4

COUNTER RECOIL

3. The recoil spring, which is compressed as the slide recoils, now forces the slide forward. The slide hits the new round, which is guided into the chamber by the lips of the magazine and the loading ramp at the breech end of the barrel. Farther forward, the slide hits the rear of the barrel and forces it forward. The barrel link pivots upward around the slide stop pin, forcing the rear of the barrel up into the locking notches of the slide to lock the slide and barrel together.

FIRING

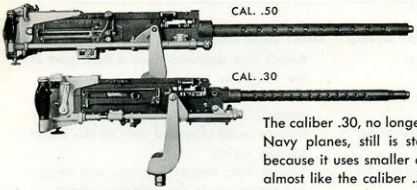
4. When the trigger is squeezed, the trigger yoke presses the disconnector back against the bottom of the sear, pivoting the upper tip of the sear forward out of the firing notch on the hammer. The hammer, forced forward by the mainspring, drives the firing pin into the primer. The firing pin spring forces the pin back into position.

CARE AND CLEANING

After a pistol has been fired, it must be field stripped for proper cleaning. With a cleaning rod and cloth patches, clean the bore and chamber in the same way a caliber .50 barrel is cleaned. Then saturate a clean flannel patch with light lubricating oil and swab the bore and chamber. Wipe the exposed working surfaces with an oily rag. Put a few drops of oil into the openings around the hammer and trigger—it will work into the mechanism.

To clean a pistol which has not been fired, rub the outside with a lightly oiled rag and then with a perfectly dry one. Swab the bore and chamber with an oily flannel patch and wipe off the oil with a perfectly dry patch. Use a small, clean brush to dust out all crevices. If the pistol is to be stored, do not use a cover or place plugs in the chamber and bore—they will cause sweating and promote rust. Because leather absorbs moisture even when it looks dry, pistols should not be stored in holsters.

THE CALIBER .30 MACHINE GUN



. . . You Will Use It in Practice

The caliber .30, no longer used in aerial combat except on some Navy planes, still is standard equipment for range practice because it uses smaller ammunition. Its operation and care are almost like the caliber .50. The only differences which must be known to use, clean, and adjust the gun are illustrated on the next pages.

DIFFERENCES IN PERFORMANCE

	CALIBER .50	CALIBER .30
Weight	64 pounds	20 pounds
Rate of fire per minute	750-850 rounds	1,350 rounds (approx.)
Muzzle velocity (at 78 feet from muzzle, with A.P. M2)	2,900 feet per sec.	2,715 feet per sec.
Chamber pressure per sq. in.	50,000 to 52,000 pounds	48,000 to 50,000 pounds
Maximum range A.P. M2	7,200 yards	4,500 yards

DIFFERENCES IN CONSTRUCTION

CALIBER .50	CALIBER .30
Back Plate Group	
Trigger always near the top of the back plate.	Trigger below the buffer tube with Mk 12 Adapter.
Bolt Group	
Ejector pivots to the rear as well as sideways.	Ejector pivots sideways only. In changing the direction of feed, the ejector must be placed on the side of the extractor assembly where it will be on the same side of the ammunition as the cartridge stops.
Extractor assembly guided by a lug which rides over the extractor switch on recoil and under it on counter recoil.	Extractor assembly guided by a plunger and spring which ride along the side of the extractor feed cam on recoil, then spring out and ride under it on counter recoil.
Both ends of the bolt stud same length.	Long end of the bolt stud goes into the bolt.
Two-piece firing pin assembly—one notch.	One-piece firing pin—two notches.
Vertical sear held by a sear slide.	Horizontal sear held by a sear holder, with a plunger and plunger spring.
Double driving spring.	Single driving spring.

CALIBER .50	CALIBER .30
Oil Buffer Group — Lockframe Group	
Removable breech lock depressors.	Breech lock depressors are a fixed part of the lockframe body.
Shoulders of the oil buffer body stop the accelerator.	An accelerator stop pin stops the accelerator.
Barrel's recoil absorbed by the oil buffer and oil buffer spring.	Barrel's recoil absorbed only by the barrel plunger spring.
Trigger bar and trigger bar pin are in the casing group.	Trigger bar, trigger bar pin, and trigger bar spring are in the lockframe group.
Barrel Group	
Eight lands and eight grooves. Barrel has narrow, V-shaped locking notches; head of the barrel locking spring is pointed.	Four lands and four grooves. Barrel has square locking notches; the barrel locking spring is square-headed.
Barrel extension shank and hook connect the barrel group with the oil buffer.	The barrel plunger stud compresses the barrel plunger spring. The barrel extension T-lug is a locking surface for the accelerator.
Cover Group	
	Same as caliber .50
Retracting Slide Group	
Grip and lever to provide leverage.	Handle, but no lever.
Casing Group	
One-piece front barrel bearing.	Front barrel bearing assembly, which increases the recoil force by letting some of the expanding gases push back on the muzzle of the barrel.
For right feed, front and rear cartridge stops and a link stripper are used; for left feed, a front cartridge stop and a right-hand rear cartridge stop assembly.	For either right or left feed, only front and rear cartridge stops are used; rear stop acts as a link stripper.
Extractor switch guides the lug on the extractor assembly.	Extractor feed cam guides the plunger and plunger spring on the extractor assembly.

DIFFERENCE IN HEADSPACE ADJUSTMENT

After field stripping the caliber .30, remove the nose of the barrel locking spring from the barrel locking notch and move it to one side, letting it rest on the barrel extension.

Put the bolt, with the extractor assembly removed, on the barrel extension, push it all the way forward, turn the parts upside down, and hold the breech lock down in its recess with your thumb. Screw the barrel in until you feel the breech end hits the lips of T-slot. **Unscrew the barrel just enough to seat the barrel locking spring in the nearest notch.**

NOTES

NOTES

SIGHTING AND SIGHTS

RESTRICTED

Don't shoot from the hip . . .

In the excitement of combat too many gunners spray their bullets at the enemy like a movie cowboy shooting from the hip. **Don't do it.**

Use your sight—and use it correctly—or you won't stand a chance of hitting. You will only throw away ammunition on which your life may depend.

Firing a gun from a fast moving bomber is far different from shooting on the ground. Except for one very rare case, you can't possibly hit a fighter by pointing your gun straight at him. You must aim a certain distance away, called **deflection.** To apply the right amount of deflection you use your sight. Two main types of sights are used by air gunners. **Computing sights** calculate the deflection automatically. You make certain adjustments. The sight does the rest. How to use computing sights is explained in the last part of this section.

But if your guns have **ring sights,** you must measure off the deflection yourself. You can only do so by using the accurate and combat-tested method of sighting called **Position Firing,** which is explained in these pages. Ring sights fall into two classes. One kind—the iron sight—is simply an iron ring near the back of the gun which you line up with a bead on a post at the front of the gun. The other kind—the reflector sight—uses a system of lenses to make the ring, the center bead and the enemy fighter all appear on the same glass screen.

Some sights, both iron and reflector, have one ring. Others have two rings, and the newest Army Air Forces sights have three rings. But Position Firing works with all of them, regardless of the number of rings. This section is illustrated with a three ring reflector sight. Once you know the rules of Position Firing, you will have no trouble applying them with any other type of ring sight. The principle remains the same. Always remember that no matter how good a shot you are on the ground, you can never shoot down an enemy fighter who is making a continuous attack on you unless you **use your sights correctly** and follow the rules of Position Firing. There is only one exception —dumb luck—and that isn't good enough. The enemy may be lucky first.

POSITION FIRING

When the fighter attacks . . .

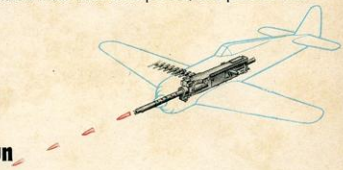
When you see an enemy fighter like this, with his guns blazing, you won't have time to think about the rules of Position Firing. You will have to know them so well that you act as quickly and automatically as your gun.

Fortunately, Position Firing boils down to three simple rules.

They have been proved in combat and scientifically checked. They work—better than any other system of sighting.

You may run into gunners who use other methods or no method at all. However, if there is a ring sight on your gun, this is the way to use it against a fighter making a direct and continuous attack on you.

If you follow the rules of Position Firing, you can get your mission through and get yourself safely home. But you will have to know these rules letter-perfect, and practice them until they become second nature.



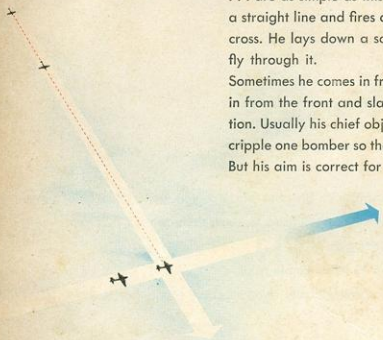
. . . he is a flying gun

To understand Position Firing, it is necessary to know what the fighter does when he attacks a bomber.

His guns are fixed. They are mounted in his wings and fuselage, pointing straight ahead. To aim them, he must aim his entire plane. He is really nothing but a flying gun. To hit you, he must point his nose at a spot ahead of the nose of your bomber, so that his bullets will be there by the time you get there.

To do this he can make a **fly-through attack,** or he can fly a **pursuit curve.**

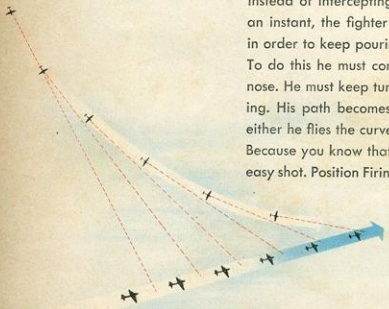
Fly-through attacks . . .



. . . are as simple as this picture indicates. The fighter flies in a straight line and fires at a point he expects your bomber to cross. He lays down a screen of fire and hopes that you will fly through it.

Sometimes he comes in from the side, like this. Often he comes in from the front and slams right through the bomber formation. Usually his chief object is to break up the formation or to cripple one bomber so that he can pick it off when it straggles. But his aim is correct for only an instant.

Pursuit curve attacks . . .



. . . develop like this. They are the standard type of fighter attack, and the most dangerous.

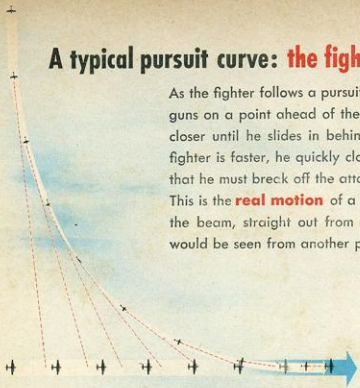
Instead of intercepting your bomber with his bullets for just an instant, the fighter tries to maintain a continuous attack, in order to keep pouring a constant stream of bullets at you. To do this he must continue to point ahead of the bomber's nose. He must keep turning in the direction the bomber is flying. His path becomes a smooth curve. He has no choice—either he flies the curve or his bullets won't keep hitting.

Because you know that he must fly this curve, he becomes an easy shot. Position Firing tells you how to hit him on that curve.

A typical pursuit curve: the fighter does this

As the fighter follows a pursuit curve, continually keeping his guns on a point ahead of the bomber, he moves closer and closer until he slides in behind the bomber's tail. Since the fighter is faster, he quickly closes in. Finally he gets so close that he must break off the attack.

This is the **real motion** of a fighter on a pursuit curve from the beam, straight out from the side of the bomber, as it would be seen from another plane high overhead.

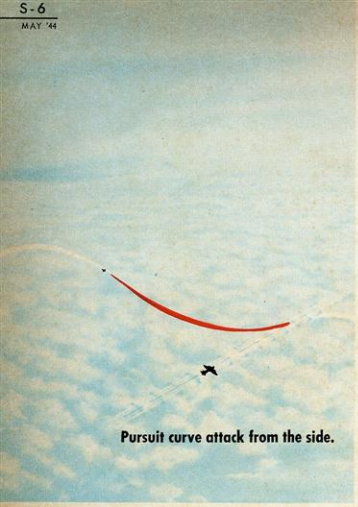


A typical pursuit curve: the gunner sees this

To the gunner, the fighter flying a pursuit curve always appears just about head-on. This is the one sure way to spot an attack.

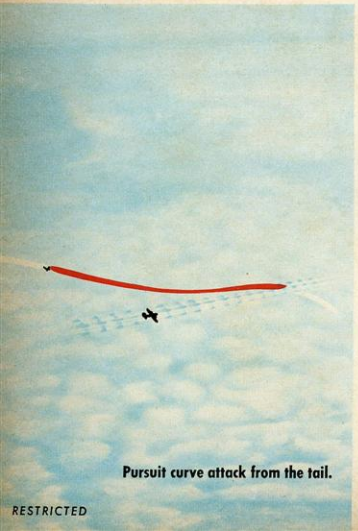
Although the fighter really flies in a curve, he always looks to you as though **he slides sideways, in a straight line, toward your bomber's tail.** This is the line of the fighter's **apparent motion.**

He also keeps getting bigger, because he is coming closer—fast. To you in the bomber, the beam attack above looks like this.



Pursuit curve attack from the side.

Pursuit curve attack from the bow.



Pursuit curve attack from the tail.

Pursuit curve attack from overhead.

Fighters will try anything . . .

They may come in from the side, the bow, the tail, or even from overhead. But all these attacks have one thing in common, as shown on the opposite page. No matter from what direction the fighter approaches, he must maneuver into a position where he can get his guns bearing on you.

To keep them bearing he must fly a pursuit curve.

That is the part of the attack where he is really dangerous to you, and fortunately, that's where Position Firing makes him easiest for you to hit.

Remember, you are moving too . . .

This is not as self-evident as it seems, because when you are flying in a bomber, you're rarely conscious of your own motion.

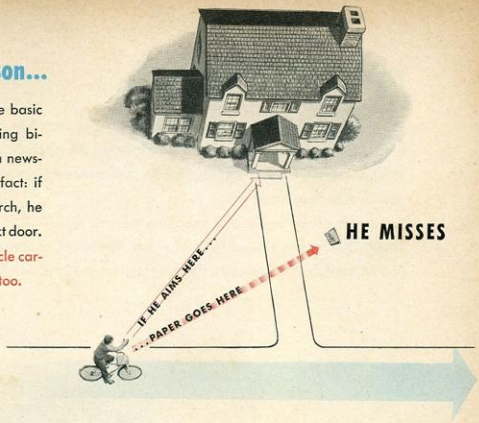
But the simple fact that you are moving at high speed is of the greatest importance in learning where to aim.

Believe it or not—

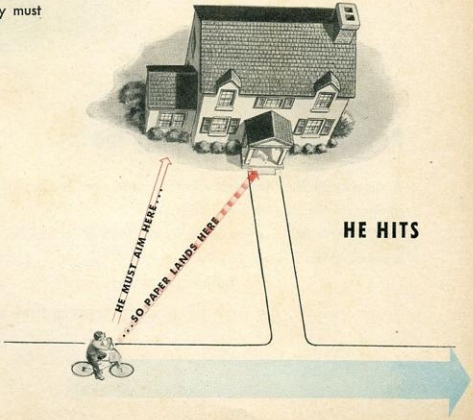
Your bullets do not go where you point your gun.

The newsboy's lesson...

Every newsboy soon learns the basic trick of aiming from his moving bicycle. The first time he tosses a newspaper he discovers a simple fact: if he aims directly at a front porch, he misses, and the paper lands next door. The forward motion of his bicycle carries the newspaper forward, too.



To hit the porch, the newsboy must aim like this

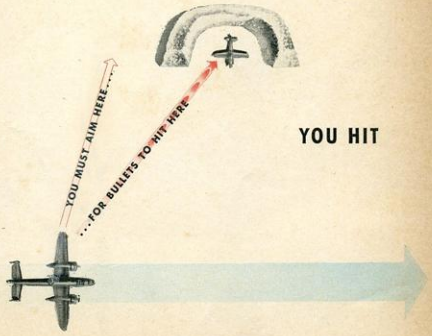


...applies to bombers, too

The same thing happens to a bullet fired from a moving plane. Before the bullet is fired, it is carried forward in the same direction as the bomber. When the gun is fired, the bullet shoots out of the barrel in a different direction. As soon as it leaves the muzzle, the bullet turns and follows a path between those two directions. It keeps the forward motion given it by the moving bomber.

You will miss if you fly over a field and shoot like this at a fighter on the ground.

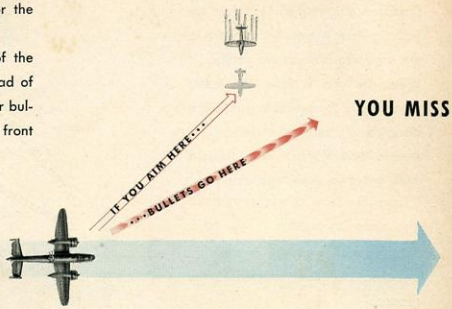
To hit, you must aim like this.



Hitting a moving fighter...

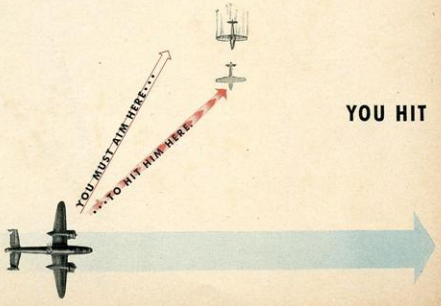
If the fighter is moving toward your bomber, you must still allow for the forward motion of your bullet.

If you aim at a point ahead of the moving fighter, as you aim ahead of a running fox, you will miss. Your bullets, carried forward, will pass in front of the fighter.



YOU MISS

To hit, you must aim like this. Then the fighter and your bullets will arrive at the same place at the same time.

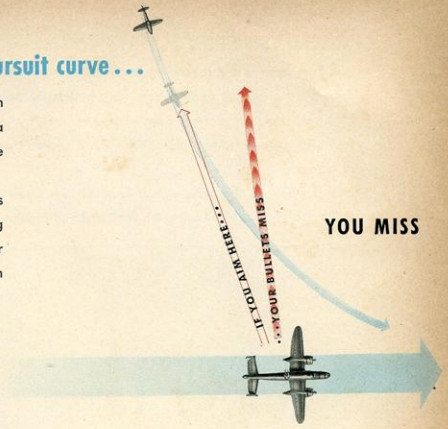


YOU HIT

Hitting a fighter on a pursuit curve . . .

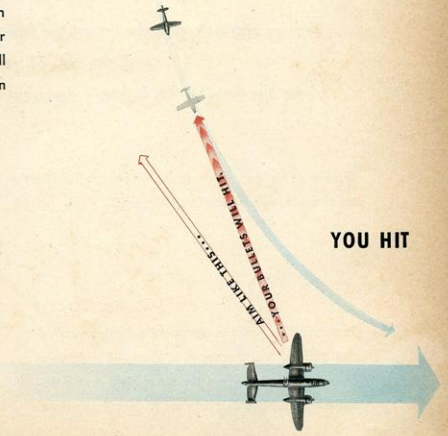
If the bomber and fighter are both in the air, and the fighter is making a pursuit curve attack, the same principle holds.

If you try to lead ahead of a fighter, as you ordinarily would aim at a flying duck, you will miss, because your bullet, carried forward by your own speed, goes ahead of him.



YOU MISS

To hit you must aim like this. Position Firing corrects for the distance your bullet is carried forward so that it will meet the fighter instead of passing in front of him.

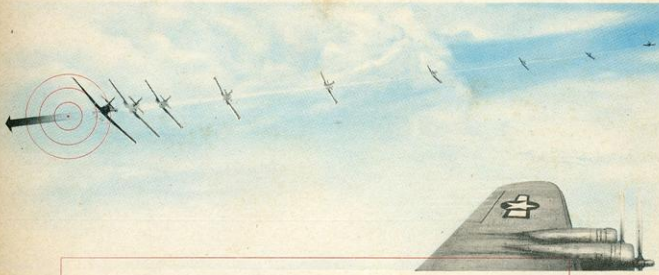


YOU HIT

Where you aim . . .

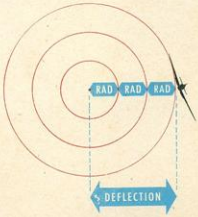
You have seen in the preceding pages, that if you shoot in any direction other than dead ahead or dead astern, your bullets do **not** go where you aim. The bullets not only move away from your gun, but they are also carried forward—and they are carried forward regardless of whether you fire to the side, above, or below.

Like the boy on the bicycle, you must always allow for this forward motion. Make this allowance by using the **first rule** of Position Firing:



Always aim between the attacking fighter and the tail of your own bomber along the line of the fighter's apparent motion

This line of his apparent motion is always in the direction of that spot on the horizon toward which your bomber's tail points.



Rads . . .

The amount you aim away from the fighter is called **deflection.** It is measured in **Rads**—the distance between the center and the inner ring, or the distance between two rings in your 35-70 mil ring sight.

The right deflection

varies in accordance with your own bomber's speed. When your bomber's normal speed is 200 knots, the right deflection will vary from 3-0 rads, depending on the direction of the fighter's attack.

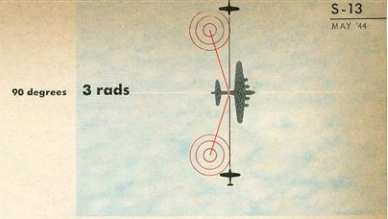
Therefore the Second Rule is:

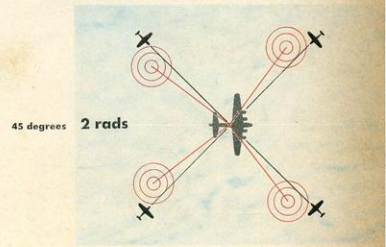
Use the right amount of deflection

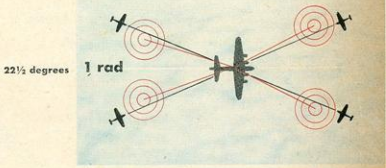
If you are flying in a bomber whose speed is 200 knots and fire at a ninety degree angle—straight out from the beam—you must make the maximum allowance of 3 rads for the amount the bullet is carried forward. When you fire dead ahead or dead astern, the forward motion of your bomber does not change the direction of your bullet; therefore, the direction is 0 or point blank.

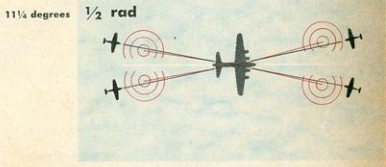
At any other angle in between, the right amount of deflection is somewhere between 3 and 0 rads.

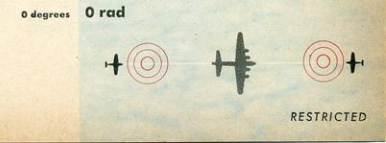
Learn the deflections for the key directions of attack shown alongside. When you are assigned to a squadron you must learn the right deflections in accordance with the normal speed of the bombers in your squadron.

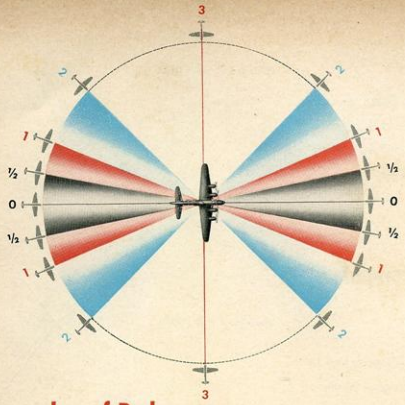








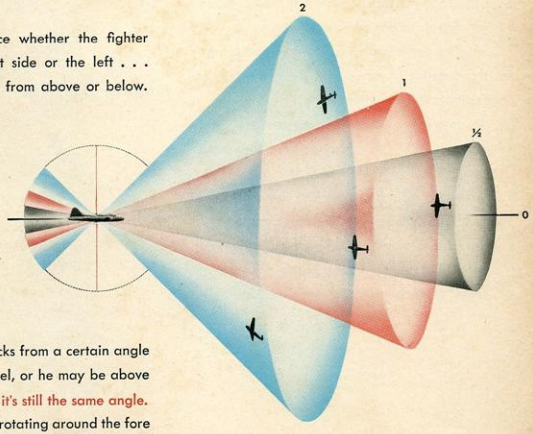




The number of Rads...

always depends on the fighter's angle to your fore and aft axis.

It makes no difference whether the fighter attacks from the right side or the left . . . or whether he attacks from above or below.

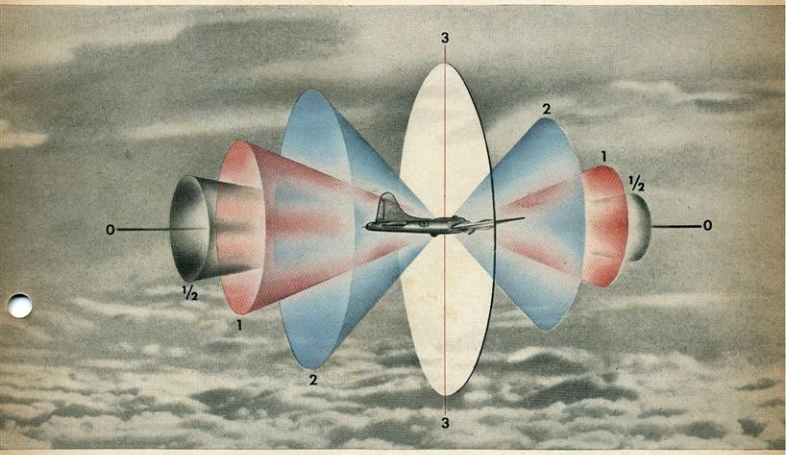


When the fighter attacks from a certain angle he may be at your level, or he may be above you or below you. But it's still the same angle. Think of that angle as rotating around the fore and aft axis of your bomber so that it forms **the surface of a cone.**

The cones tell you the deflection...

Think of the key directions of attack as surfaces of cones which go out into the sky around your bomber, both behind and in front of you.

Remember these imaginary cones by their numbers—½, 1, 2, 3. The number of the cone gives you the deflection in rads for any fighter on the surface of that cone, whether he attacks from the right or the left; high, level, or low, based on your bomber's speed.



Know your true airspeed...

Changes in the speed of the fighter on the pursuit curve do not change your deflection.

BUT CHANGES IN YOUR TRUE AIRSPEED DO CHANGE YOUR DEFLECTION.

The deflections shown above are correct for 200 knots true airspeed of the bomber. To hit an attacking fighter on cone ½—off your fore-and-aft axis—use ½ rad deflection. For a fighter on cone 1, use 1 rad, and for a fighter on cone 2, use 2 rads of deflection. The 3 rad position—at right angles to your line of flight—is a wheel rather than a cone. But the same rule applies: for a fighter in this position, use 3 rads of deflection.

(A good rule of thumb to remember is:—For each 25 knots increase in bombers speed, increase deflection ⅓ rad. For each 25 knots decrease in bombers speed, decrease deflection ⅓ rad.)

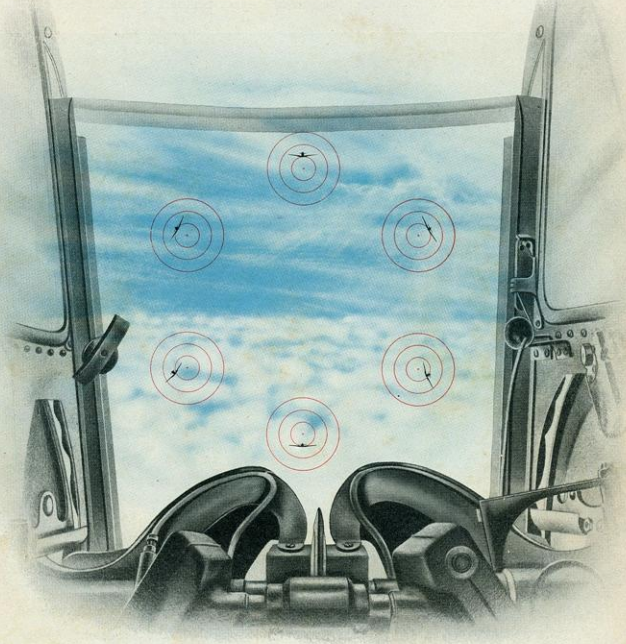
Check your true airspeed with your pilot, navigator or bombardier.

The illustrations on these two pages demonstrate how to apply Rules 1 and 2—using the three-ring optical sight which is shown in all the drawings in this section.

Note, on both pages, how the deflection is laid off in the direction of the tail of your bomber (Rule 1).

Note also how all fighters coming from the same angle are given the same deflection (Rule 2)—regardless of whether they come from above, below, or to one side.

All the fighters on these two pages are on cone 1 and take a 1 rad deflection.



The tail gunner aims like this . . .

On tail attacks you always aim **inside** the fighter. When he dives on you, aim below him. When he climbs on you, aim above him. In these illustrations, of course, the sliding motion of the fighter toward the bomber's tail cannot be seen. But the point of aim has been placed along his line of apparent motion.

In attacks from the front, the fighter's line of apparent motion is still in the direction of your bomber's tail.

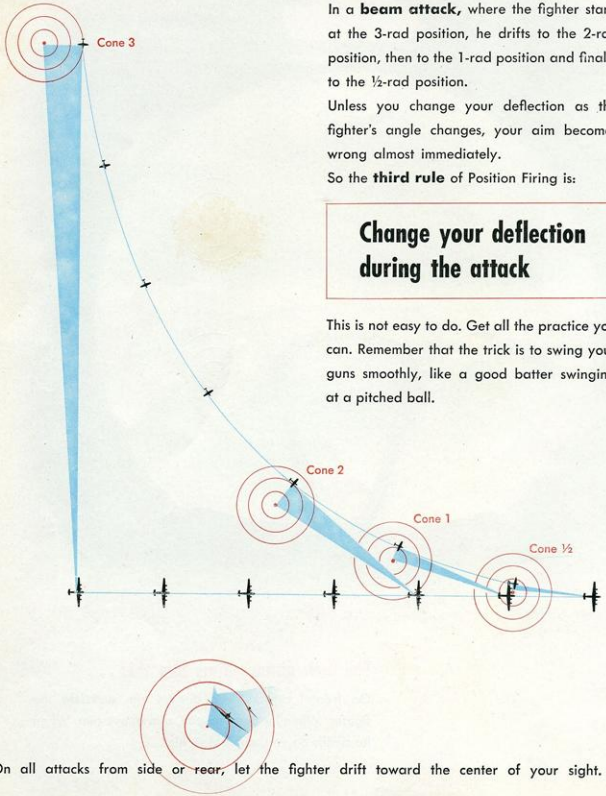
If you have trouble thinking of aiming in the direction of the tail, just remember to aim away from your bomber's nose—which is the same thing.

The bow gunner aims like this . . .

On frontal attacks, you always aim **outside** the fighter. When he dives on you, aim above him. When he climbs on you, aim below him.

Deflection changes during an attack . . .

The fighter is sliding in from . . .



The fighter never stays on one cone. His pursuit curve always forces him closer to the bomber's tail. During the attack, he moves from one cone to another—and he moves fast. In a **beam attack,** where the fighter starts at the 3-rad position, he drifts to the 2-rad position, then to the 1-rad position and finally to the ½-rad position.

Unless you change your deflection as the fighter's angle changes, your aim becomes wrong almost immediately.

So the **third rule** of Position Firing is:

Change your deflection during the attack

This is not easy to do. Get all the practice you can. Remember that the trick is to swing your guns smoothly, like a good batter swinging at a pitched ball.

On all attacks from side or rear, let the fighter drift toward the center of your sight.

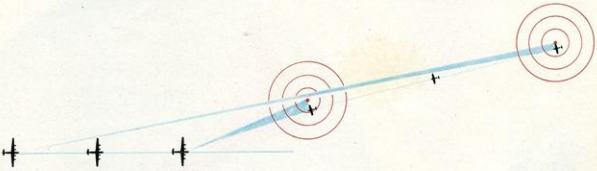
He is on your beam at right angles. Give him 3 rads.

As he slides to Cone 2, reduce your deflection slowly to 2 rads.

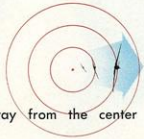
He swings to Cone 1. Follow through smoothly to give him 1 rad.

As he moves to Cone ½, let him slip in to ½ rad.

These pictures show how you change deflection during the beam attack on the opposite page.



If a fighter starts a **bow attack** on Cone ½, he will move very quickly to Cone 1 and even faster toward Cone 2—if he can hold his pursuit curve that long without blacking out.

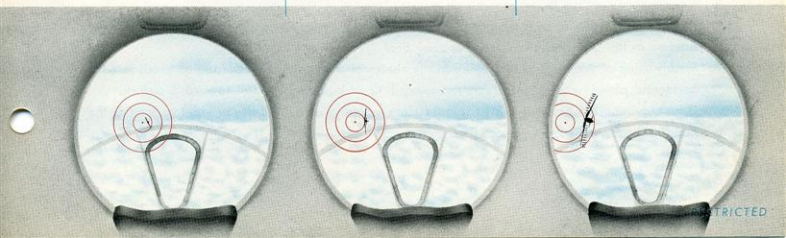


On attacks from the front, let the fighter drift away from the center of your sight.

When he's on Cone ½, you give him ½ rad.

He changes to Cone 1. Let him drift out to the 1 rad ring.

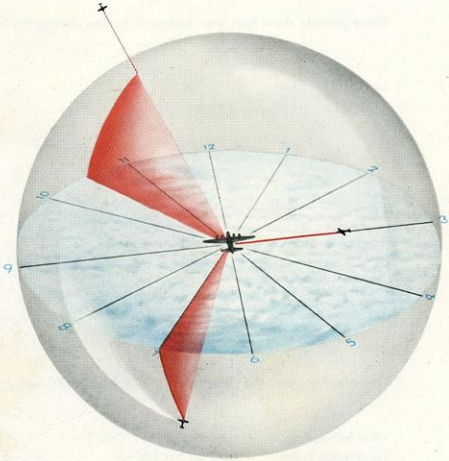
As he whips toward Cone 2, increase deflection to 2 rads.



You've got to be on the ball—or else.

No bomber is safe unless each gunner searches the sky constantly throughout each mission. Search systematically and continuously the portion of sky assigned to you, especially in the sun and in broken clouds, where fighters like to hide. Be ready for any trick from any fighter you see. You are responsible for seeing that your airplane is never surprised.

Bombers and their crews have been needlessly lost because gunners were not watching and let fighters sneak in on them.



The clock system . . .

. . . has nothing to do with the cones. You use it to tell the entire crew when there are enemy fighters in the sky, and exactly where they are.

Simply think of your bomber as flying in the center of a huge clock, the face of which is on a horizontal plane, with the nose pointed toward 12 o'clock and the tail toward 6 o'clock.

If you imagine the hand of this imaginary clock pointing at a fighter you want to locate, the hand will show at what "o'clock" that fighter is.

If you are a tail gunner, don't be confused by the fact that you are riding backward. You are facing 6 o'clock. 3 o'clock is on your **left,** 9 o'clock is on your **right.**

When you spot an enemy, sound off . . .

1. "Bandits"—The word used to call attention.
2. The number of bandits and the type—for example; "two bandit fighters".
3. The approximate range.
4. At what o'clock the bandit is.
5. "High", "level", "low", depending on whether the bandit is above, at the same level, or below your bomber.
6. "Coming in" but only when the bandit really turns into the attack.

For the top fighter in the picture call:

One Bandit - 10:30 o'clock. - High.

For the right hand fighter call:

One Bandit - 3 o'clock. - Level. **Coming in!**

For the bottom fighter call:

One Bandit - 7 o'clock. - Low.

Never fail to sound off when bandits appear, because you may be the only one who sees them. No single crew member can see all the sky around the bomber from his turret or window. Even the pilot can see very little except straight ahead.

Your warning may be the crew's only notice of an attack. It will help other gunners bring their guns to bear and will allow the pilot to take the necessary evasive action.

On the other hand, don't jam the interphone with excited double talk. Be sure to say "coming in", but **only** when the fighter really turns in. Otherwise you may have the whole crew swinging their guns at a plane a mile away, while some smart fighter slips in and picks you off. Some pilots may want you to call "in range" when the fighter is about to get his guns bearing, to guide them in any special evasive action they may wish to take.

WATCH THIS ONE—he's up to no good.

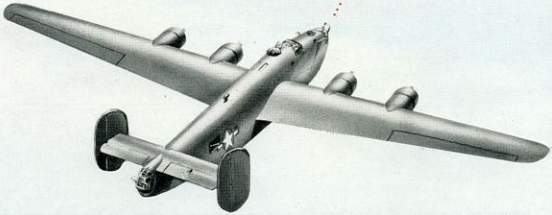
When to fire...

Expert studies show that aerial machine guns are most effective at ranges up to 2000 feet. Very careful calculations prove that further out bullets scatter so widely that they make your chances of a hit almost entirely a matter of luck. You can't hope to break even on the game that way.

Most fighters who are any good won't open up on you outside of 2000 feet. A good fighter pilot may wait until he is much closer. Watch him through your ring sight. Be ready with the right deflection and let him have it at 2000 feet. Nose attacks are so fast that you should begin shooting when he's lined up on you—normally at 3000 feet.

The exact time to start firing and the proper length of burst to fire depend on combat conditions. They are determined, in each theater, by the type of mission usually flown, ammunition loads, and enemy tactics.

....GIVE HIM THE WORKS....



Some squadrons, for example, instruct their gunners to start shooting as soon as the fighter appears head on, short bursts at first, longer ones as he gets within 2000 feet. Bursts at a longer range than 2000 feet have been known to scare fighters away. On long missions the length of bursts must be kept short to conserve ammunition. **You can't afford to be left with empty ammunition cans.**

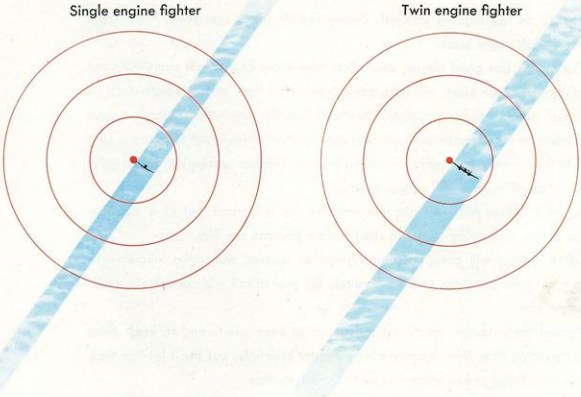
If you do run out of ammunition, or your guns fail, keep swinging them at the enemy anyway. Never let them know you can't hurt them—or they will be all over you.

....LET HIM GO

You can tell the range...

by the size of the fighter in the 35 mil rad of your sight. At 2000 feet the average single engine fighter fills about ½ rad in your ring sight. Most twin engine fighters fill ¾ of a rad. At 3000 feet they fill less—⅓ of a rad for a single engine fighter and ½ of a rad for a twin engine fighter.

How a fighter looks at 2000 feet



Average single engine fighter	Range	Average twin engine fighter
⅓ rad	3000 feet	½ rad
½ rad	2000 feet	¾ rad

When you spot a fighter — or get the warning over the interphone— be ready for anything.

There's no use kidding yourself. Enemy fighter pilots are good. They know every trick in the book.

The enemy has good planes, and pilots who know how to get everything out of them. Fighter pilots will take advantage of all their strong points—such as armor, speed, maneuverability. They will look for any weak points on your bomber or your formation—such as a gun position which is not firing, or a spot with the fewest guns bearing on them. When a bomber is crippled or straggles out of position, they will attack it viciously.

A smart fighter pilot will also use weather. He will sneak out of a cloud or out of the sun—trying to get in close before you can see him.

Often fighters will gang up. One fighter, or several, will make fake attacks to draw your attention. In the meantime, the real attack will come from somewhere else.

Against these tactics, your best defense is to keep alert—and to keep calm at the same time. Watch every enemy fighter carefully, but don't let him trick you in to firing at him when you don't have a chance.

> On pages S-26-31 you will see four fundamental fighter attacks.
>
> To make these attacks, the fighter must go through certain easily recognized maneuvers—illustrated on the opposite page for an attack from the left beam. All these attacks have some or all of these phases, but they all end up with guns bearing in the pursuit curve—sliding toward your tail.

That's when he's your meat.

OVERTAKING

The fighter flies a parallel course with the bomber, usually more than 3000 feet away. He continues this until he reaches the right point for his . . .

TURN-IN

The fighter banks for a turn that will bring his guns to bear slightly ahead of your nose. For a moment he seems to hang motionless in the air—his far wing up, as though hanging from a hook.

ROLL-THROUGH

He has now turned toward you, but must still reverse his turn to get his guns bearing.

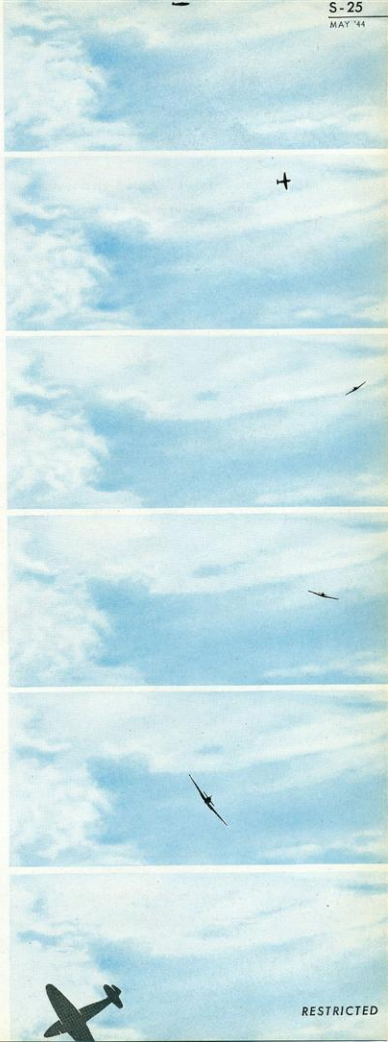
As he does this, he rolls his high wing down, which brings him to the beginning of . . .

GUNS BEARING

This is where you get him. Rapidly growing larger as he comes closer, he appears to slide back toward your tail.

BREAKAWAY

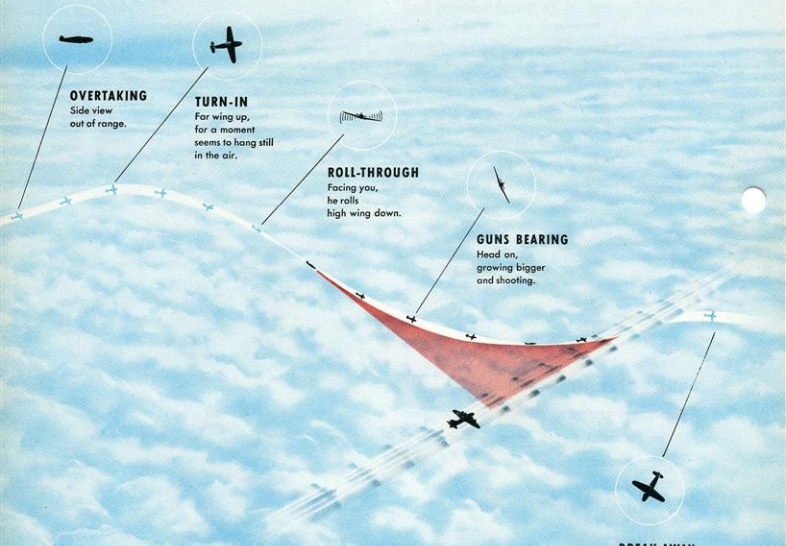
When he decides to break off, the fighter sometimes makes a climbing, but more often a diving turn. He frequently rolls over on his back to expose his seat armor as he tries to get away and into position for a new attack.



SIDE attack...

The side attack is usually used against single bombers, rarely against formations. It can be made from above, at, or slightly below your level.

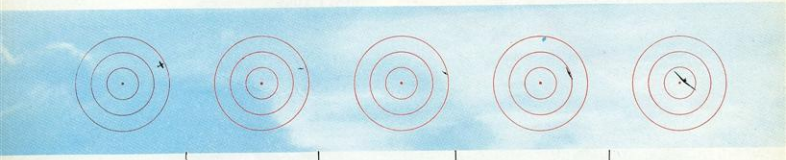
This drawing shows a high side attack from the beam, with the fighter getting his guns bearing about 2000 feet out. To press the attack home to close range, he must drift well into your tail cone where you really have a good crack at him.



The planes in the white circles on this and the following pages show how the fighter looks from the bomber during the different phases of the attacks illustrated.

From a top turret . . .

A high side attack looks like this. Out of range, the fighter pulls ahead of you. His far wing goes up, and for a moment he seems to hang from it as though from a hook. He then quickly swings into a head on position and starts his apparent slide. Rolling his high wing down, he moves in a straight line toward your tail. As he shifts from cone to cone, he gets bigger. He may break away above you. This gives you a momentary no deflection shot only if he appears to hang there. More often he'll roll on his back and dive away under you.



1 He's over 3000 feet. "Give the word" but hold your fire.

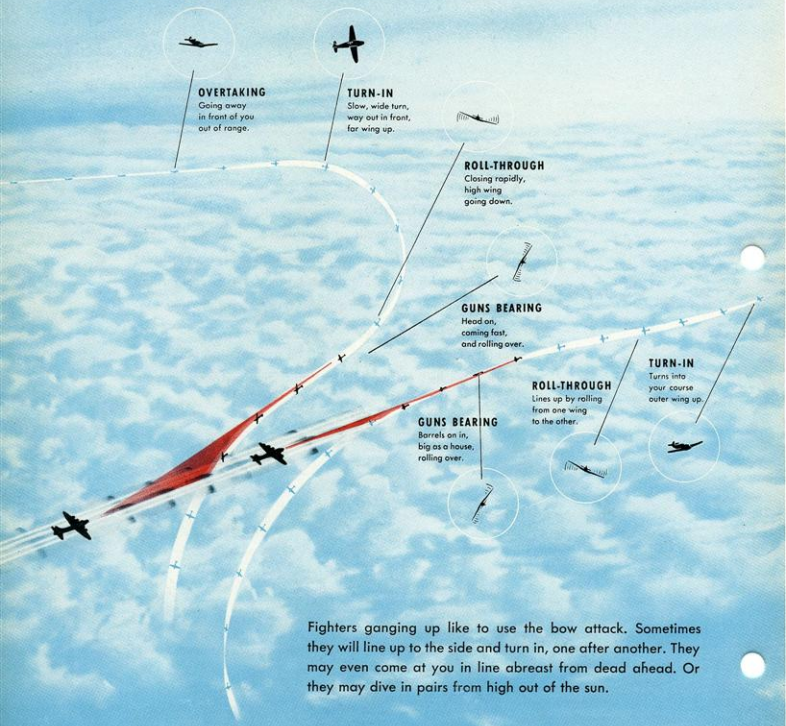
2 Still too far, but start tracking him.

3 2000 feet on Cone 3. Give him 3 rads and start shooting.

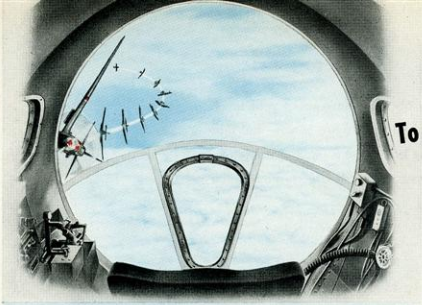
4 1000 feet. By now he's on Cone 2. Let him drift smoothly toward your sight center.

5 500 feet. "He's cooking with gas." Stay with him— ½ rad on Cone ½.

BOW attacks are extremely fast. Closing speeds may be 500 to 700 miles per hour. They may be made by fighters intercepting your formation, or overtaking you while flying in the same direction. The enemy will fly out to the side, well out of range, until he reaches a point far ahead. After turning until he faces you, he rolls through and hurtles toward you. He may try for a few seconds to hold a pursuit curve, a little from the side, and probably high. Or he may come from dead ahead, generally almost level with you, and possibly roll over on his back as he dives under you.



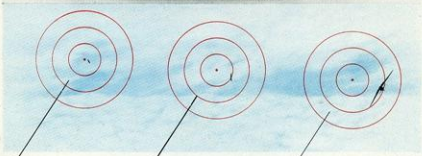
Fighters ganging up like to use the bow attack. Sometimes they will line up to the side and turn in, one after another. They may even come at you in line abreast from dead ahead. Or they may dive in pairs from high out of the sun.



To a bow gunner . . .

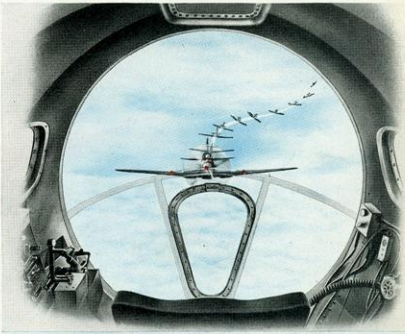
. . . a bow attack from the side looks like this. The fighter tries to hold a curve of pursuit for a second or two. As he does it, you must let him drift away from the center of your sight.

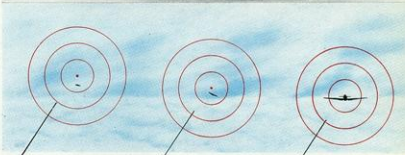
This illustration shows how you should follow him in your sight.



In an attack from dead ahead the fighter lines up with the bomber. He may roll over on his back or come straight on in as shown here. He grows larger at tremendous speed, and whips past almost before you know it. You only have a few seconds, but if you keep cool, he's an easy shot—almost no deflection.

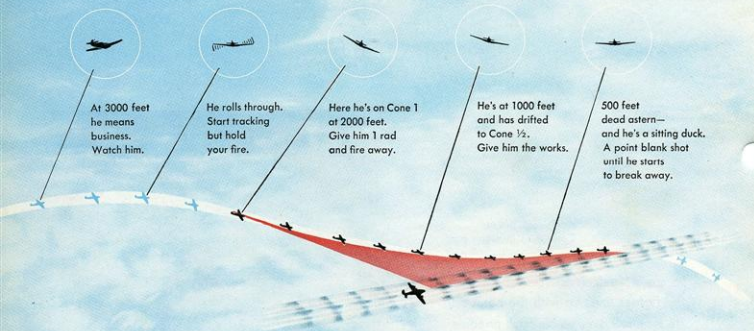
It is a little high, so you aim just above him as he expands in your sight . . . Because of the tremendous closing speed, you should begin firing at all bow attacks when the fighter is about 3000 feet out.





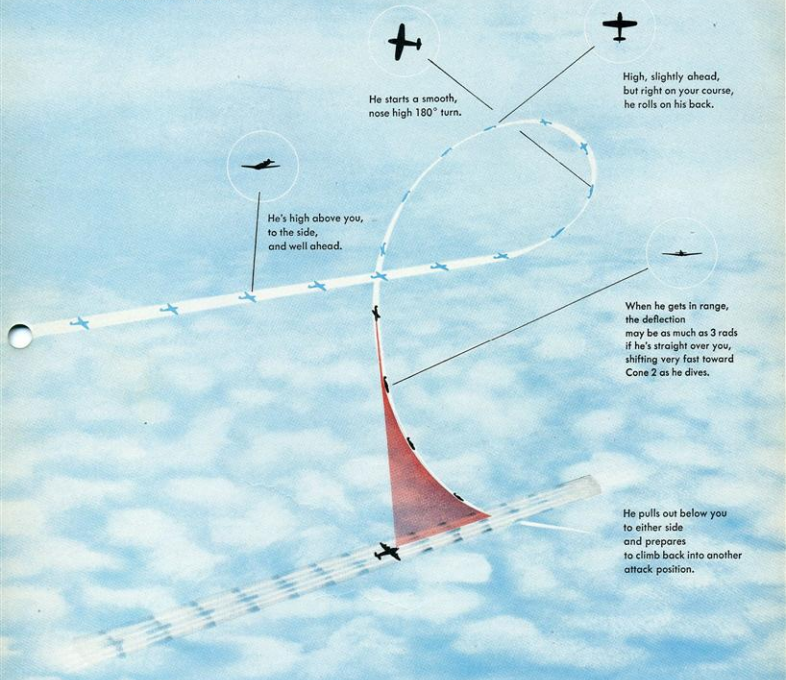
TAIL attack . . .

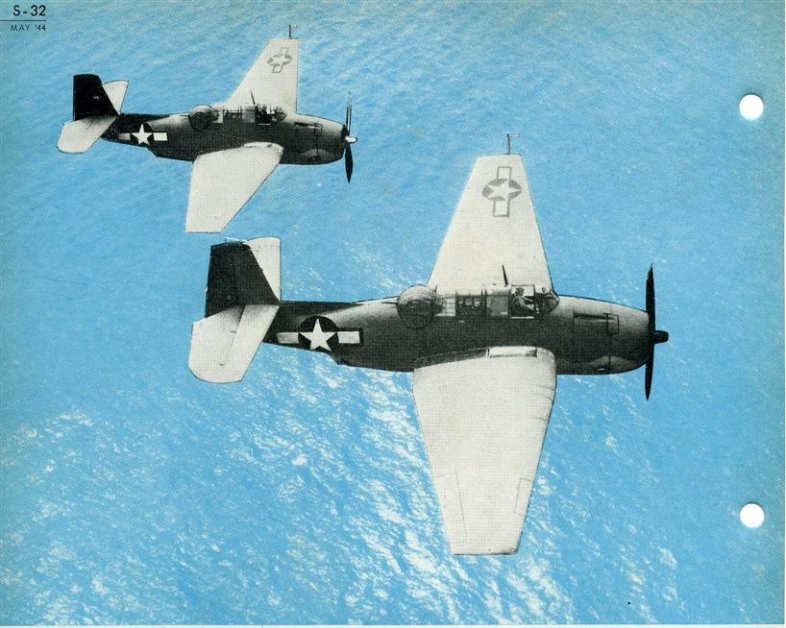
Tail attacks may come from above, below, or at your level. They give the fighter the longest time to fire at you—but that works both ways. You and he both have a small or no deflection shot, but with your turrets the odds are on you if you know your stuff.



A single enemy may dive in at an angle for a quick burst and twist away. Or several fighters may weave in and out, dead astern. Or one of a pair may try to distract you from a real attack by the other. Keep your fire on the one who keeps coming in. As soon as a fighter breaks away, forget him.

OVERHEAD attacks are rarely seen, because few fighter pilots are expert enough to try them. But if they are pulled on you by a good pilot, watch out. Don't be caught flat-footed. The fighter will count on surprising you. His dive is very fast, and you have a tough overhead shot. Any fighter high above you flying in the same direction you are, or on an opposite course, can dive into this attack.





When you finally take off—

- Remember that Position Firing is used only with 35 mil rad ring sights—not with computing sights—and only against fighters attacking you on a pursuit curve—or fly through.
- Position Firing is no cure all but it does take care of the enemy when he is most dangerous to you.
- Never let anybody sneak up on you.
- Spot his cone—pick the right deflection—stay with him.
- Don't waste your ammunition.
- Use your sight and—*never be caught with your guns down.*

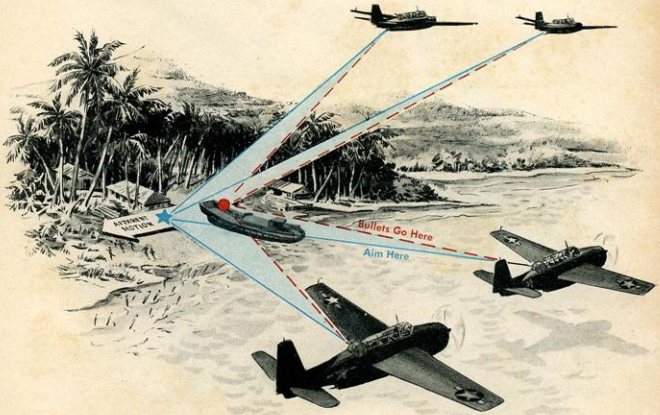
STRAFING

You will probably go often on missions where you will have the opportunity to strafe grounded planes, troops, ships or enemy installations. Your training in Position Firing will help you get the proper deflection. **The principles for strafing are the same fundamental ones that you use in firing at a fighter in a pursuit curve attack.** That point was brought out at the start of the section on Position Firing.

LOOK AT YOUR THREE RULES FOR POSITION FIRING.

1 **Always aim between the attacking fighter and the tail of your own bomber along the line of apparent motion.**

In strafing you also aim behind the target to allow for the effect of the motion of your own plane on your bullet. The picture of the newsboy in the Position Firing section illustrated this point. Just remember that in strafing, as well as in firing at an enemy plane in a pursuit curve attack, the deflection is still always applied **toward your tail.**

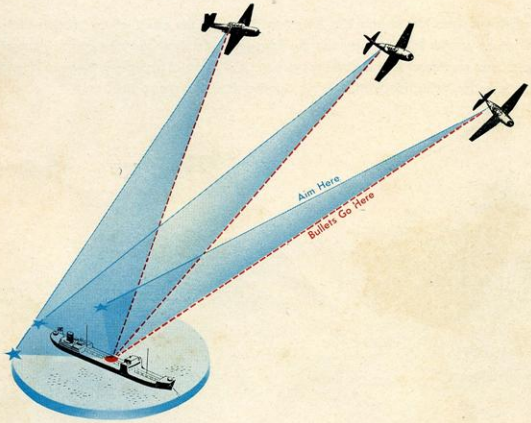


2 Use the right amount of deflection.

Your study of Position Firing will drill into you the correct Position Firing deflections for your own bomber's speed. When strafing, always allow a little bit **more,** usually not more than an additional ½ a rad at 90° and less than that for the smaller angles off, than you use in a pursuit curve attack. That is because of the slight difference between firing at a fighter in a pursuit curve attack and firing at a stationary target.

3 Change the deflection during the attack.

In strafing you also change your deflection according to the angle-off of the target. When strafing, it sometimes will be possible to see where your bullets are hitting. This will aid you in correcting and changing your deflection, but use the basic rules of Position Firing as the primary method of determining deflection.



The fact that Position Firing principles apply whether your plane flies a curved course or not is a great help in strafing. Even if your pilot flies a curved course around your target, your correct deflection is based on your own speed and the target's angle-off.

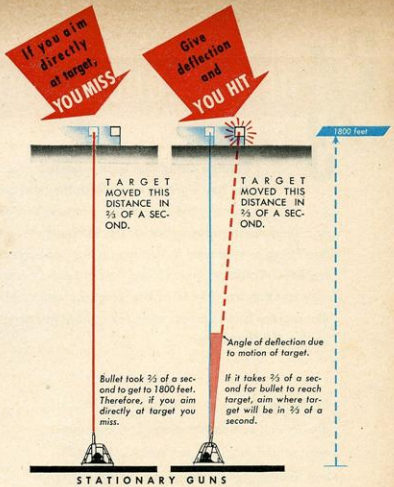
2/3 OF A SECOND METHOD OF SIGHTING

Position Firing has been emphasized in this manual because it is considered the best sighting method for the most dangerous firing situation you will face; namely, the pursuit curve attack. It "works" whether your pilot flies a straight or curved course when under attack. Furthermore, as has been said, the principles of Position Firing can be used in strafing. Important practice in Position Firing will be gained on the **3A-2 Trainer,** which is the best ground device so far developed for aerial free gunnery sighting training. Gunners returning from combat say their work on the 3A-2 trainer was a great help in preparation for combat gunnery. **Make the best use of your time in the 3A-2 rooms.**

Sighting practice, however, is not limited to the 3A-2. It can also be gained on your gunnery school machine gun ranges. It is difficult to simulate a pursuit curve attack on the railroad and towed sleeve ranges. These ranges do, however, give you practice in applying deflection on a moving target. On these ranges you should use another sighting method that is also a part of your free gunnery knowledge—namely, the ⅔ **OF A SECOND METHOD.** This is a **LINE OF APPARENT MOTION** method of sighting. You have already learned about the "line of apparent motion" in Position Firing. If you use the ⅔ of a Second Method on your gunnery school ranges you will be better able to handle firing situations in the air that cannot be handled by Position Firing—situations, for example, where a predetermined deflection will not apply.

A caliber .50 bullet travels about 1800 feet in ⅔ of a second.

The main principle of the ⅔ of a Second Method is that it takes a bullet about ⅔ of a second to get out to 1800 feet, a good average in-range firing distance, and a good range for your railroad targets. If you can estimate the distance that the moving target will move in ⅔ of a second, you can give the target the proper amount of deflection and get hits. A way to get the right amount of deflection on a target moving parallel to you at a range of 1800 feet is given in the three steps below:



1 Center the target in your ring sight at 1800 feet.

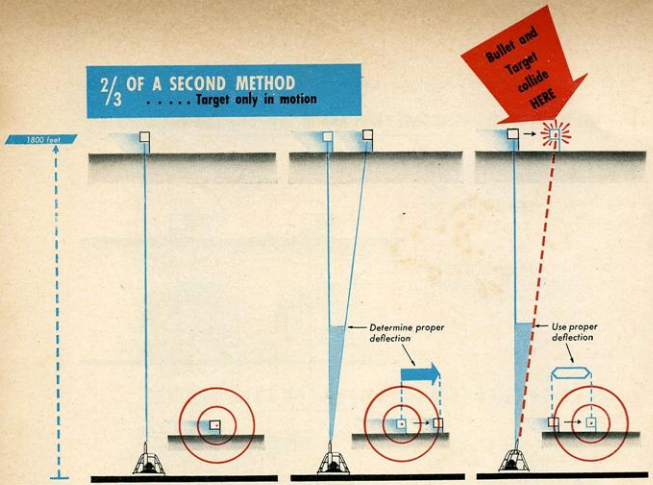
2 "Freeze" your gun and say out loud a word such as "elephant." (It has been found that saying a three syllable word takes about ⅔ of a second.) Note the target's line of apparent motion and how far it moves across your ring sight in ⅔ of a second while saying "elephant."

3 Place the target in the same corresponding position on the opposite side of your ring sight and open fire. You are now applying the proper deflection along the target's line of apparent motion.

If your target range is 1200 feet you should say a two syllable word such as "Japan" rather than "elephant." If the range is 600 feet you should say "Jap."

After enough practice with these steps you should be able to estimate the deflection for your moving target ranges without having to follow the full routine. But use the method at the start. Find out your own deflections on your railroad ranges by this method. With sufficient practice you will learn to determine the correct point of aim without stopping to think about it.

2/3 OF A SECOND METHOD
. . . . . Target only in motion



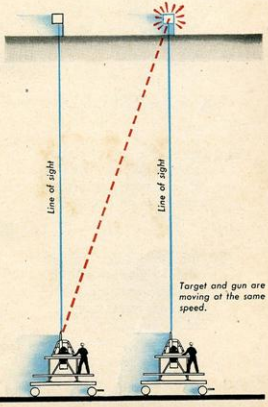
1 *Place target in center of sight.*

2 *"Freeze" gun and note direction and distance target moves in ⅔ of a second.*

3 *Then place the target the same distance on the opposite side of ring sight and fire.*

2/3 OF A SECOND METHOD
. . . . . Target <u>and</u> Gun in motion

So far, discussion has been directed toward the use of the ⅔ of a Second Method on the moving target-fixed base machine gun range (the target is moving, you're standing still). When it is used on a moving target-moving base machine gun range (the target moves and so do you), the situation is closer to what it will be in the air. By giving motion to your own shooting base, the real importance of the target's **LINE OF APPARENT MOTION** becomes evident.

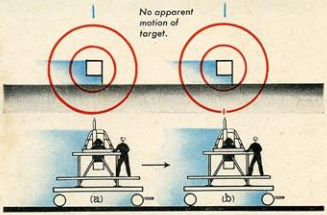


In the following cases, deflection is determined by the target's apparent motion.

1 WHEN TARGET IS MOVING AT SAME SPEED AND IN SAME DIRECTION AS YOU ARE . . .

(a) Freeze gun on target and note that there is no apparent motion in ⅔ of a second.

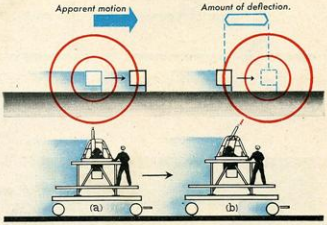
(b) Center sight on target (for all intents and purposes a no deflection shot) . . . . . and fire.



2 WHEN TARGET IS MOVING FASTER THAN YOU ARE . . .

(a) Determine line of apparent motion by freezing gun and note distance target moves on line in ⅔ of a second.

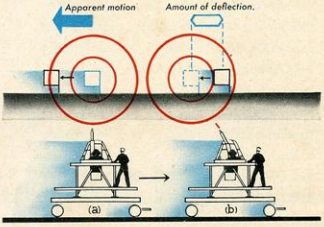
(b) Place target on opposite side of center of sight an equal distance on line of apparent motion and . . . fire.



3 WHEN TARGET IS MOVING SLOWER THAN YOU ARE . . .

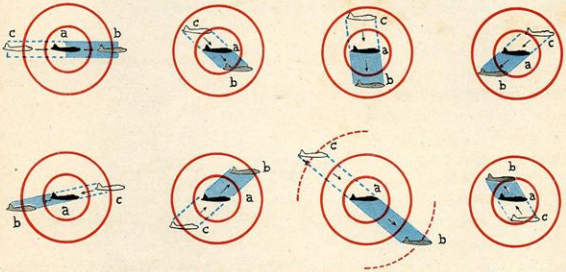
(a) Determine line of apparent motion by freezing gun and note distance target moves on line in ⅔ of a second.

(b) Place target on opposite side of center of sight an equal distance on line of apparent motion and . . . fire.



The same picture is present in the air. Assume that you are flying parallel to an enemy bomber. If the enemy is moving faster than you are, he will move forward in your ring sight. If he is moving slower than you are, he will move backward in your ring sight. In the air, the line of apparent motion may be in any direction—forward, back, up or down. As on the ground, you will find that when you fly a straight course, the deflection will always be applied along the target's line of apparent motion In air firing, at any but close ranges, a slight allowance for bullet slow-down will have to be made.

WHEN AN ENEMY BOMBER IS FLYING IN THE SAME GENERAL DIRECTION OR ON A PARALLEL COURSE AND IS WITHIN RANGE.



APPARENT MOTION FROM **a** TO **b**. PLACE ENEMY PLANE AT **c** AND FIRE.

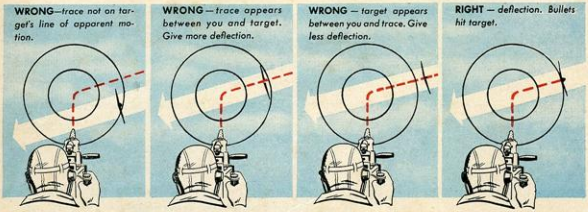
As illustrated in the examples above, the apparent motion may be in any direction. Through your training in the ⅔ of a second method, you can determine the line of apparent motion and the amount of deflection.

In Position Firing, deflections can be figured out ahead of time, based on the speed of your own plane. This is possible because a fighter plane trying to hit you usually flies a set track known as a Pursuit Curve. The fighter is limited by his fixed guns. However, oftentimes while on patrol you may come in contact with enemy bombers. On some occasions you may attack those planes; on other occasions, they may attack you. When they attack, the course they can fly is not limited by fixed guns. They will also have free guns and possibly turrets. The rules of Position Firing cannot ordinarily be used against this type of attack, but the principles of the **"LINE OF APPARENT MOTION" METHOD OF SIGHTING** learned on your gunnery school ranges through the use of the ⅔ of a Second Method **can.** Whenever you have a duel with an enemy bomber, while flying a **STRAIGHT** course, you can use the fundamentals of the ⅔ of a Second Method, learned on your gunnery school machine gun ranges.

TRACER

Tracer can be of help to you in sighting, but it also can play many false tricks unless you understand its behaviour. The main point to remember about tracer is—**never use it as the sole means of sighting.** When you use it, it should be used in connection with your ring sight and your regular sighting method.

Tracer bullets actually do not curve any more than any other kind of bullet, but when fired from a moving gun they appear to have what is called "CUT BACK." "Cut back" is what a stream of water appears to do when you swing a garden hose. When you swing your guns, the trace also appears to "cut back." The faster you swing your guns, the greater the "cut back." This effect will often make you think you are hitting the target when actually you are not. This is particularly true if you watch the whole tracer path, but if you watch the trace through your ring sight **at the target,** tracer can help. It can help you keep on the target's line of apparent motion. It can help you correct your deflection, if you watch the trace at the target. If the trace appears between you and the target, you are not giving enough deflection. On the other hand, if the target appears between you and the trace, you are giving too much deflection.



Again—to use tracer properly, use your regular sighting method to determine deflection; then watch the trace at the target through your ring sight.

Squadron doctrine will determine whether you have tracer belted in your ammunition and how it will be belted. When you have it, remember that tracer alone is not to be used as a sighting method. However, tracer can be a supplement to your regular sighting method, if properly used.

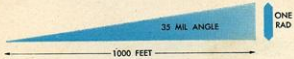
YOUR SIGHTS

Every gun you will use in combat, regardless of its construction, is equipped with some type of gun sight. The sight in **your** gun is a ring sight. It is designed to do two jobs. It can tell you, in the first place, when a fighter is in range, and in the second place, where to aim your gun to knock down that fighter.

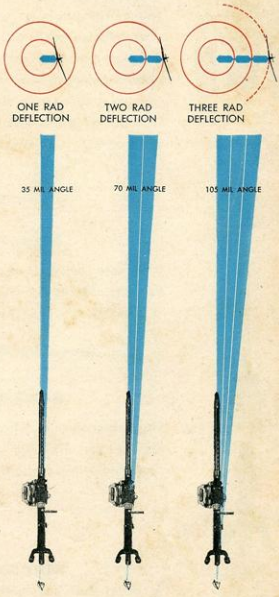
THE **35 MIL RAD** IS THE BASIC MEASURE OF ALL REFLECTOR AND IRON RING SIGHTS IN CURRENT USE IN NAVAL AVIATION FREE GUNNERY

To help you estimate range and apply the deflections required for Position Firing, your ring sights should have rads that are of a convenient size for range estimation, as well as of a standard size for Position Firing deflections.

Rads are based on mils. A mil is a unit of measurement for very small angles. One gunnery mil is the angle formed at the eye when viewing a one foot object at 1000 feet.

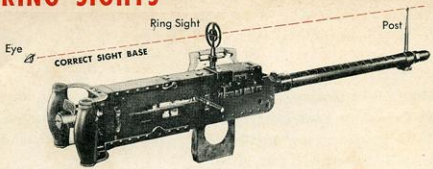


A 35 mil angle measures off 35 feet at 1000 feet. One rad of your sight is 35 mils. Therefore, a 1 rad deflection must offset the gun barrel at an angle of 35 mils. A 2 rad deflection must offset the gun at an angle of 70 mils, and a 3 rad deflection must offset it at an angle of 105 mils. The standard rads deflections given in the section on Position Firing apply only when 1 rad of a sight is equal to 35 mils. Thus, the inner ring of all ring sights must have a radius which will give a 35 mil angle.



Although the caliber .50 BAM gun is the gun that the great majority of you will use, the illustrations for iron sights are made with the caliber .30 gun because iron sights are more frequently used with this gun.

IRON RING SIGHTS



a Mk 13 ringsight and a Mk 7 post mounted on a cal. 30 B.A.M. gun.

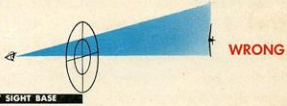
The simplest of all aerial gun sights is the iron sight—a metal ring or set of rings at the rear of the gun and a metal post topped by a bead or small ring at the front. By lining up the center of the rear ring sight and the center of the bead or ring on the front post, your guns will fire in the direction you want them to fire. If your sights are not lined up, you will not get hits. Another important rule that you must remember when using iron sights is to keep your eye the proper distance behind the rear ring at all times. The distance between your eye and the ring is called your **sight base.**

Rear view

Look through a 35 mil iron ring sight using the proper sight base. A 35 foot plane at 1000 feet fills exactly one rad of your iron ring sight.

Now move your eye back from the correct sight base and the plane fills more than one rad. The sight has become less than a 35 mil sight because you have lengthened your sight base.

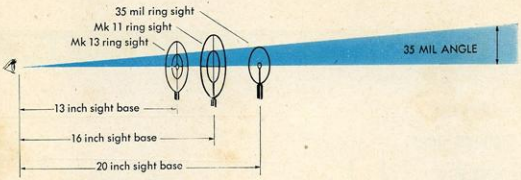
Next move your eye closer than the correct sight base and the plane fills less than one rad. The sight is now more than a 35 mil sight because you have shortened your sight base.



A correct sight base is therefore **essential** to keeping your iron sight a 35 mil sight.

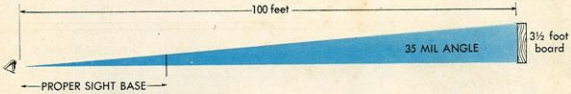
Top view

The correct sight base varies with the actual size of the ring sight itself. Below are shown a number of correct sight bases for 35 mil sights of various sizes.



While all of these ring sights are of different sizes, their sight bases have been so adjusted that they are all 35 mil sights. Proper sight bases are given for each 35 mil iron sight in the Aviation Ordnance Equipment Catalogue.

However, if you are ever in doubt as to whether you have a 35 mil sight or not, place a board 3½ feet long at a right angle to the eye and 100 feet away. Line up your ring sight on the board, and if the board fills 1 rad of your sight you know that you have a 35 mil sight.



To sum up, maintaining the correct sight base with a 35 mil iron sight is essential for:

1 **Proper range estimation.** Remember the single engine fighter fills ⅓ of a rad of your 35 mil sight at 3000 feet, the in-range firing distance for bow attacks, and ½ of a rad at 2000 feet, the in-range firing distance for other attacks. The twin engine fighter fills ½ rad at 3000 feet and ¾ rad at 2000 feet.

2 **Proper use of Position Firing Deflections.** Your deflections are given in terms of rads of 35 mils. When applying the deflection with an iron sight, keep the proper sight base and apply the proper number of rads deflection toward your own bomber's tail.

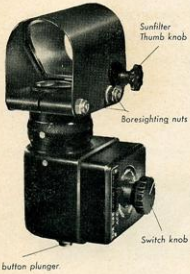
The 35 mil iron sights that you may use are shown below.

IRON RING SIGHTS AND CORRECT SIGHT BASE

Name and description	Post Ring	Mounted on gun
35 MIL TRAINING SIGHT **MK 1 FORE POST** Radius of 35 mil ring sight ..... .7" Sight base ..... 20"		
MK 11 RING SIGHT **MK 1 MOD 1 FORE POST** Radius of 35 mil inner ring ..... .6" Sight base ..... 16"		
MK 13 RING SIGHT **MK 7 FORE POST** Radius of 35 mil inner ring ..... .48" Sight base ..... 13"		

One great advantage of iron sights is that they seldom get out of order unless the metal is bent, broken, or rusted through. They need only be checked for these defects which can be seen at a glance. The only care they require is occasional oiling to prevent rust and to make the mounting adjustments operate easily.

REFLECTOR RING SIGHTS



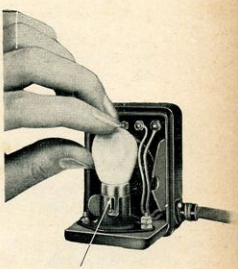
THE MARK 9 or two-ring reflector sight, is a simple arrangement of a single electric light bulb inside a small housing, a reticle, lens and reflector plate. You use the sight by looking at your target through a glass plate on which the light bulb projects the dot called a "pipper," and two rings which show you where to aim.

The pipper shows exactly where your guns are pointed; in applying Rule 1 of Position Firing, you **place the pipper between the attacking fighter and the tail of your bomber, along the fighter's line of apparent motion.** To apply any deflection up to two rads, simply place the fighter on the appropriate place as shown in the diagrams in the section on Position Firing. To apply deflections greater than two rads, simply imagine additional rings outside of the two rings and the same distance apart as the 35 mil ring and the 70 mil ring. Then place the fighter with reference to the appropriate imaginary ring as shown in the diagrams in the section on Position Firing.

With reflector sights there is no problem of lining up the bead and peep and the **optical system makes it unnecessary to keep a set sight base.** Each rad is always equal to a 35 mil angle, even if you move your head as you look into the sight.

Use and care of the Mark 9 sight are extremely simple. Your chief job is to make sure that the sight is in working condition before each mission.

Using the Mark 9 Sights On the side of the case is a knurled thumb screw switch which can be turned to "off," "Night," or "Day" to allow varying degrees of light. A 21-6 candle power double filament, double contact, type S8, **24-28 volt** inside frosted lamp bulb is used in the sight. The lamp bulb has a line on one side of its base. The lamp socket in the sight has a white line on one side of it. **The lamp bulb must be placed in the lamp socket so that the mark on the base of the lamp bulb lines up with the white line on the lamp socket in the sight.**



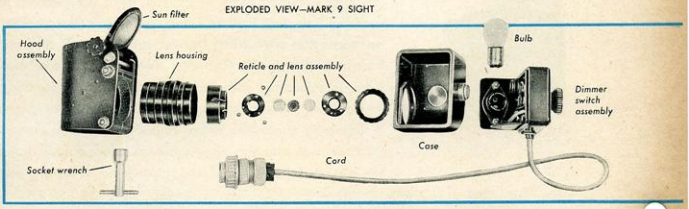
Be sure to line up index mark on bulb and socket

If the lamp is installed so that these two lines do not "line up" a coil in the sight will burn out and the lamp will not light. To change lamp bulbs, pull off the side of the lamp housing by pressing **up** on the button on the bottom of the sight. Replace the bulb as soon as possible after one filament burns out—or in any case after every third mission. **Always carry a spare bulb.**

In front of the hooded section is a sun filter which may be positioned in or out of the line of sight by a scalloped thumb wheel. Always use the filter when firing into the sun.

Keep fingerprints, grease, oil and dirt off the exposed glass parts. If the exposed glass parts get dirty, clean with liquid lens cleaner and a clean chamois or piece of soft tissue paper.

EXPLODED VIEW—MARK 9 SIGHT



Pre-Flight Check.

1. Make sure that the reflector plate is clean.

2. Test the knurled thumb screw switch to make sure that both filaments work and that the dimmer works properly.

3. Make sure that the rings and pipper look sharp and clear.

4. Center the sight on some distant object and then move your head from side to side. The rings and pipper should stay right on the object. If they move away or if they appear fuzzy, the sight needs adjustment.

5. Make sure that you have at least one new spare bulb.

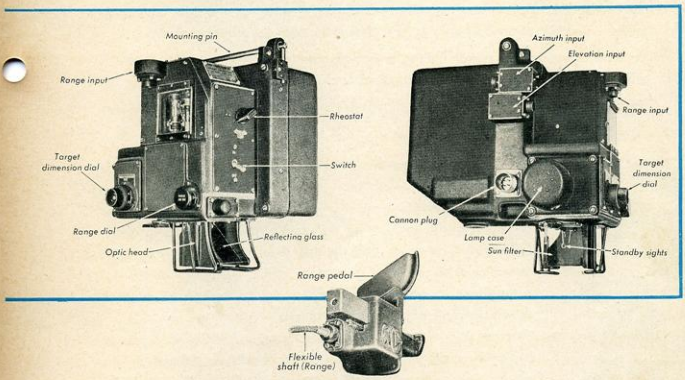
THE MARK 9 Mod 1 SIGHT The Mark 9 Mod 1 sight is identical with the Mark 9 except that it operates on 12 volts. The Mark 9 operates on 24 to 28 volts. If the electrical system of your airplane has an output of 24 to 28 volts you will use the Mk 9 sight. If the electrical system of your airplane has an output of 12 volts you will use the Mk 9 Mod 1 sight. The Mk 9 Mod 1 uses a 21-6 candle power, double filament, double contact, type S8, 12 volt inside frosted lamp. The line of the base of the lamp base must be lined up with the white line on the lamp socket the same as in the Mk 9. Everything stated above with reference to the Mk 9 applies equally to the Mk 9 Mod 1 except as to the voltage.

COMPUTING SIGHTS

Automatic computing sights are one of the new developments of air warfare. These sights serve as mechanical brains in helping the gunner shoot down enemy planes. They do this by calculating the needed deflections and making it simple for the gunner to apply them. They are completely different—in construction, operation, and use—from ring sights. With a computing sight you do not need to apply the rules of Position Firing and range estimation. Instead you must learn a new mechanical technique of aiming. And you will need plenty of practice—for unless you use a computing sight properly, the sight will not calculate deflections accurately.

The descriptions of automatic sights in the following pages are confined to operational information which you need to knock down planes. You will not be concerned with how the mechanisms work, for only trained technicians should make adjustments or repairs.

THE SPERRY K-4



The Sperry K-4, mounted in the Sperry Lower Ball turret, is used by sighting through a glass screen mounted in an optic head—just as you look into a reflector sight. Visible in the K-4's glass screen are three lines called reticles—one horizontal and two vertical. These reticles are used, instead of a ring, to line up the target. Connected with the optic head is a computing

unit which contains all the mechanism for calculating deflections and offsetting the guns to the proper angle.

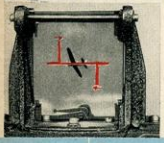
To make its computations, the sight requires three specific items of information about the enemy fighter:

1. The target dimension, which you supply by setting a target dimension dial on the sight housing to the wingspan of the target plane.
2. The range of the fighter, which you supply by adjusting the range control—a pedal which you operate with your left foot—to keep the vertical reticles framing the target.
3. The apparent motion of the target, which you supply by tracking the enemy plane so that the horizontal reticle is always across the center of the target.

Given this information, the K-4 makes computations which increase the effective range of your guns to 3,000 feet.

To use the K-4:

1. Turn on the sight switch, which is on the front panel of the sight housing. This will light the reticles and turn on the computing unit. Use the rheostat on the sight housing to adjust the reticles to the proper brightness. Adjust the filter for proper contrast.
2. As soon as you see an enemy fighter, determine what type of plane it is, recall the wingspan for that type, and set the target dimension dial.
3. Track the enemy fighter by moving your guns to keep the horizontal reticle right across the center of the fighter.

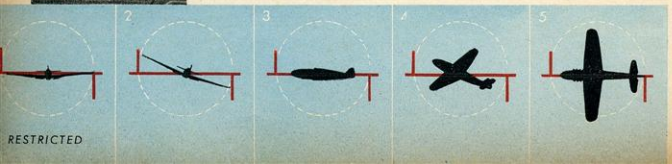


4. Keep moving the range control to make the vertical reticles frame the width of the fighter's wingtips.

By turning the range control, you can move the reticles closer together or farther apart. By keeping the reticles right on the width of the fighter's wingtips, you enable the sight to make a sufficiently accurate estimation of his range.

If the fighter is banked, an imaginary circle through his wingtips should be framed by the vertical reticles.

If you see the top or bottom of the fighter instead of the nose, an imaginary circle through the wingtips should be framed by the reticles. Targets seen from the side present a special problem. On most planes, wingspan and length are nearly the same; ranging will



be sufficiently accurate if you frame the fuselage or an imaginary circle drawn through the ends of the fuselage. But if you know that the wingspan is considerably longer than the fuselage, keep the reticles a corresponding distance from the ends of the fuselage. The target dimension dial registers only up to 60 feet. For the very few enemy planes which have a wingspan over 60 feet, set the dial at half the wingspan and frame the center half of the plane only.

5 Fire at the enemy—using bursts of the length found most effective in your combat theater—as long as he is within range.
When you have set the target dimension dial for the wingspan of the enemy plane he will be in range when he just fills the smallest possible reticle opening.

6 Track the target as smoothly as possible
The sight can work effectively only if you give it a clear, smooth picture of the fighter's apparent motion. Its computations require a little time; your aim will not be correct if you fire without tracking smoothly. This is not too easy and takes a lot of practice.

Care of the K-4

Avoid bumping or jarring the delicate optic head. Don't touch it except to clean the reflection glass, dust shield, and sun filter. Never try to oil or adjust the sight yourself.
Never operate the turret unless the sight switch is on—or you will ruin the computing mechanism.
Never turn on the sight switch before the turret's main power switch has been turned on.

Pre-flight Check

1 Before starting on a mission, turn on the sight switch and make sure that the reticles light, and that the rheostat works properly.

2 Move the guns and track to the left, right, up, and down. The reticles should lag a little, moving across the optic head in the opposite direction.

3 Make sure the vertical reticles move closer together and farther apart as you turn the range control.

THE SPERRY K-3

The Sperry K-3 is the original computing sight developed and was designed for the Sperry Upper Turret. The K-4 is actually an upside down version of the K-3. The range control for the K-3 is a thumb knob or motorcycle type handgrip on the turret control handle.
In all other respects, the K-3 and K-4 are exactly alike.

BORESIGHTING

No sight can do its job accurately unless it is properly lined up with the bore of the gun. The sight and gun must work together; the technique of making them work together is called boresighting.

Boresighting does one thing. It lines up the sight and gun so that you can look through the sight and know where your gun is pointing.

Before you fire a gun you have never used before, be sure it is correctly boresighted. All guns should be checked constantly for boresighting—before each mission in combat zones. All guns, whether hand-held or mounted in turrets, and all sights, whether iron, reflector, or computing are boresighted in the same basic way. In the pages that follow, boresighting of iron sights and hand-held guns will be discussed. In the turret section, a more detailed discussion of boresighting turret guns will be given. With turrets you will usually be dealing with more than one gun. Boresighting of multiple gun installations is called **harmonization.**

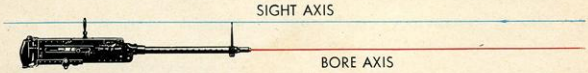
To understand boresighting you must understand two definitions: sight axis and bore axis.

The sight axis is the straight line drawn from your eye through the bead and peep and on out into space. With the reflector sight, this line is drawn from your eye through the pipper out into space.

The bore axis is the straight line drawn through the center of the barrel of the gun and on out into space.

Boresighting establishes a relationship between these lines, so that you can aim your gun accurately.

Squadron doctrine will decide how those two lines are to be set. They may be made to run



parallel; they may be made to **converge;** they may or may not be adjusted so as to allow for the pull of gravity on your bullets. The relationship of those two lines should be set, however, to give the densest pattern to your bullets at a given range.

The simplest boresighting will be on your primary machine gun range in gunnery school. There the target will be about 100 feet from you. You don't need to worry about the effect of gravity drop. Your only problem will be to line up the sight axis and bore axis on the same mark on the target. In other words, you want those two lines to converge or come together on the target.

To do that, take the following steps:

1. Place the gun in a mount which will permit you to lock it in position.

2. Loosen the front post sight locking nuts. (If the Mark 9 Reflector sight is used, loosen the sight adjusting nuts on the hood of the sight.)

3. Remove the back plate, bolt, and driving spring assembly.

4. Trip the accelerator forward.

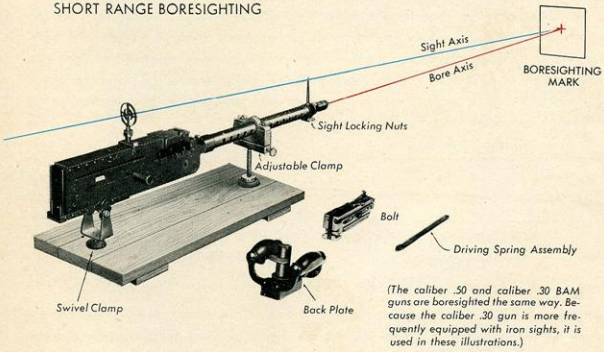
5. Line up the bore axis dead center on the reference mark.

6. Line up the sight axis dead center on the same refernce mark.

7. Tighten the front sight locking nuts. (If the Mark 9 sight is used, tighten the sight adjusting nuts on the hood of the sight.)

8. Reassemble the gun.

SHORT RANGE BORESIGHTING



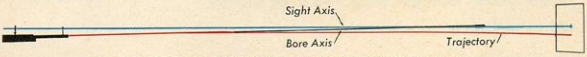
(The caliber .50 and caliber .30 BAM guns are boresighted the same way. Because the caliber .30 gun is more frequently equipped with iron sights, it is used in these illustrations.)

Your gun is now boresighted for firing at a range of 100 feet.

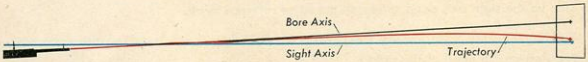
(If a Mark 1 boresighting kit is used, steps 3, 4, and 8 can be omitted, because the kit contains muzzle and breach adapters which are used with a periscope-like attachment, and which make it unnecessary to sight through the rear of the barrel in order to line up the bore axis.)

For longer ranges, the problem is a little different. The bullet will gradually drop off due to gravity, and the further it goes the more it drops.

If you lined up the sight axis and bore axis on the same mark at 1200 feet, for example—the range at which your guns are boresighted for advanced firing in gunnery schools—your bullets would hit about four feet low at that range. To allow for this, two marks should be on your target—the one for the bore axis to be above the one for the sight axis. If you



BORESIGHTING WITHOUT ALLOWING FOR GRAVITY



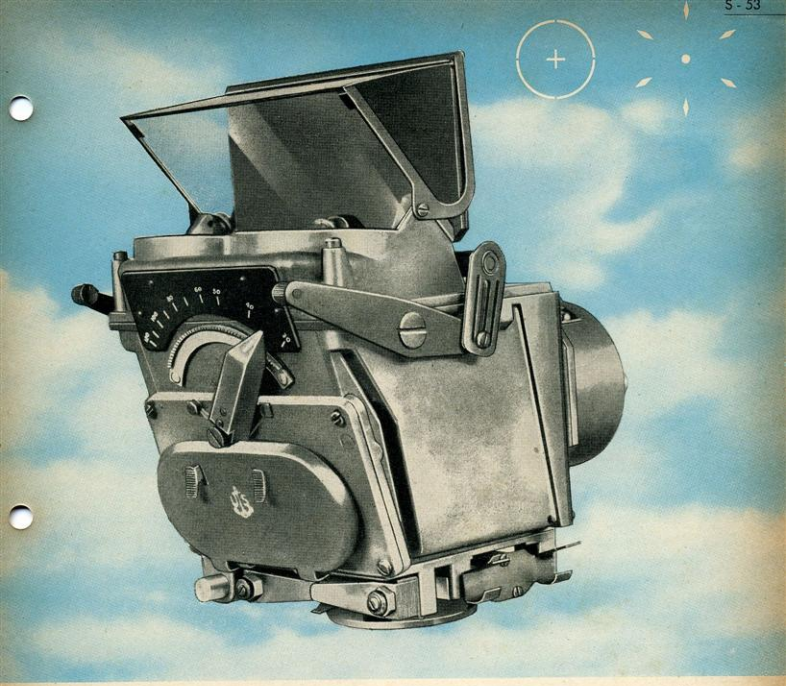
BORESIGHTING ALLOWING FOR GRAVITY

are boresighting your guns at 1200 feet, the marks should be 40″ apart for the caliber .50 gun and 48″ apart for the caliber .30 gun. Boresighting would then be simple if you had a full 1200 foot range. However, this range is not always available. In that case, you use **templates,** which are usually figured out by your gunnery officer. A template is a boresighting card showing the proper marks on which to line up your bore axis and sight axis, and can be used successfully at short distances. The proper position for the marks are figured out mathematically. However, since any error on your template will be magnified at the full range, be certain the templates are official and correct.

BORESIGHTING WITH A TEMPLATE SET AT A SHORTER RANGE.

At gunnery schools a full allowance for gravity drop will be made, because there you are firing on the horizontal. In combat you will not always be firing on the horizontal, which means that there will be a varying effect of gravity drop. In the Fleet, therefore, gravity allowance will be determined by squadron doctrine. You may boresight your guns on a template, or you may merely boresight them on some distant object. The latter method is called infinity boresighting. Boresighting on templates is the general practice on carriers. You will also use templates in gunnery schools. However, for convenience, infinity boresighting is often used in land based squadrons. Regardless of what prescribed marks you use, you follow the same procedure as previously outlined and in the exact sequence.

The point to remember is to be certain that your guns are boresighted properly according to the method prescribed in your squadron.



GUN SIGHT MARK 18

The Gun Sight Mark 18 is an electrically operated, computing, reflector-type sight designed for use in power turrets. The gunner makes the proper settings on the control units, after which it is only necessary for him to "range and track" the enemy plane, for the sight automatically figures the proper point of aim. It makes no difference whether or not the enemy plane is in a pursuit curve, or whether the gunner is strafing a stationary target. This sight handles all situations equally well.

It is not necessary for a gunner to be familiar with the internal construction of the Mark 18

Gun Sight or the theory of how it computes deflections. Gunners should never dismantle or open up the sighting head or any of the other units. Only experienced maintenance men are allowed to replace units, alter adjustments or check for malfunctions, except as specified in "Boresighting" and "Gunner's Check."

GENERAL DESCRIPTION

The Gun Sight Mark 18 is really two sights in one. It has two optical systems and two reticles. When you look at these reticles through the reflector plate they appear to be projected out into space. The reticle on the left which you view with your left eye resembles the inner ring of the Mk 9 reflector sight. This 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 "pipper" which is surrounded by six diamond-shaped pips arranged in the form of a circle. This is the **gyro reticle** or **movable reticle.**

GYRO 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 you operate your turret the gyro reticle (the center pipper and six diamonds) moves around on the reflector plate. If you use the Mk 18 sight properly the gyro reticle automatically computes the correct deflection and gets hits for you. All you have to do is keep the enemy framed or "spanned" in an imaginary circle drawn so that it cuts the inside points of the six diamond pips of the gyro reticle. The center pipper of the gyro reticle, also forms the center of the imaginary circle.

THE FIXED RETICLE

The fixed reticle is essentially the same as the inner ring of the Mk 9 reflector sight. The only difference is that the center of the fixed reticle is a cross instead of a round pipper as in the Mk 9. The fixed cross indicates the direction that your guns are pointing.

The fixed reticle is used for aligning the two reticle systems, for boresighting, for maintenance checks (also gunner's checks) and as a standby sight in case of malfunction or failure of the gyro reticle. Sighting with the fixed reticle is the same as with the Mk 9 sight, except it has only a one-rad ring whereas the Mk 9 has a one-rad and a two-rad ring.

THE CONTROL UNITS

The complete Mk 18 sight installation consists of a number of units. Only those units that are of concern to you as a gunner are discussed.

SIGHTING HEAD

The sighting head is in reality the **sight.** It contains the reflector plate through which you view the fixed and gyro reticles.

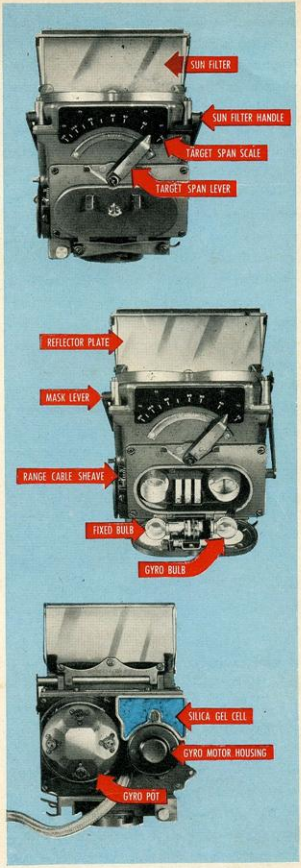
The lever on the right side of the sighting head is the **sun filter control handle.** Depressing this handle lowers the sun filter. On bright days the sun filter may be raised by lifting up the control handle.

On the left side of the sighting head is the **fixed reticle mask lever,** which when depressed will blank out the ring of the fixed reticle and leave only the center cross showing. Below the fixed reticle mask lever is the **range cable sheave,** which is mechanically connected to the movable reticle and controls the movement of the six diamond-shaped pips. It is numbered in feet from 600 to 2400.

Directly in front of you on the sighting head is the **target span scale** numbered from 30 to 120. These numbers represent the size of the target in feet. The **target span lever** can be moved from side to side to correspond with the known target dimension.

Just under the target span scale and lever is a double-latched door which opens downward. Depress both latches to open the door, and mounted inside are two lamp bulbs which provide light for the two reticles.

On the front of the sighting head (side farthest from you) is a small plastic container filled with blue material. This is the **silica gel cell** which



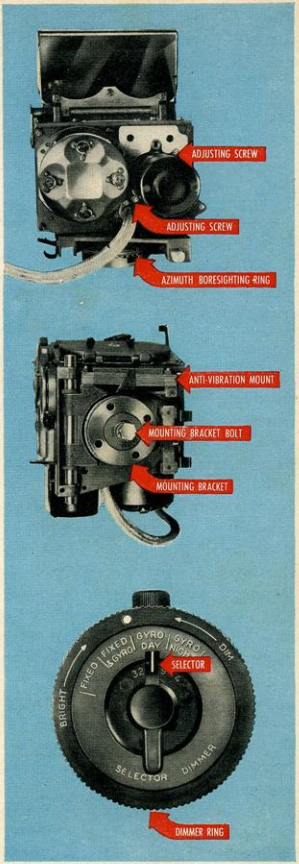
dries out the air entering the sighting head and prevents the sight from fogging up.

The large cup or gyro pot to the side of the silica gel cell houses the gyro and electromagnets of the computing mechanism.

The small cup beneath the silica gel cell is the gyro motor housing. It houses the electric motor which turns the gyro.

On the sighting head next to the gyro motor housing are two small screws. One screw cannot be turned unless the silica gel cell is removed. These two screws adjust the fixed mirror within the sighting head so that the fixed reticle can be aligned with the gyro reticle. The adjusting screw underneath the silica gel cell gives horizontal adjustment while the other gives vertical adjustment.

An azimuth boresighting ring on the bottom of the sighting head is equipped with notches to permit movement of the sighting head. To move the sighting head right or left the number of notches necessary to harmonize the sight to the guns, loosen the mounting bracket bolt projecting from the bottom of the sighting head. To absorb shock, an "anti-vibration mount" is provided on the underside of the sighting head near the mounting bracket.



SELECTOR-DIMMER

This unit consists of a four-point switching device and a rheostat. It is usually mounted near your left hand or on some other place you can reach easily. The "selector-dimmer unit" enables you to turn on either the fixed reticle or the gyro reticle, or both at the same time.

On the face of the unit a pointer can be turned to any one of the following four positions:

FIXED—only fixed reticle visible in reflector plate. This switch position is used for boresighting, maintenance checks, gunner's checks and

when the fixed reticle is used as a standby sight.

FIXED & GYRO—fixed and gyro reticles visible in reflector plate. This switch position is used for day firing, for alignment of the two reticle systems and for gunner's checks.

GYRO DAY—only gyro reticle visible. This switch position is optional for daytime firing.

GYRO NIGHT—only gyro reticle visible. This switch position is used for night firing because the combat ranges are necessarily short.

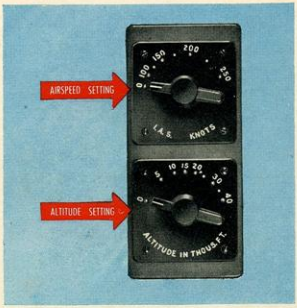
On the outer circumference of the selector-dimmer unit is a knurled ring (dimmer) which operates the rheostat controlling the brightness of the reticles. Turn the dimmer clockwise for greater brightness or counterclockwise for dimming the reticles.

ALTITUDE AND AIRSPEED UNIT

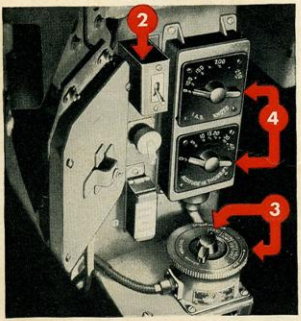
This unit is mounted so that its numbers are visible and control pointers easily reached.

The upper half of this unit is the airspeed section and is numbered in knots from 0 to 250. The indicated airspeed (IAS) of your plane is "set in" by moving the pointer to the correct figure.

The lower half of the unit is the altitude section and is numbered in thousands of feet from 0 to 40. The altitude of your plane is "set in" by moving the pointer to the correct figure.



OPERATING THE MARK 18 SIGHT



For Day Firing

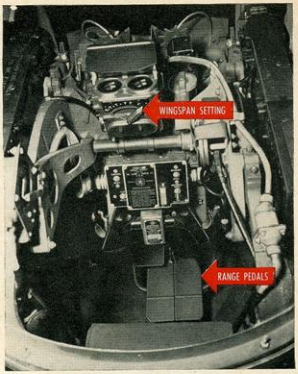
BEFORE YOU SEE THE ENEMY

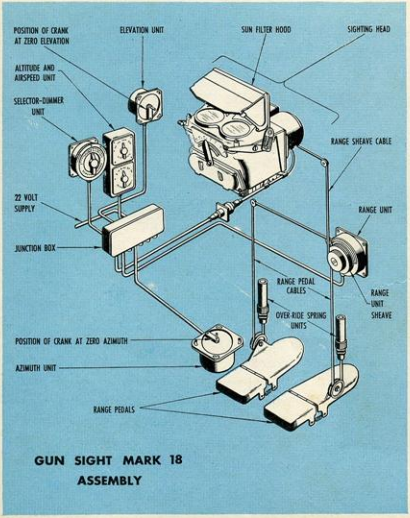
1. Turn on turret Main Power Switch (see Turret Section for location).
2. Turn on Sight Power Switch.
3. Turn Selector-Dimmer to "FIXED & GYRO" position; then turn knurled ring (dimmer) of this unit until the reticles have the desired amount of brightness.
4. Adjust the altitude and airspeed settings of your plane on Altitude and Airspeed Unit. During an attack, however, if your pilot is taking evasive action, do not use precious time re-setting the altitude and airspeed.
5. Raise the sun filter if it is needed.

WHEN YOU SEE THE ENEMY

1 Wingspan Setting

As soon as you recognize the enemy plane, "set in" his wingspan on the target span scale. For example, if you recognize the enemy plane to be the Jap fighter "Hamp" you should know that his wingspan is 36 feet. Move the target span lever to the proper position on the target span scale. If you were attacking or being attacked by a Jap "Betty," set the target span scale at 70 feet. If you were being attacked by both, you must change the wingspan setting when you shift from one to the other. It is very important that you know enemy planes and their wingspans. Keep your knowledge of recognition up to date.





GUN SIGHT MARK 18 ASSEMBLY

2 Ranging

After you have "set in" the correct wingspan of the enemy plane you must "range and track" him properly if the sight is to compute the deflections. You "range" the enemy by the use of the two foot pedals attached to cables in the turret. If you push down on the right pedal the "aiming" or "ranging" circle (an imaginary circle drawn through the inside points of the six diamond pips of the gyro reticle) gets larger. In other words, the six diamonds move farther away from the center pipper, thus making the aiming circle larger. This is minimum range. If you push all the way down on the left pedal the diamonds move closer toward the center pipper and the aiming circle is smaller. This is maximum range. It is very important that you always keep the enemy "spanned" or framed within the aiming circle if you want to get hits.

NOTE: Be sure you frame the enemy plane within a **circle,** not within a six-sided figure formed by joining the pips with straight lines.

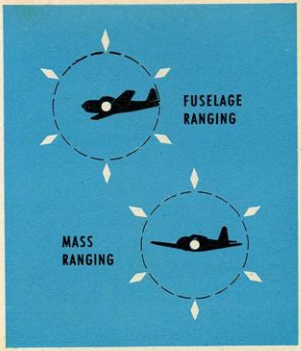
Let's assume that you are in a bomber making 200 knots at an altitude of 20,000 feet. You have already "set in" the airspeed and altitude of your plane. As you are cruising along you see a Jap "Hamp" heading toward you at an approximate range of 4000 feet. You immediately adjust the target span scale to 36. Then place the center pipper of the gyro reticle right on his nose and press the left pedal all the way down to make the ranging circle smallest. At first, Hamp's wingtips may not extend all the way across the ranging circle, as he may not yet be within range. As he gets closer he will appear to get larger, and soon his wingtips

will touch each side of the ranging circle. He is now "spanned" and in range. Open fire. He appears to get larger as he gets closer. It will be necessary for you to make the aiming circle get larger and larger in order to keep it just touching his wingtips. You do this by pressing down on the right pedal gradually and smoothly. **You must track him carefully and keep him accurately spanned or you will not get hits.** Then just keep the center pipper right on the spot you want to hit and watch Hamp fall to pieces.

If an enemy gets within 600 feet of you the ranging circle will not get any larger. This does not mean that the sight is not accurate within 600 feet. It is very accurate. All you have to do now is hold the right pedal all the way down and keep the pipper where you want to hit.

Sometimes it may not be possible for you to span on a full-square view of the enemy's wingspan. If you have a full-square view of the enemy plane's fuselage instead of the wings, you still set the wingspan of the enemy on the target span scale. However, keep the pipper on the cockpit and one edge of the aiming circle on his tail and you will have him "spanned" properly. This is because enemy fighters are approximately one-half as long from cockpit to tail as from wingtip to wingtip.

When the position of the enemy does not present a full-square view of either its wings or fuselage, set in his wingspan as usual; then do your spanning on whatever target dimension appears longest to you. In some cases he may appear wider than long or longer than wide, and in others the enemy plane may simply appear as more or less a



mass in the sky. When spanning such a target keep the ranging circle a little larger than necessary to touch the longest dimension of the target that is apparent to you—about 1/10 the diameter of the ranging circle on each side of him. As soon as the angle of the enemy changes so that you can see his full wingspan or full fuselage, use the procedure for wingspan and fuselage ranging.

The ranging mechanism may not always be controlled by foot pedals. Other types may be developed and used. However, the principles will be the same regardless of the type of control used.

3 Tracking

As the attacking enemy moves in, you must operate your turret to keep him framed within the ranging circle. This is referred to as "tracking." Frequently it will be necessary for you to move your turret rapidly at first to pick up your target. This is called

"slewing." Always keep the right pedal fully depressed while slewing the turret, regardless of the range of the enemy. Otherwise the gyro reticle will "tumble" (drift entirely off the reflector plate) and the sight will be out of commission momentarily. Therefore, when slewing pick up the target with the fixed reticle and swing ahead of it along its line of apparent motion. The fixed reticle shows where your guns are pointing. To help the gyro reticle to "catch up," reverse the direction of slewing along the target path; then depress the left pedal to frame the target with the gyro reticle. Track smoothly for a moment and then open fire. When you are on the target your tracking must be smooth and deliberate. The sight will not compute properly if your tracking is jerky. After you have spanned the target always track a short distance before opening fire to enable the sight computing mechanism to figure deflection.

For Night Firing

1. Turn on turret Main Power Switch.
2. Turn on Sight Power Switch.
3. Turn Selector-Dimmer to "GYRO NIGHT" position; then turn knurled ring (dimmer) of this unit until the gyro reticle has the desired brightness. It should not be very bright.
4. As soon as you see the enemy, put the center pipper on him and keep firing as long as you can see him.

   NOTE: There is no need for the sun filter. No setting is required on altitude and airspeed unit; pointer may be in any position. No setting is required on target span scale; target span lever may be in any position. Ranging is not necessary and it makes no difference what you do with the foot pedals. The sight is set for a fixed range of 450 feet, as the range during night firing will rarely be greater than that.

Firing with Fixed Reticle

If for any reason the gyro reticle system does not function properly or fails to function, use the "fixed reticle" as a standby sight. To use the fixed reticle turn selector-dimmer to the "Fixed" position; turn the dimmer to adjust the brightness of the reticle; and then use the fixed reticle the same way you would a Mk 9 sight. The fixed reticle has a 35 mil radius—one rad.

BORESIGHTING

Boresighting the Gun Sight Mark 18 establishes a parallel relationship between the center of the fixed cross of the fixed reticle and the bore axes of the guns. Before boresighting this sight, **the fixed and gyro reticles *must* be aligned.** They are aligned when the center pipper of the gyro reticle and the center of the fixed cross of the fixed reticle are superimposed at an infinite distance with no windage, gravity or relative speed allowances in the system.

ALIGNMENT CHECK

1. Turn the selector-dimmer unit to the "FIXED" position.
2. Turn the turret so that the fixed cross of the fixed reticle bears on some distant object

(at least 1000 feet away). Make sure that the fixed cross is accurately centered on the object.

3 Turn the selector-dimmer to "GYRO NIGHT." The center pipper of the gyro reticle should bear within one mil upon the object on which the fixed cross was sighted. (The diameter of the pipper is approximately two mils.) If the sight fails the above test, the fixed mirror is out of adjustment.

ALIGNMENT ADJUSTMENT

1 Secure the optical gage in position on the sighting head. The gage brings the patterns of both reticles into one line of vision when, without the aid of a distant reference point, both reticle patterns are observed at the same time.

2 Turn selector-dimmer to "FIXED & GYRO."

3 Remove the silica gel cell.

4 Manipulate the range pedals until the range unit sheave is at the 1250 mark. Secure the sheave in this position. The range unit sheave is connected to the range pedals by the range pedal cables. The range unit sheave is numbered from 600 to 2400 feet to correspond with the graduations on the range sheave of the sighting head. The reading of 1250 should be the same on both sheaves. If they are not the same, make adjustments to synchronize them.

5 Disconnect the GREEN wire in the range section of the junction box.

6 Settings of altitude and airspeed are immaterial, and the turret may be turned to any convenient position in azimuth and elevation.

7 Look through the optical gage. Bring the center of the fixed cross to bear upon the center pipper of the gyro reticle by adjustment of the two screws located near the gyro motor housing.

NOTE: The fixed cross is made to move horizontally by adjusting the topside screw and is moved vertically with the lower screw. If no optical gage is available, pick out some distant point (at least 1000 ft. away) and bring the center pipper to bear on this point. Adjust the screws until the center of the fixed cross bears on the same point.

8 When the two reticles are aligned, release the range unit sheave and slowly manipulate the range pedals to move from maximum to minimum range. Observe the pipper and cross; the pipper must not move more than two mils. If the pipper moves more than two mils, replace the sighting head and return to an overhaul shop. The diameter of the pipper is approximately two mils.

9 Remove the optical gage. Replace the GREEN wire in range section of junction box. Replace the silica gel cell.

BORESIGHTING PROCEDURE

1 Level the airplane athwartships and longitudinally.

2 Turn the turret so that the guns are at a right angle to the center line of your plane.

3 Using a spirit level, adjust the nuts on the rear mounting post so that the guns are level. Make sure the level is aligned with the center line of the gun barrel. Secure the nuts on the rear mounting post.

4 Swing the turret to any convenient position, and adjust the guns so that both bore axes bear upon a distant object (at least 1000 ft. away). Do not disturb the elevation setting; the guns need only be adjusted horizontally.

5 Adjust the sighting head so that the center of the fixed cross bears upon the same distant object.

NOTE: It is not necessary to allow for gravity drop of the projectile. The sight automatically compensates for this.

To adjust the fixed sight axis in azimuth, loosen the center bolt in the bottom of the mounting bracket and rotate the sighting head to the desired position. The mounting bracket incorporates a differential toothed arrangement for large and small movements. An adjustable azimuth boresighting ring on the underside of the anti-vibration mount has 36 large teeth on its underside face which mate with the teeth on the top face of the mounting bracket. The ring also has 109 small teeth on its topside which mate with teeth on the anti-vibration mount. A movement of the sighting head and azimuth boresighting ring of one large tooth represents 10°. A movement of the sighting head alone of one small tooth represents 3.30°. Therefore, if the sighting head and azimuth boresighting ring are moved one large tooth, and then the sighting head alone is moved in the opposite direction three small teeth, a total movement of 0.1° of the sighting head is made. Since 0.1° is approximately 1.7 mils, the differential toothed arrangement permits adjustment in azimuth to within .85 mils.

No elevation boresight fittings are provided with the sight. These fittings are integral parts of the turret and therefore will be peculiar to different installations. The manner of adjusting the fitting will have to be determined by personnel making the boresight.

GUNNER'S CHECK

The most expert and painstaking maintenance of this gun sight, as of any gun sight, will not insure accurate results if the turret is operating badly. Make sure your turret is checked and serviced frequently.

PRE-FLIGHT INSPECTION

1 Test the sun filter's operation and the fixed reticle mask lever. Check that all glass surfaces are clean; use lens paper for cleaning. Make sure the range cable sheave does not rotate when the sighting head is moved back and forth on its sliders or when the guns are elevated or depressed.

2 Check the silica gel cell; its color must be BLUE. When the gel is dry, its color is blue. The gel begins to lose its blue color and turns pinkish white as it absorbs moisture. If the gel is not blue, it must be replaced. The moist gel may be dried out by removing it from the cell and heating mildly. Heat the gel in a metal container over a low flame until it regains its original blue color.

3 Inspect the light bulbs; if glass surfaces have blackened, replace them. Until service experience dictates otherwise, it is recommended that bulbs be replaced after each five hours of sight operation. Be careful to keep the light bulb reflecting cavities clean.

4 Examine the sheaves and range cables between the sighting head and foot pedals, making sure there is no interference with

smooth operation. Check that the fully depressed position of the left and right pedals against the stops corresponds to 2400 and 600 feet respectively on the range unit sheave. Check that the over-ride springs do not "give" before the pedals reach the stops. Check that 1250 feet on the range unit sheave corresponds to 1250 feet on the range cable sheave on the sighting head.

5 Examine the selector-dimmer unit pointer to see that it turns to each of its four positions. See that the dimmer ring rotates from dim to bright properly; check its action against the stops. Examine the altitude and airspeed unit pointers to see that they turn easily and cover the scales.

6 Examine all electric cables to the junction box and to the various units to see that they are secure.

PIPPER CHECK

Use the optical gage if there is no distant object to employ as a target. The figures that follow are not to exact scale, so the positions are relative. For clarity, the six diamond-shaped pips are not shown. The check will be easier to understand if you remember that the fixed cross is boresighted to the guns; therefore, the allowance between the fixed cross and gyro pipper illustrates the angle between the sight axis and the gun bore. Unless your plane is connected to an external power supply, operate the turret manually—do not use plane batteries.

ALIGNMENT

If the cross and pipper are not aligned, make the necessary adjustments. (See Boresighting Instructions.)

MAKE PIPPER CHECK AS FOLLOWS

SELECTOR-DIMMER UNIT

FIXED

1 Turn the selector to "FIXED."

2 Note the fixed reticle pattern. The ring may be blacked out by action of the mask lever. The gyro motor should not run. See Figure 2.

3 Run the dimmer ring from dim to bright and note the increase in reticle brilliance.

FIGURE 1

SELECTOR—**FIXED**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ZERO
ELEVATION—ZERO

FIGURE 2

SELECTOR—**FIXED**
RING—BLACKED OUT
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ZERO
ELEVATION—ZERO

FIXED & GYRO

1 Turn the selector to "FIXED & GYRO."
2 Both fixed and gyro reticles should be visible and the gyro motor should run. The gyro reticle pipper should be directly below the fixed cross; this is the gravity allowance. See Figure 3.

FIGURE 3
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—90°
ELEVATION—ZERO

3 Turn the turret slowly in azimuth to the right and note that the gyro reticle pipper lags the fixed cross. See Figure 4.
Continue to turn the turret at the same speed and shift rapidly to short range. Note that the lag effect is less at short range. See Figure 5. Repeat the above while rotating the turret in the opposite direction and at the same speed. The deflections should be the same as the above, but in the opposite direction.

FIGURE 4
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ROTATING CLOCKWISE
ELEVATION—ZERO

FIGURE 5
SELECTOR—**FIXED & GYRO**
RANGE—SHORT
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ROTATING CLOCKWISE
ELEVATION—ZERO

GYRO DAY

1 Note the azimuth deflection, which indicates that the guns are pointing ahead of the sight axis. The fixed reticle disappears and the gyro reticle remains stationary when the selector is turned to "GYRO DAY." The faded reticle in Figure 7 is for reference only.
2 Note the difference between Figure 3 and Figure 6. Windage deflections are not generated when the airspeed is zero.

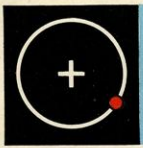


FIGURE 6
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

FIGURE 7
SELECTOR—**GYRO DAY**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

GYRO NIGHT

1 When the selector is turned from "GYRO DAY" to "GYRO NIGHT" the gyro reticle pattern should shift to the left as in Figure 9. Faded reticle is for reference only. Movement can be observed by selecting a distant reference point in the field of view corresponding to the position of the fixed cross. No windage or gravity deflections are generated.

FIGURE 8

SELECTOR—**GYRO DAY**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

FIGURE 9

SELECTOR—**GYRO NIGHT**
RANGE
ALTITUDE
AIRSPEED
AZIMUTH
ELEVATION
} POSITION HAS NO EFFECT

RANGE UNIT

1 Note that as the range is changed from maximum to minimum, the gyro pipper shifts to the left and almost touches the fixed cross. This illustrates the smaller allowance needed between the sight axis and gun bore at short ranges. Also note that at short range the allowance for gravity drop is less.

FIGURE 10

SELECTOR—**FIXED & GYRO**
RANGE—SEE FIGURE
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

ALTITUDE AND AIRSPEED UNIT

ALTITUDE CHECK

1 Note that as the altitude control pointer is turned from zero to maximum altitude the gyro reticle pipper moves to the left toward the fixed cross. Its position is halfway between the fixed cross and the zero altitude position. This illustrates that at high altitudes, the air being less dense, the bullet travels faster, so a smaller allowance is needed. See Figure 11.

FIGURE 11

SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—SEE FIGURE
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

AIRSPEED CHECK

1 As the airspeed control pointer is turned from maximum to minimum, the gyro reticle pipper moves to the left, and at zero airspeed it lies directly below the fixed reticle cross. This illustrates the fact that at zero airspeed no windage allowances are needed.

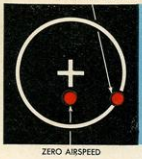


FIGURE 12
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—SEE FIGURE
AZIMUTH—90°
ELEVATION—ZERO

NOTE: In some turrets the guns cannot be positioned at cardinal points of azimuth and/or elevation. Example: The depression of the guns in an upper deck turret is very small. In such cases, follow the check throughout the allowable positions; i.e. the pipper should be in the direction indicated on the figures.

AZIMUTH UNIT

1 With turret at 0° or 180° the gyro reticle pipper should be directly under the fixed cross as in Figure 13. When firing directly fore or aft, no azimuth windage allowances are needed.

FIGURE 13
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—0° OR 180°
ELEVATION—ZERO

2 With the turret at 90° azimuth, the gyro reticle pipper moves to the right of the fixed cross as shown in Figure 14. With the turret at 270° azimuth, the gyro reticle pipper moves to the left of the cross as shown in Figure 14. Both positions illustrate the guns pointing ahead of the sight axis.

FIGURE 14
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90° OR 270°
ELEVATION—ZERO

ELEVATION UNIT

In the early production units, there is a dead zone beyond 82½° elevation and depression; so, the pipper deflection will drop to zero. If this condition exists, only elevate or depress 82½° when making the test. In later units there is no dead zone.

1 With the turret at zero azimuth and guns at zero elevation, the gyro pipper should be directly below the fixed cross.

FIGURE 15
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—ZERO
ELEVATION—ZERO

2 With the turret at zero azimuth, 90° elevation, the pipper shifts to a point directly above the cross. If the guns are swung to maximum depression (90°), the gyro pipper will shift to a point considerably below the cross. The positions are illustrated in Figure 16. Note that in both positions the guns point ahead of the sight axis.

3 With the turret at 180° azimuth and the guns at 0° elevation the pipper shifts to a point directly below the fixed cross.

4 With the turret at 180° azimuth and the guns at maximum elevation (90°), the pipper shifts to a point directly below the fixed cross. If the guns are swung to maximum depression (90°), the gyro pipper shifts to a point directly above the fixed cross. Positions are illustrated in Figure 18. Note that in both positions the guns are pointed ahead of the sight axis.

5 With the control positions as indicated under Figure 19, there is the allowable gravity deflection but no azimuth windage allowance.

6 As the guns are elevated or depressed, the gyro pipper moves toward the center of the fixed cross. At 90° elevation or depression, the pipper should be at the center of the cross. This action indicates that the gravity shunt is working properly.

MAXIMUM ELEVATION

MAXIMUM DEPRESSION

FIGURE 16

SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—ZERO
ELEVATION—SEE FIGURE

FIGURE 17

SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—180°
ELEVATION—ZERO

MAXIMUM DEPRESSION

MAXIMUM ELEVATION

FIGURE 18

SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—180°
ELEVATION—SEE FIGURE

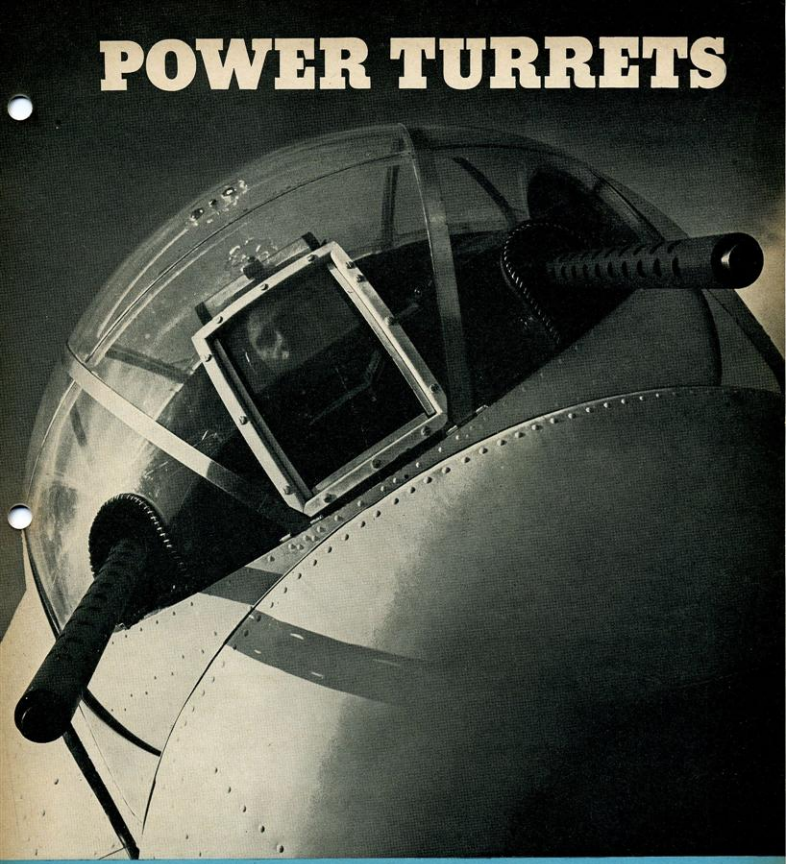
FIGURE 19

SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ANY POSITION
ELEVATION—ZERO

FIGURE 20

SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ANY POSITION
ELEVATION—ELEVATED OR DEPRESSED 90°

POWER TURRETS



How to operate and take care of them

RESTRICTED

Thanks to the Turret . . .

THE BOMBER FIGHTS BACK

• Without the men who invented the turret, today's great bombing missions would be impossible. For without turrets, the bomber would be almost as helpless over enemy territory as an ordinary transport plane without a single gun.

• No one knows exactly who should get credit for inventing the modern turret. The first crude models came out in the 1920's. One was a circular mount, illustrated on this page, which the United States developed to put a little flexibility into bomber guns. The Russians tried a movable platform, cranked by hand, in which the gunner sat right out in the open, fighting the slipstream as well as the enemy.

• The modern power turret—driven by electricity and mounted inside the bomber—was developed after many experiments in the 1930's and proved its worth in action in the second year of World War II. Its effect on air strategy was spectacular. At last the bomber—heavier and slower than the fighter plane—could really fight back.

• For turrets—little blisters of plexiglas or safety glass, bristling with caliber .50s, swinging around to meet enemy fighters no matter where they come from—enable the bomber to match the enemy slug for slug in an air battle.

• Approach an American bomber today, from any angle, and you will see a turret whose guns could be turned toward you in an instant.

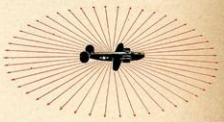
• The top turret swings in a full circle; its guns move up and down from straight out to nearly straight up; it protects the whole top of the plane.

• The lower ball turret swings in a full circle and points its guns anywhere from straight out to straight down; it can fight off any attacker who comes from below. The tail turret throws

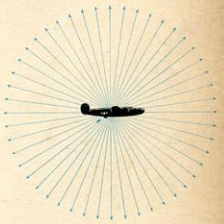
out a big cone of fire toward the rear, and the nose or chin turret a heavy cone of fire straight ahead.

• Along with hand-held guns sticking out the waist windows and the radio position, the turrets cover almost every square inch of sky around the bomber. No matter where the enemy fighter comes from, he must take his chances with a hail of caliber .50 bullets.

• The turrets are spun around, and the guns raised and lowered, by electric motors or by hydraulic pressure systems run by electric motors. (In the language of turrets, swinging from side to side is called moving in **azimuth;** up and down movement is called **elevation.**) All the gunner has to do is hold on to the control handles of his guns and move them to steer the turret; the mechanism does the rest.



. . . the turret covers every angle



• Inside the turret is everything the gunner needs for combat, arranged so that he can get at it in an instant. No space is wasted; although turrets are small, they have everything it takes to fight the enemy.

• As a turret gunner—no matter which turret you are assigned to—you will ride into combat seated in back of caliber .50 machine guns and a sight. Often your seat and footrests will be adjustable; if so, learn to use the adjustments properly and you will find them a great aid to both your comfort and your efficiency.

• Armor plate or bulletproof glass will protect you as much as possible—though your best defense, like a good boxer's, will still be the offensive power packed by those caliber .50s.

• Your guns will be equipped with a special charging system—usually a pulley and cable—which makes it easy to hand charge them in the crowded space of the turret. The guns will be mounted in adapters which cushion their recoil. You will fire them by pressing triggers, usually under your index fingers on the control handles, which release the firing pins by means of electrical devices called *ELECTRIC TRIGGERS*.

• Ammunition for the guns—enough to carry you through any mission if you don't waste it—will ride in cans mounted so that the belt runs smoothly into the feedways. Often *BOOSTER MOTORS* will help lift the belt to the guns. And often the

empty cases will drop through special *EJECTION CHUTES* out of the turret or into *SPENT ROUND BAGS* attached to the ends of the chutes.

• As you swing the guns around, you won't have to worry about shooting at parts of your own bomber. Every turret where this danger exists has a system of *FIRE INTERRUPTION*, or *FIRE CUTOFF*, which stops the guns automatically when they are pointed toward any part of the bomber.

. . . the controls are in easy reach

. . . once you have developed the touch, the turret practically runs itself

• Nor will you have to worry about swinging the guns so far that they bang into your own ship. Turrets have *LIMIT STOPS* which prevent that. On some turrets the limit stops are simply bumpers; others, in addition, have automatic switches which halt the turret before any damage can be done.

• All the switches you need to operate the turret will be located within easy reach. The control handles will enable you to run the turret as easily as an automobile. Once you have developed the touch—the secret is to keep a steady hand, without jerking—you will be able to track the enemy smoothly and accurately.

• For whirling around quickly to meet a new attack, your turret will be able to get up to high speed. The distance you move the control handles will determine the speed—and in some turrets you will have a special high speed button which throws the turret into high gear to give you an extra boost. If your turret has a high speed button, use it only when you really need it—to avoid unnecessary wear and tear on the power system.

• If the turret power should ever fail, you will usually have a *MANUAL SYSTEM* for operating it by hand cranks. Some turrets even have foot pedals which enable you to fire the guns while using both hands to crank the turret into position. This is an important emergency protection; use it to keep your guns pointed at enemy fighters even though your fire cannot possibly be so accurate as when the power is on, for a motionless turret is an invitation for fighters to attack.

• Even if the guns are out of order, keep tracking the enemy; if you can't hit him, you may at least scare him away.

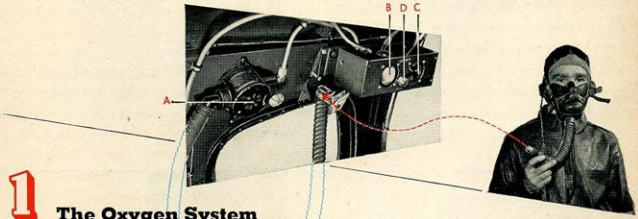
The Auxiliary Units

. . . all turrets have them
. . . they are designed for living five miles up

The manual system for operating the turret is one of the **auxiliary units,** which are like an automobile's accessories. Without the auxiliary units, the turret and guns would still operate, but the gunner himself would have a tough time of it.

For one thing, you can't go five miles up in the sky—which is where you will do most of your fighting—without special equipment for breathing in the thin air and keeping warm in temperatures that range down to 50 degrees below zero. Your turret has that equipment, as well as other auxiliary units for keeping in touch with other crew members, making emergency repairs in the dark, and taking training or combat films.

The manual system differs from turret to turret and will be discussed separately in the descriptions of individual turrets. But all other auxiliary units are basically alike, regardless of what turret you use.



1 The Oxygen System

Over 10,000 feet, the air gets so thin that a man's efficiency falls off rapidly; he can neither move nor think with any speed. At 25,000 feet, where heavy bombers usually fly, no man can stay conscious without extra oxygen.

Your oxygen supply, therefore, is your most important auxiliary unit. You will have a mask connected by a large flexible hose to a **regulator** (A) which adjusts the flow of oxygen to the amount required at various altitudes. In most turrets, the regulator will be the new **demand type,** which operates automatically and will always make sure that you get exactly the right amount, no more and no less.

There will also be a **flow and pressure gage** (B, C) which shows whether oxygen is flowing and how the supply is holding up. If the pressure goes down to 100 pounds—the danger level—a warning light (D) will flash on.

The source of oxygen supply will depend on the turret. In most turrets, the oxygen comes directly by tubing from the bomber's central tanks. In some, you will have one or two bottles which contain enough oxygen for about one and one half hours, and can then be refilled from the central supply.

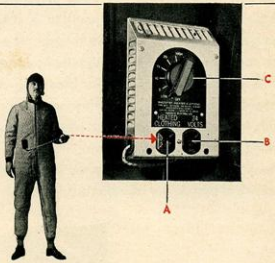
Before each mission, check all the connections on the oxygen system, particularly swivel joints,

to make sure they are tight. Check the hose to make sure there are no cracks or leaks. Then put on your oxygen mask, connect it, and make sure oxygen flows into it—take a look at the flow gage. Check the pressure to make sure it is up to the point required for the mission, as determined by your crew chief.

One important precaution: Never leave oil or cleaning fluid around the oxygen leads. Oil plus oxygen adds up to an explosion.

2 The Heated Suit

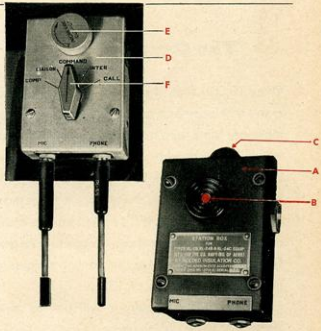
Your flying suit is like an electric heating pad. By adjusting the rheostat on the suit you can be comfortable at all times. In the Navy two types of plug-ins are provided. One, also used by the Army, consists of a box with two outlets, one marked **Heated suit** (A) and the other **24 Volts** (B). The rheostat (C) may be disregarded after turning it to "High," as the heat will be regulated by the rheostat built into the suit. The other type, used only by the Navy, consists of an ordinary electric outlet located on your control panel or some other convenient place. Before each mission, plug



in your heating suit and make sure it is working. Test the rheostat in the suit by turning it from high to low to make sure the heat is controlled.

3 The Interphone

The inside of a bomber is noisy and the crew members are stationed far apart. To talk to your crewmates—to tell them what you see and to get their warnings of enemy fighters—you use the radio interphone system. You have a microphone—either a throat, oxygen mask or hand-held microphone — and earphones which plug into a jack box in or near your turret. This jack box will be of two types, selector or non-selector. The non-selector type jack box (A) is equipped with a push-to-talk button (B) and a volume control (C). In the latest turrets an additional push-to-talk button may be built into the control handles. The



push-to-talk button for the selector type jack box (D) is located on or near the control han-

dles. The jack box itself is provided with a volume control button (E) and the selector switch (F) with five different positions:

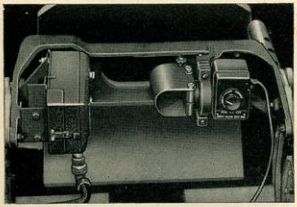
INTER—On this position you can hear and talk to all other crew members whose jack boxes are on INTER.

CALL—This position is used only when it is necessary to contact some crew member whose jack box switch is not on INTER.

COMP—When the switch is turned to this position you hear the radio compass receiver.

LIAISON—At this position you will hear the pilot's Very High Frequency command equipment, used for plane-to-plane communication.

COMMAND—At this position you will hear the pilot's Medium Frequency command equipment, generally used for plane-to-ground communications such as landing instructions. To speak over the interphone system you will have to hold down a push-to-talk button. You will hear your own voice as you speak. Release the button immediately after talking so that you can hear your crew mates again. Speak naturally. Don't shout—it blurs your voice. Turn the volume control knob on the jack box to adjust the volume of your earphones. At high altitudes interphone operation is seriously interfered with if more than one push-to-talk button on the plane is held down at the same time. Don't attempt to speak while someone else is speaking except in emergencies. Try out the interphone before every mission. Make sure you can hear your crew mates clearly, and that they can hear you.



4 The Gun Camera

For taking photographs in combat or training, you will have a small bracket, usually near the gun sight, on which a gun camera can be mounted. A switch on the control panel operates the camera. When the switch is on, the camera will expose film as long as you are pressing the gun triggers.

5 The Trouble Light

For working in the dark, you will have a small trouble light with a switch and usually about six feet of cord. The socket is adjustable to provide either a floodlight or spotlight. Test the trouble light before missions. Make sure it goes on when you turn the switch. Examine the cord for worn places, and make sure the light bulb is seated firmly in its socket.

The Turret Gunner's Job

The preceding pages have described, in general terms, the compact yet complicated equipment which you will use as a turret gunner. You will have to know where all this equipment is in your own turret, how to prepare it for flight and make sure it is working properly, and how to use it in combat.

You will not be expected to be an expert turret mechanic; if something goes wrong, trained maintenance men will repair it. But you will have to know enough about how the turret works to recognize trouble when it occurs, and to spot it before—not during—a mission.

Some of the checks you will make—on auxiliary units such as the oxygen system, interphone, and trouble light — have already been described.

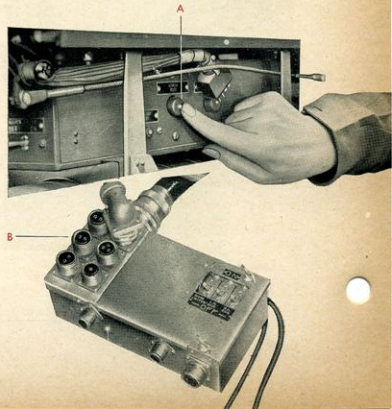
In the next few pages, you will become acquainted with the purpose, use, and care of such standard turret equipment as plexiglas domes, safety switches, reset buttons, clutches, cutoff systems, and many others. With the information contained in these pages, you will then be ready to start specializing on the turret to which you will be assigned.

Reset Buttons and Fuses

To protect the electrical circuits, most turrets have a set of either reset buttons (A) or fuses (B). The fuses operate just like those in a house; they blow out when a circuit gets overloaded or shorted and must then be replaced. The fuses are plugged in the turret's main switch panel; spares are usually carried in clips nearby or in a spare parts box.

Reset buttons, which are usually found on the control panels, do the same job in a little different way. When anything goes wrong with a circuit, its reset button pops out and cuts off the current. To make the circuit work again, you must push the button back in.

A combat tip on reset buttons: Sometimes, if you have been operating the turret at high speed, the electrical circuits which drive the turret will become so over-heated that the reset buttons will pop out as soon as you push them back in. If you are in the midst of an attack and must keep the turret working at all costs, hold the reset button in with one hand and operate the turret controls with the other. Do this only in real emergencies: You will overwork the circuits so badly that you will probably burn out motors or other equipment.



The Safety Switches

are built into the control handles. One type is set into the handle and is closed by squeezing it. The other and more standard type (A) is built out from the handle, like a wing, and is closed when you grasp the handle and press down the edge of your hand on the switch. Both have the same safety feature; the turret won't move unless one switch is closed.

Test the switches by pressing one at a time. The turret should respond. Then release the switch. It should spring back into open position immediately, and the turret should stop cold. Try the switches several times. Always close them quickly to avoid burning them out.

The Trigger Switches

are always located right on the control handles (A), usually under your index fingers. To test them, first make sure there is no ammunition in the guns. Then press the triggers. A sharp click in the electric trigger control will tell you if the firing circuit is working properly. Usually both guns are hooked up to fire from either trigger—press one trigger at a time and make sure both guns click.

The How and Why of Clutches

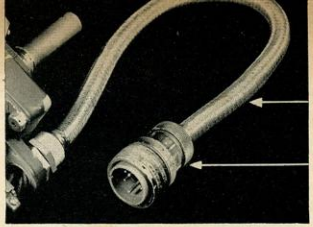
Clutches are provided on almost all turrets to allow you to disconnect the azimuth and elevation power gearing. Without this heavy gearing to move, it is easier to push the turret around by hand in making repairs and easier to run the turret manually in emergencies.

The clutches are in different places in different turrets. Most of them are simply levers, which you push back and forth into the engaged or disengaged position. You can then make a final check by trying to push the turret around by hand and trying to move the guns up and down. If you have a hard time moving the turret, the clutches are properly engaged.

Never take off or attempt to run the turret under power without first making sure that the clutches are engaged. It's like trying to drive your car with the clutch down to the floor. The mechanism is out of control. The turret will swing freely up, down, and around in the slipstream in a way that is dangerous to the navigation of the plane and may even cause a crackup. The sight cradle swinging around dizzily inside may crack your head. For the protection of others, always leave the clutches engaged when you leave the plane.

Leads Breezes Cannon Plugs

. . . they carry your current
. . . make sure the connections are always tight

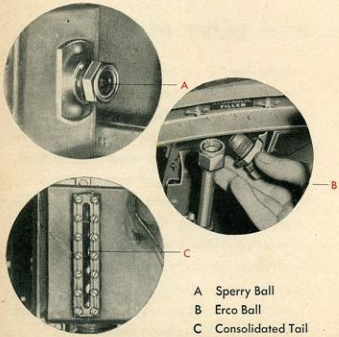


In all turrets the current is distributed through electric leads usually covered with flexible metal conduits commonly called Breezes (A). These Breezes are important; if they are frayed or pulled out at the ends, the circuits won't work. Connections between Breezes are made by Cannon plugs (B)—plug-ins with a threaded ring and sleeve to hold them together. Before each mission, examine the Breezes closely. Watch out for frayed or worn Breezes and pay special attention to where they are attached to the Cannon plugs. Check the Cannon plugs to make sure they are plugged in and screwed up tightly.

Testing the Limit Stops

They prevent your guns from banging into the fuselage and must be tested before each mission. Run your guns into the fuselage, wherever they could possibly strike when moving up, down, or sideways. Take it easy, to avoid damage if the limit stops are not working properly. Unless the stops halt your turret before the guns hit the fuselage, report them.

Checking Hydraulic Systems

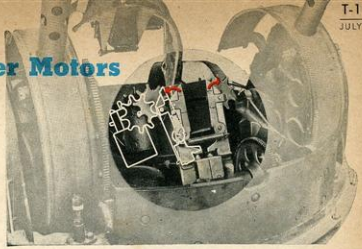


A Sperry Ball
B Erco Ball
C Consolidated Tail

In all turrets which operate hydraulically, the hydraulic systems must be filled with oil to the correct level to work properly. You will find a gage with a mark or screen to show the correct level. Check the gage every day. If the gage does not read FULL, report it.

Make a habit of inspecting the hydraulic system and lines carefully for leaks. This is best done with someone operating the turret to keep pressure in the lines, while you go over the system with a flashlight. Examine the line tubing for cracks. Take particular note of swivel joints and tubing connections. If your turret has hydraulic gun chargers, make a careful check of their parts and lines, too. Report all leaks to turret maintenance.

Use and Care of Booster Motors

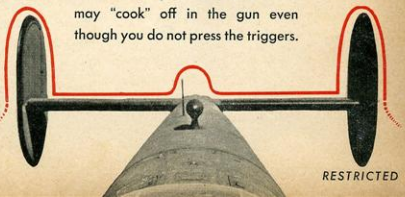


The booster motors found in most turrets, to help lift the ammunition belts into the guns, always operate automatically. The motor, which turns a sprocket wheel on which the ammunition belt rides, is pulled toward the gun when the gun is fired; this automatically turns on the booster motor switch. When the gun stops firing, the pressure on the ammunition belt stops and springs pull the motor back to its normal position; and the switch cuts off.

Test your booster motors before every mission, before you have loaded ammunition over the sprockets. Tilt the motors toward the guns. See if they start immediately and run smoothly. Then release the motors. Make sure their springs pull them back to normal position and the motors stop at once. But be careful around these motors: They are powerful, and their sprocket wheels can cut off a man's finger. Occasionally vibration during combat causes the automatic switches to lock; in that case the booster motors keep turning and the ammunition belts are piled up against the guns, preventing the guns from firing. If this ever happens in your turret, disconnect the electric cables which lead to the motors. Your ammunition belts may not feed so smoothly, but at least you will get your guns back to work.

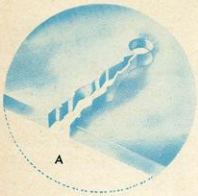
Testing the Fire Cutoffs

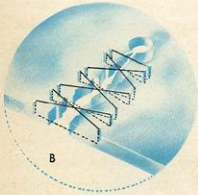
Fire interrupter systems are so complicated that adjustments are always handled by turret maintenance, but you are responsible for testing the interrupter before missions to make sure it is working. Test with the guns unloaded. Detach the Cannon plug from the electric trigger control and insert a test light in its place. Squeeze the trigger and swing the turret guns across the portions of the plane into which the guns could fire. The test light should go out just before the guns come to bear on any portion of the plane. This indicates the interrupter has gone into action. With a boresighting tool check the distance from the point where the light goes out to the structure of the plane into which the guns could fire. Repeat this procedure for each gun and each danger area bringing the guns to bear first from one side and then the other. Then do the same thing while moving the guns in elevation bringing them first down on the danger areas and then up. Each gun should cut off with an ample clearance on the danger areas. The amount of clearance should be about equal above and below the danger areas and to either side. If the guns fail to cut off, if the clearance is too small or if the clearance is not the same in all directions, report it at once. It is not wise to put complete confidence in the fire interrupter particularly after you have been firing long bursts because it is possible that a round may "cook" off in the gun even though you do not press the triggers.

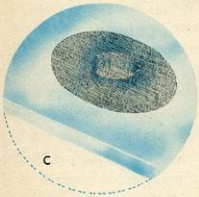


The Dome

. . . it serves as your windshield
. . . keep it clean and in good repair







All turrets have plexiglas domes or panels to protect you from the slipstream and still give you a clear view of the sky around you. Plexiglas is a glass-like plastic. It scratches easily; and the first rule is to be careful with it.

Clean plexiglas with plenty of soap and water. Never use a dry cloth—it may scratch, and it will build up static electricity that attracts dust. Never use hot water because heat softens the plastic. You may use a little plain kerosene or naphtha to remove grease or oil, but beware of all cleaning sprays or solutions. They usually contain chemicals which soften and crack the plexiglas.

Only qualified maintenance men should repair major scratches, cracks, or holes in plexiglas. But sometimes you may have to make temporary repairs.

Rub out minor scratches with automobile or furniture wax, always using a circular motion in rubbing. This gives a good gloss and helps prevent future scratching. In fact, an excellent scratch preventative is a good simonizing job on the whole dome.

At the first sign of a crack in plexiglas, notify maintenance. If cracks aren't caught soon enough, they rapidly grow into major breaks under further strain and the ripping force of the slipstream. If you have to make a temporary repair yourself, first drill a hole about 1/8 to 3/16 inch in diameter in the end of the crack (A); this will distribute the strain over a wider area. Then drill a series of small holes on each side of the crack, about a half inch away, and lace the two edges together with wire (B). This will prevent the crack from spreading. If you have to make a temporary repair on bullet holes in plexiglas, use a half-round file to trim the hole and any cracks surrounding it to a circle. Then put on a round patch of wing fabric or thin plexiglas or cellulose acetate sheeting (C), using "dope" or other solvent on both surfaces to make them stick. Mask the area around the hole so that the "dope" or solvent, which softens and cracks the plexiglas, can't spread. If you have no patching materials handy, whittle out a wooden plug for the hole until you can have permanent repairs made.

How to recognize "Creep"

. . . it is a common turret ailment which requires immediate repairs

When your turret is suffering from "creep"—a fairly common turret ailment—it is in no shape to go into combat.

Watch for creep when you test operation of the turret before each mission. It is easy to recognize. When the control handles are held neutral the turret, instead of stopping, continues to creep a little farther in one direction or another. If you try to use the turret in combat, every time you try to train your guns on the target the turret will go a little beyond, so that you will always miss your mark.

Report even the slightest amount of creep immediately. At the same time, watch for "binding". Make sure the turret does not stick or drag.

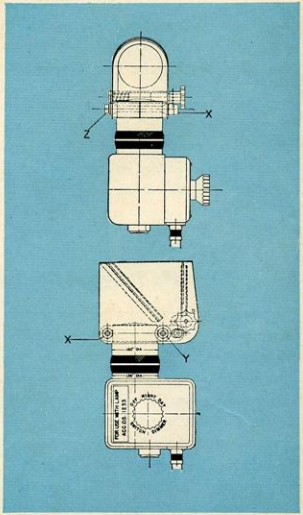
The MK 9 Reflector Sight

Most Navy turrets are equipped with a MK 9 Reflector Sight mounted directly in front of you at eye level. This sight is a sturdy mechanism, but it will not stand being used for a hand grip when you climb into the turret. Normally in harmonization you will adjust the turret guns to the sight, but sometimes there may not be enough adjustment in the gun mounts to do this. If this is the case, it will be necessary to make adjustments on the sight head, to line up the sight with the guns.

Elevation adjustment is obtained by loosening the nut (Y) on the side of the sight and turning the boresighting cam (Z).

Azimuth adjustment is obtained by loosening the adjustment nut (X) on the side of the sight and rotating the hood in azimuth until the desired adjustment is reached.

Before a mission, test the sight bulb, making sure both filaments are good. If either is burned out, replace the bulb. Check the rheostat for operation by turning it from dim to bright. Clean the reflector plate of the sight.



The Turret Guns

A machine gun is always a machine gun, whether in a turret or on the ground. It requires the same care, the same adjustments, the same field stripping and detail stripping to enable you to clean it, oil it, and inspect it before and after every mission. The pre- and post-flight checks described in the Guns section must be followed to the letter.

The special equipment which makes the caliber .50 easy to use in the crowded space of the turret will be installed for you by turret maintenance, and you will never have to remove it. You will leave the gun casing group mounted in the turrets, and will not install, remove, or adjust the special charging unit or the ejection chutes provided in some turrets to carry away used links and brass. You will simply take off the backplate and then pull out the "guts" of the gun—the bolt, oil buffer, and barrel groups—to clean, inspect, and oil them. But you will have to know from which side the guns feed, so that you can reassemble the bolts properly. And you will have to know how to install and adjust your electric triggers and how to check the charging units to make sure they are working properly.

1 Assembling the Guns

In all turrets, one gun must be assembled for left-hand feed and the other for right-hand feed. Use the standard procedure for changing the direction of feed as described in the Guns section of this manual.

In some turrets, the two guns are installed to feed from the inside—with the right-hand feed gun at your left and the left-hand feed gun at your right. In other turrets, the guns feed from the outside.

2 Electric Trigger Controls

The guns in your turret are fired by electric trigger controls (gun firing solenoids) which are mounted either on the buffer tube or on the side plate of the gun. Of the various types of electric trigger controls found in Navy turrets the MK 7 Mod 1 is the most common. It is mounted on the buffer tube. When you squeeze the trigger in the control handles an electric magnet in the electric trigger moves a plunger which trips the trigger bar, firing the gun.

Other trigger controls such as the MK 5 Mod 1 or the MK 4 Mod 1 are mounted on the side of the gun. The plunger in these types cams the sear slide which disengages the sear from the firing pin assembly and the gun fires. All electric trigger controls are adjusted in a similar manner. The procedure for adjusting the MK 7 Mod 1 which follows will serve as a guide for the adjustment of other electric trigger controls found in turrets.

3 Adjusting the Electric Trigger Controls

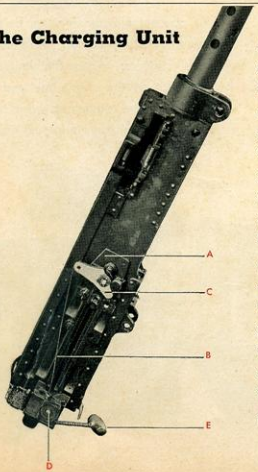
Be sure the headspace adjustment is correct as shown in the section on machine guns. Make sure the firing circuit is on. Then follow this procedure for adjusting each electric trigger:

A Turn the adjusting cap to the right, *clockwise*, until it stops.

B Turn the cap to the left, counterclockwise, one notch at a time, charging and attempting to fire the gun each time, until you reach a notch where the firing pin releases each time the gun is charged. Test it at this point two or three times. Then turn the cap another three notches counterclockwise.

C Check the adjustment at this point with a standard fire and no-fire timing gage. Place the .020-inch gage (FIRE) between the trunnion block and barrel extension, charge and fire the gun, and make sure the firing pin releases. Then use the .116-inch gage (NO FIRE) and make sure the firing pin does not release.

4 The Charging Unit



Most charging units operate mechanically, by a pulley-and-cable arrangement. Some work hydraulically. But the purpose of all charging units is the same—to enable you to charge your guns easily in the crowded space of the turret. On mechanical units, you will simply pull two cables, one for each gun. On hydraulic units, you will press a button which charges the guns automatically.

Before every mission test your charging units—without ammunition in the gun—until you are satisfied they are working properly. If you have a mechanical unit, make sure the charger plate (A) is properly bolted and safety wired to the gun's receiver. Make sure the cables (B) are attached properly to their levers (C), are free from kinks, and ride smoothly in their pulleys (D) when you pull on the charger han-

dles (E). If your turret uses a hydraulic charger, watch for leaks as you test the charging action. In loading ammunition into your guns before the takeoff, you will simply push the first round of the ammunition belt into the feedway. The gun will then have to be charged twice, after you are in the air, to make sure that the first round enters the chamber and is ready to fire. Your flight commander will signal when to charge the guns.

5 Loading Ammunition

In all turrets, ammunition must be carefully inspected before it is loaded into the plane or turret cans. Lay the belts out flat in some dry place where they will not pick up grit, dirt, or moisture. Watch for bad rounds and inspect for proper belting. Make sure that all rounds are pressed evenly into the links in line with one another. If the belting is irregular, it may jam your gun just when you need it most.

This is the standard method of folding the belt into the ammunition can, regardless of the shape or size. Note the pattern in which the rounds lie in the can. All cans are loaded starting with the single-link end of the belt first, so that the final topfold ends with the double-link end of the belt. The double-link end must always feed toward the gun. This can is loaded for a gun with right-hand feed. For left-hand feed, the double-link end must feed from the other side of the can.

To connect one ammunition belt to another, use this method. Use a single cartridge as a connecting pin to join the double-link end of one belt to the single-link end of another. Make sure the connecting round is pressed into the link all the way, in line with both belts.

Pre-Flight and Post-Flight Checks

. . . in all turrets, they are your life insurance

No matter what turret you use, your most important job as a turret operator will be making pre-flight and post-flight checks. You will check lists at the end of each individual turret section in the following pages, showing step by step every procedure you must follow from inspection before the flight, through the mission to the post-flight check after you return.

The pre-flight is particularly important, for it is the final, crucial examination of your turret—including all the specific checks already discussed—to make sure it is ready for battle. Unless you make these checks with great care, never omitting a single step, you cannot expect your turret to stay in working order. And if your turret ever fails in a pinch, you are out of luck.

A caution on pre-flight checks: You will have to run the turret on the bomber's auxiliary power, which means that you will be drawing on the same batteries that the plane depends on for takeoffs. Always have your crew chief supply the power; never use it without the crew chief's knowledge. Never operate the turret on the batteries alone.

At the end of each pre-flight, which naturally is different for each turret, you must make a general visual check. This is the same for all turrets. Run your eyes slowly over everything inside the turret. Then get out and do the same from the outside. Watch for such things as cracks or damage in the turret castings, loose covers on junction boxes, loose or missing nuts and bolts, nuts not safely wired properly, and so forth. Don't be afraid to report anything that seems to be wrong, however small it may appear.

These checks are often the difference between life and death. They are double indemnity insurance on the lives of your entire crew. Don't skip anything. Make them the most careful and serious jobs of your Navy career.

How to Use the Rest of this Manual

. . . it will describe each turret individually

Up to now, this manual has discussed only the features common to all turrets; the instructions up to this point apply to all turrets in use by the Navy today.

In the following pages, you will find individual descriptions of each turret, with special instructions for its use, care, and inspection. Described in the manual are eleven turrets, in this order:

GRUMMAN BALL	GRUMMAN 150SE-1 & 2
ERCO TEAR DROP	ERCO 250TH-1 & 2
ERCO BALL	ERCO 250SH-2, 2A & 3
MARTIN BALL	MARTIN 250SH-1A & 2
MARTIN ELECTRIC UPPER DECK	MARTIN 250CE-7 THROUGH 21
MARTIN HYDRAULIC UPPER DECK	MARTIN 250CH-1 & 3
MARTIN HYDRAULIC TAIL	MARTIN 250CH-2
CONSOLIDATED TAIL	CONSAIR 250CH-3, MPC 250CH-6
SPERRY RETRACTABLE BALL	SPERRY 250SH-1
BENDIX UPPER DECK	BENDIX 250CE-3 & 4
EMERSON BOW	EMERSON 250CE-1

★The official Navy name for turrets gives you a complete story on who designed the turret, the number of guns, the shape, the type of power and the model airplane for which it was designed. In other words, Martin 250CH-1 means Martin was the designer, 250 is two cal. 50 machine guns, C stands for cylindrical in shape, H for powered hydraulically and -1 indicates the model airplane the turret was built for. Other shapes are T for teardrop, S for spherical and R for remote control.

As a combat crew member, you will probably specialize in only one turret. But you will have to have a working knowledge of the other turrets in your plane, so that you can take over whenever necessary. You will find that knowledge in the following pages, and in your classroom instructions. As far as possible, this manual has been stripped down to the practical, working information that the gunner needs under everyday conditions. For each turret, the order of presentation will be as follows:

1 HOW TO GET IN
(This is not so easy as it sounds. In some turrets a man can be seriously injured if he tries to enter without knowing exactly how.)

2 HOW TO OPERATE THE TURRET
(Where to find the switches, and how to turn them on.)

3 WHERE TO FIND THE AUXILIARY UNITS

4 HOW TO GET OUT
(By this time, you will have a practical working knowledge of the turret and how to use it in combat. The rest of the instructions will show you how to prepare the turret for a mission.)

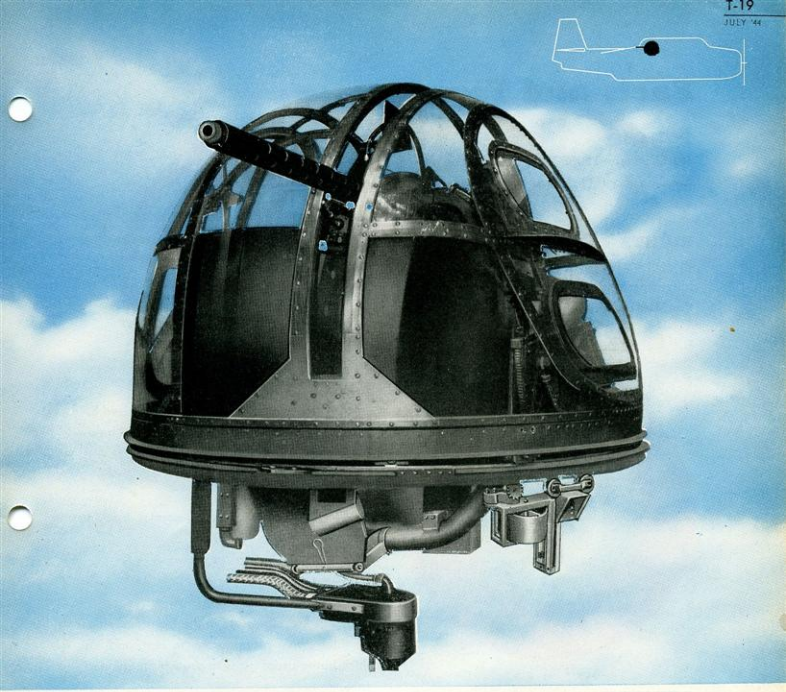
5 HOW TO ADJUST THE SIGHT

6 HOW TO ADJUST THE GUNS

7 HOW TO HARMONIZE GUNS AND SIGHT

8 HOW TO LOAD AND MOUNT THE AMMUNITION CANS

9 A CHECK LIST of the pre-flight and post-flight routine on each mission.



GRUMMAN BALL TURRET

GRUMMAN 150SE-1 & 2

The Grumman 150SE Turret, the only turret in the TBF Avenger, takes care of beam, overhead, or tail cone attacks on the airplane. In this turret, which is of the ball type, the gunner moves with the gun and sights in elevation and azimuth in the direction he turns the control handle. It is powered electrically and packs a mighty punch in its single cal. .50 machine gun.

The turret has been produced in two models—the Grumman 150SE-1 used in the Avenger 1 and the Grumman 150SE-2 used in the later model Avenger 2.

Facts and Figures

POWER

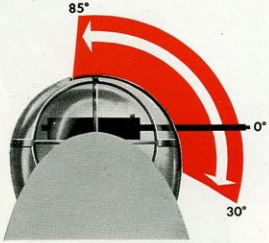
The Grumman 150SE Turret operates on power supplied from the airplane's central electric system.

SIGHTS

Its sight is a Navy standard Mk 9 reflector sight, fully described in the introduction of this section. The auxiliary sight is the Mk 11.

AZIMUTH

The turret can move—a full circle—in azimuth.



ELEVATION

In elevation the ball and gun can be raised 85° above horizontal and be depressed 30° below horizontal.

SPEEDS

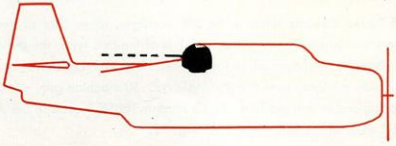
The turret has two speeds—normal tracking and high speed.

ARMOR

The armor plate protection in the turret consists of ½″ thick armor plate in the front and sides; ¼″ thick armor plate under the seat, and 1½″ thick bullet-proof glass to protect the gunner's face.

STOWING POSITION

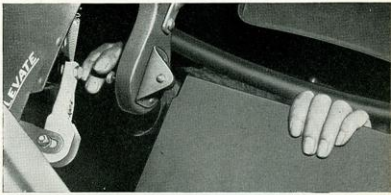
The stowing position is 0° elevation and 180° azimuth, gun pointing straight aft.



Getting In

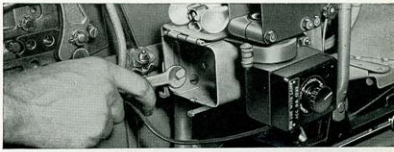
Having been introduced to the turret in the Grumman Avenger, you will now want to know how to get into it. Pursue the following steps carefully, or damage to the turret might result.

Before entering the turret, make sure the **main battery switch** on the pilot's control switch panel is "on". Then check to determine if the **emergency switch** in the junction box is "on". This junction box is attached to the left bulkhead in the bombardier's compartment. To turn this switch off or on, it is necessary to remove the cover of the junction box.

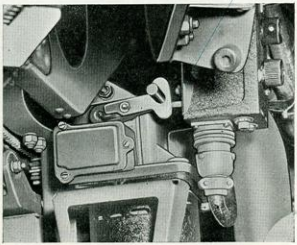


A flap of ¼" armor plate is hinged to the front of the turret's seat and stowed in the **up** position with a spring loaded pin. Pull out the stowing pin and swing the armor plate flap **down.** Facing forward enter the bottom of the turret. Reach up and grasp the side armor plate with your left hand. As you pull yourself up into the seat twist around so that you are facing aft. **Do not use the sight or the control handle as a hand grip.** Then place your feet on the front armor plate above the flange. Pull up armor plate flap, and lock it in **up** position with the stowing pin. **It is very important that this armor plate flap be stowed in the "up" position before you put the turret into operation. If left down, you can seriously damage the turret as well as the airplane.**

Look through the **sight** and determine if it is at the proper height. If the sight is not, loosen the adjusting bolts that hold the sight bracket and raise or lower it to adjust the height to your liking. Don't forget to secure the sight bracket adjustment bolts. Next to your left knee is the **elevation manual crank.** Check to see

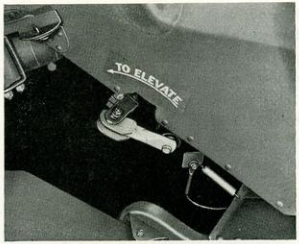


that the crank is disengaged and that the handle is stowed in its retaining clip. Outside the ball on the right side under the right trunnion at track level is the **azimuth clutch.**



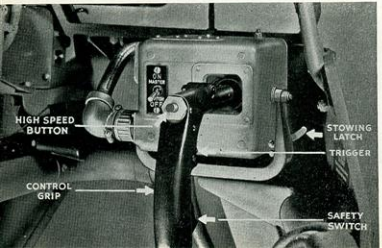
Make sure that this is in the engaged **up** position.

Fasten and adjust your safety belt—you will need it in this turret.



Operating the Turret

. . . Where to Find the Controls
. . . How to Use Them



Seated in the turret, you are now ready to begin to operate it. Directly in front of you and below the bullet-proof glass is the **control box** in which is installed the **pistol grip control handle,** and the **master switch.** This control box should be in the stowed position. On the right side is the **stowing lever.** Push down on it and the control box will drop into operating position. Make sure the lever is re-engaged. Next to your left shoulder is the **control panel.** Reach over and flick on the **train** (azimuth) and **elevation switches.** Then turn on the master switch on the control box in front of you. The turret is now ready for instant action.

Remember at all times to keep your feet up on the front armor plate and your hands away from the moving parts while operating the turret.

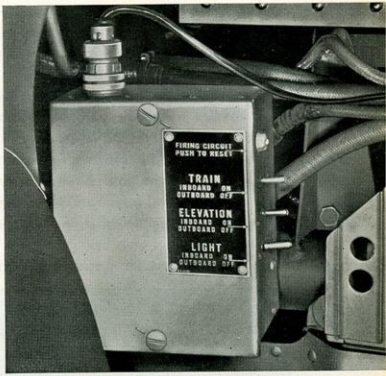
Grasp the pistol control handle, at the same time squeezing the safety switch in the handle to put the turret into operation. To move the turret operate the pistol grip control handle as you would a pistol. To roll the turret up, point the pistol grip up; to roll it down, point the grip down. The same is true for movement right or left.

The pistol control grip also contains a **high speed button** for increasing the speed of the turret for slewing from one extreme position to the other. Merely press the button on the back top of the grip with your thumb to bring this high speed control into operation.

Releasing the control grip will automatically return the gun to the trailing aft position and cut off power to the drive motors.

Right under your index finger in the pistol grip control handle is the **trigger** switch for firing the gun.

Charging the guns in the turret is a manual operation. In front of your left knee is the **charging handle.** Grasp the charging handle with both hands, one above the other, and give a hard pull all the way back. Then quickly release the handle and let it slide forward by itself. To hold the bolt back in the gun to facilitate boresighting and the removal of jams, a latch is provided to lock the gun charging handle in the back position.



Using the Auxiliary Units

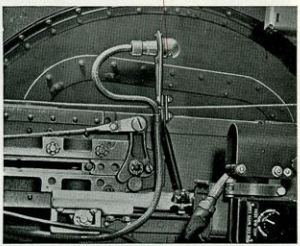
The **oxygen system** of the turret is dependent on the main oxygen system of the airplane. The oxygen is brought into the turret through the slip ring assembly at the bottom. Here is attached a flexible hose, which conducts the oxygen to the gunner's mask.

The **interphone jack box** located next to your right knee is where you plug in your inter-phone jacks for your headphones and throat microphone. This box is also provided with a volume control and a wave band selector switch.

In this turret no **heating suit outlet** is provided. However, in the bombardier's compartment directly beneath you, you can attach your heating suit to an outlet provided there.

A stationary **trouble light** located above the gun is installed in a bracket which is attached to the inboard side of the Bell Mount Adapter. The **light switch** is located on the control panel. As soon as the battery switch in the pilot's cockpit is turned on, you are able to turn on the trouble light in the turret and also the Mk 9 sight by means of its built-in switch.

Provisions are made for mounting a **gun camera** on the top left side of the bullet-proof glass face plate frame. To operate the camera depress the safety switch and trigger switch.



A built-in combination **elevation clutch** and **hand crank** is provided to permit manual operation of the turret without the power on. To put it to use, carefully unfold the handle halfway out, and rotate it until the clutch dogs engage; then completely unfold the handle and operate as desired. Never operate the elevation hand crank without being in the turret and then not below 0° elevation. This is because the gun and front armor plate are so heavy that the hand crank will whirl out of your hand, allowing the turret to roll down and damage the fuselage of the plane with the gun. If you are outside of the turret and wish to elevate or depress the gun with the elevation hand crank, have someone hold the gun.

An **azimuth clutch** is also provided for disengaging the azimuth drive so that the turret may be pushed around freely by hand. Both of these units will be of little or no use to you as a gunner, as they were mainly installed to help the maintenance men.

Getting Out

To get out of the turret be as careful as you were in getting in. Remove your hand from the pistol control handle, and the turret will return to the stowing position, 0° elevation and 180° azimuth—gun pointing straight aft. Push down the latch on the right hand side of the control box and raise the box up to its stowing position, allowing the latch to reengage, and secure the box in place. When stowing the control box, do not lift it by its pistol grip control but rather by the control box itself. Otherwise you can damage the internal mechanism of the box.

Turn off all switches and disconnect the auxiliary units you have been using.

Unfasten the safety belt.

Reach down and pull out the stowing pin which holds up the armor plate flap beneath you and push down the flap. Climb out of the turret facing aft, feet first, using the side armor plate as a hand grip to assist you in getting out.

Once outside the turret, push the armor plate flap **up** to its stowing position and lock it in place with its stowing pin.

Emergency Exit

If it is necessary for you to leave the turret in a hurry, an emergency exit is provided in the right hand side of the turret plexiglas enclosure. In the center of the hatch is a handle —grasp it and turn it **up**; then push out on the escape hatch and it will fall away leaving a hole big enough for you to get out. Another exit is to get down out of the turret and escape through a hatch on the side of the plane.

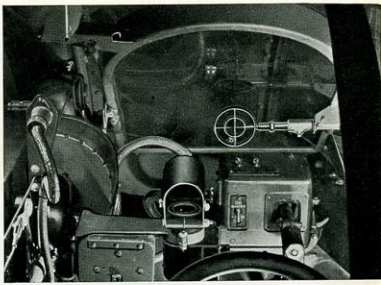
Preparing the Turret for Combat

You now have a good working knowledge of how to get in the turret, how to operate it, use its auxiliary units, and how to get out.

To complete your knowledge of the Grumman 150SE you have still to learn the rest of your duties, which consist of adjusting the gun and sights, harmonizing them, and loading ammunition. These will be taken up in the following pages.

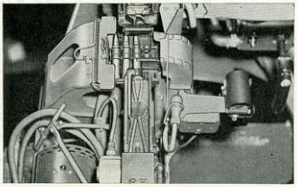
The Sights

Two sights are provided in the Grumman 150SE Turret—the standard Navy Mk 9 reflector sight and the Mk 11 iron ring and post sight. The Mk 9 reflector sight is the sight you will use, but if for any reason it should fail, you have the iron ring and post sight to fall back on. In adjusting the Mk 9 sight for harmonizing it with the gun, make all your adjustments on the sight head. For full instructions for making these adjustments, see the section on the Mk 9 sight in the general introduction on turrets.



Adjusting the Gun

The single cal. .50 gun of this turret is installed in a Bell Mount Adapter on which no provisions are made for boresighting adjustments. The gun is mounted to feed from the **left side.** This should be remembered when the gun is assembled in the turret.

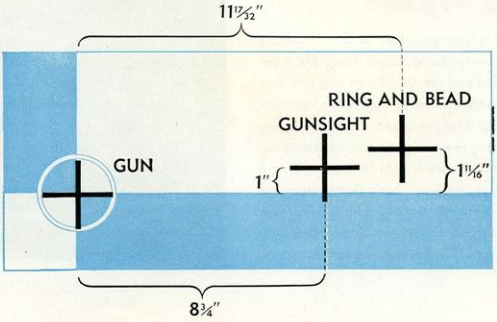


Harmonizing the Sights to the Gun

There is only one way to harmonize the gun and sights in a Grumman Turret. As there are no boresighting adjustments on the gun, it will be necessary to harmonize the sights to the gun. Set up the special pattern stand or template illustrated here, as level as possible 100 feet from the side of the airplane. Latch the gun charging handle in the back position and insert a breech boresighting tool into the gun. Operate the turret until the gun is lined up squarely in the center of the gun cross on the pattern stand. Turn off the master switch and hold the gun on the cross until the motors have stopped. The turret will remain there. Do not move the turret again.

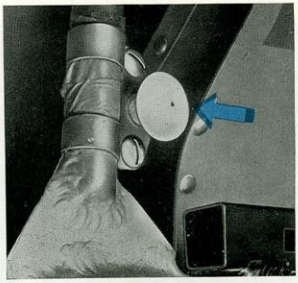
Now turn on the reflector sight switch, which is built into the sight, and make whatever adjustments are necessary on the sight head to line up the dot squarely on the reflector sight cross on the pattern stand. To complete the job line up the auxiliary ring and post sight on its respective cross on the pattern stand.

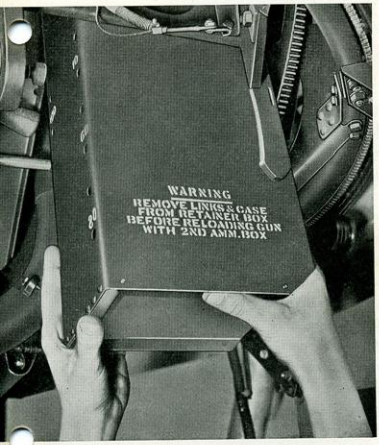
If your plane is land based, another method is to boresight the gun on some small object, such as a tree or chimney, at least 1000 yards away. Then adjust the sight head until the dot of the sight is squarely on the object. Both methods described here are parallel boresighting.



Loading Ammunition

The Grumman Turret is provided with one ammunition can which holds 200 rounds and is located directly under the gun. To remove the ammunition can, the turret is brought to the stowing position and the ammunition can is released by pulling the little **yellow knob** mounted right under the gun sight bracket. This knob operates a wire release which unlatches the can. In addition to this locking arrangement there is a cable lock which hooks on to the bottom of the ammunition can to prevent it from falling out in the event the yellow knob is accidentally pulled, or the mechanism holding the ammunition can in place fails.

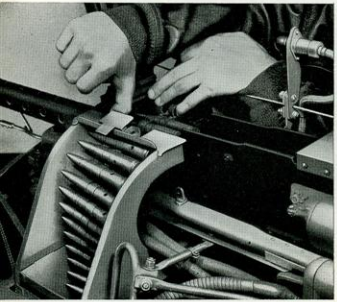


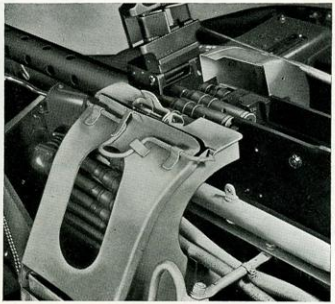


Installation of the ammunition can in the turret is done from the outside. Hold the can with the right hand on the bottom and the left hand near the top so that the guide rails on the can register with the guide track. Push upward until the can is approximately half way in the stowed position, and the can will latch itself. Now use both hands at the bottom of the can to push it home where it automatically locks in place. Hook the cable lock on the bottom of the ammunition container.

1. To load the gun, open the cover on the top of the gun.
2. Open the feed chute cover on the left hand side of the gun; slide your hand through the feed chute down into the ammunition can; pull up the ammunition belt and insert the first round through mouth of feed chute into the machine gun receiver. (The non-return ratchet prevents the belt from falling back into the feed chute.)

3. Pick up the extractor, pull back the charging handle approximately ¼", and pull up the belt until the first round is aligned against the cartridge stop. Drop the extractor between the first and second rounds. Slam the cover plate back into position.
4. Slam the feed chute cover to close position, and the job is complete.



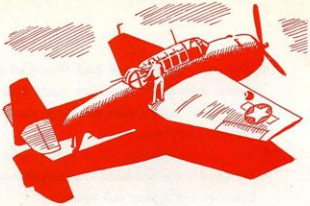


Removal of Empty Cartridge Cases and Links

The empty links and cartridge cases are collected in a container almost directly under the gun. A lever secured with a winged Dzus fastener is mounted above the elevation hand crank to dump the container. Free the lever and push it down. Catch the empty links and cartridge cases in the special bag provided, or in some other container. Allow the ejection door on the bottom of the container to slam shut and resecure the lever with its winged Dzus fastener.

Always remember to empty the expended ammunition container when you load a new can of ammunition into the turret. This is very important because if the container becomes overfilled, the gun will jam.

Pre-flight Routine



. . FOLLOW STEP BY STEP

1. Completely reassemble the gun in the turret, making sure the gun is assembled properly to feed from the left.
2. Lock the bolt back by latching the gun charging handle in the aft position. Check harmonization of the gun and sights by boresighting on a pattern stand or some other object 1000 yards or more away.
3. Try to rock the gun in its mount. Make sure it is securely mounted. Check to see if the nuts are properly safetied.
4. Check to determine if the azimuth clutch is in the "up" position so that the turret cannot be pushed around by hand.
5. Check the elevation clutch and hand crank. Determine if it is not engaged and if the handle is stowed in the clip provided for it.
6. Hand charge the gun several times to test if it is working properly.
7. Inspect the flexible electric conduits (Breezes) to determine if they are frayed or broken.
8. Check all Cannon plugs to see that they are properly seated and screwed up tight.
9. Check the oxygen connections to make sure that they are tight.
10. Make sure the plexiglas dome, escape hatch, and bullet-proof glass face plate are clean and properly secured.
11. Check for ease of operation in elevation and azimuth. Depress high speed button and check the turret in slewing.
12. Remove your hands from the pistol control handle to determine if the turret returns to the stowing position. While in the stowing position check for turret "creep."
13. Operate the turret to extreme elevation to determine if the limit stops are functioning properly.
14. With guns completely depressed, carefully rotate the turret to determine if the contour follower keeps the gun from swinging into the fuselage.
15. With power on, safety switch depressed, squeeze the trigger and listen for the "click" of the electric trigger control.
16. Insert a test light in place of electric trigger control and with trigger depressed swing the turret across the portions of the ship into which the gun could fire. The test light will go out in this area. With a boresighting tool check the distance from the surface that the interrupter cuts out.
17. Turn on the sight switch and rotate the sight rheostat from dim to bright to adjust the brightness of the reticle to existing light conditions. Make sure the rheostat is working properly. Try both filaments of the sight bulb. If either is burned out, replace the bulb. Make sure the reflector plate of the sight is clean.
18. Open the spare light bulb stowing box on the sight bracket to determine if you have the required number of spares.

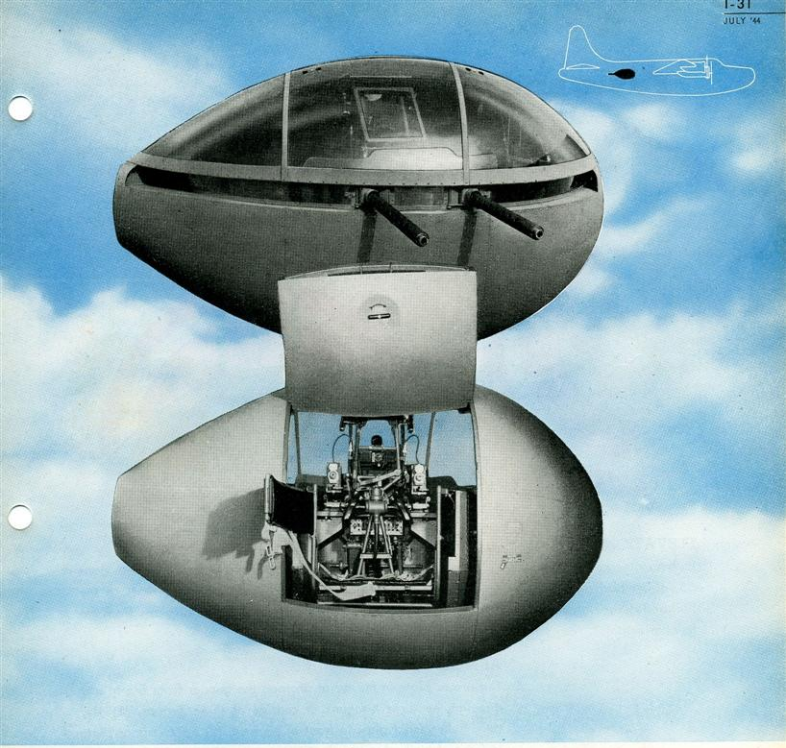
19. Plug your headphones and throat microphone into the inter-phone jack box to test if your crew mates can hear you and you can hear them.
20. Plug in your heating suit in the receptacle provided in the bombardier's compartment. Check to see if your suit heats.
21. Make sure the trouble light is operating.
22. Inspect all ammunition belts to determine that the rounds are in good condition and properly belted.
23. Make a complete visual check of the turret inside and out.
24. Load the ammunition can and install it in the turret. Feed the belt up through the feed chute into the feedway of the gun. You will not charge the gun until you are in the air and so ordered by the pilot.

Before Landing

1. Let go of the pistol grip control handle, and the turret will return to its stowing position—0° elevation and 180° azimuth, gun pointing straight aft.
2. Clear the gun by lifting the gun cover, removing the ammunition, and charging the gun twice.
3. Remove all ammunition from the feedway.
4. Check all switches and make sure they are off.
5. You will remain in the turret during landings.

After Landing

1. Disconnect any auxiliary units that you have been using.
2. Get out of the turret.
3. Remove the ammunition can.
4. Open the access door on the bottom of the ejected link and cartridge case container on the bottom of the turret, dumping the empty cartridge cases and links.
5. Field-strip the gun by removing its working parts. Clean and inspect the gun receiver. Then detail-strip the parts you have removed from the gun. Clean them and make a thorough check of their condition. Do not leave excess oil or cleaning fluid in the turret.
6. Report any malfunctions of the gun or turret noted on the mission.



ERCO TEAR DROP TURRET

ERCO 250TH—1 AND 2

The Erco 250TH Turrets have the approximate shape of a tear drop. They are installed in the waist positions on either side of the PB4Y-2 airplane—the Erco 250TH-1 on the starboard side and the Erco 250TH-2 on the port side. With their wide cone of fire they protect the plane from beam or belly attacks, besides offering a considerable area of protection from above. In operation they are somewhat similar to a ball type turret inasmuch as the gunner moves with his guns and sight in the direction he moves his control handles.

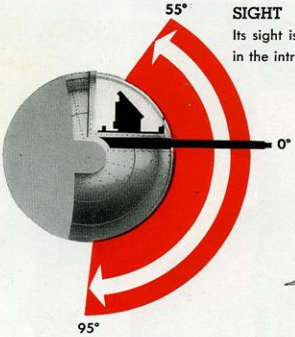
Facts and Figures

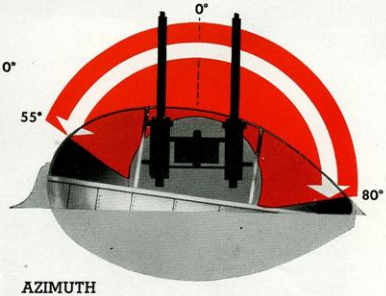
POWER

The Erco Tear Drop operates hydraulically on pressure built up by a hydraulic pump driven by a constant speed electric motor.

SIGHT

Its sight is a standard Navy Mk 9 reflector sight fully described in the introduction to this section.





ELEVATION

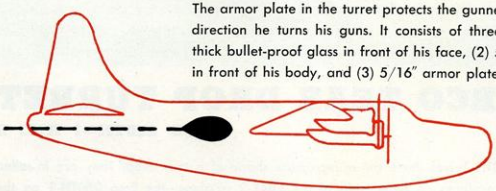
Both turrets can raise their guns 55° above horizontal in elevation and depress them 95° below horizontal.

AZIMUTH

In azimuth, the Erco Tear Drop turret allows the guns a movement of 135°, 55° towards the bow from the beam and 80° towards the tail of the airplane from the beam.

ARMOR

The armor plate in the turret protects the gunner from fire in any direction he turns his guns. It consists of three groups: (1) 1½" thick bullet-proof glass in front of his face, (2) 5/16" armor plate in front of his body, and (3) 5/16" armor plate under his feet.



STOWING

The stowing position is 0° elevation with guns pointed in the extreme aft position in azimuth (80° aft of the beam).

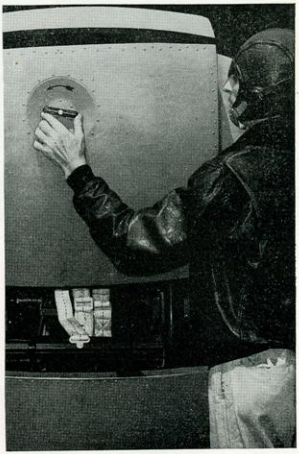
Getting In

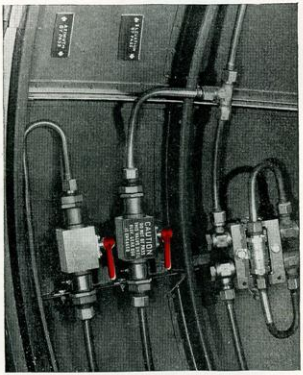
Now that you have been introduced to the Erco Tecr Drop Turret, the next thing you must learn is how to get in the turret. You will find this an easy job. However, you must pursue the following steps carefully, or you might seriously injure yourself or damage the turret.

To begin with, have your flight engineer throw on the **waist turret** switch on the flight engineer's panel.

On a junction box, mounted to a bulkhead conveniently located near the turret, is the **main power** switch, along with a **push release button** switch and a **red indicator light.** Flick this main power switch to the **on** position. The push release button is provided for emergency use only in turning off the power to the turret.

You are now ready to get into the turret. Turn the handle counterclockwise on the entrance door in the back of the turret and raise up the door to its stowed position. Inside the turret on the forward inboard side, right next to the





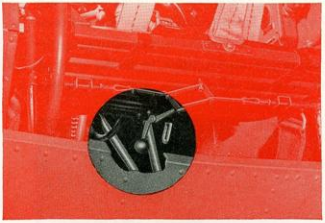
entrance door, you will see two levers painted red and marked **elevation by-pass valve** and **azimuth by-pass valve.** Make sure these levers are in the **down** position.

As your turret is in the stowed position, it will be necessary to move the seat and guns in azimuth to a right angle from the center line of the plane for you to get in. To do this, raise up the azimuth by-pass valve lever which frees the seat and guns so that you are able to move them around to the desired position. Lock the seat and guns in position by turning the azimuth by-pass valve lever down.

Unhook the back of the turret seat and swing it back. Be sure you keep the shoulder harness over the back of the seat.

Duck your head under the top of the door and put one leg into the turret. Grasp the tubing on either side of the sight to assist yourself and slide in on the seat. Reach around behind you and snap the seat back rest into place.

Now that you are seated, take a look through the **sight** to determine if you are at the proper height. If not, reach down between your legs under the seat and grasp the **seat adjustment lever** so that you may raise or lower the seat to the desired position.

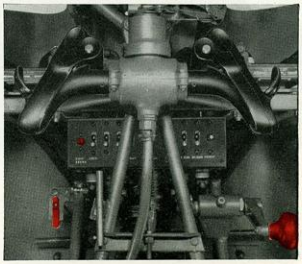


You have yet to close the entrance door; so reach around in back of you to the side and lift up again the azimuth by-pass valve lever, which we spoke about before you entered the turret. This frees your turret in azimuth so that you are able to move your seat around freely. Using the upper ribs of the turret as a hand grip, push your seat around so that you have your guns pointing aft. Reach around and lift the bottom of the door, freeing it from the locks in the channel guide. Then carefully let the entrance door down. Grasp the handle in the top section of the door; open the door latching handle in the bottom section, and pull the door in sharply, releasing the latching handle so that the door locks. Check the latching handle to see that it is completely secured. Now turn the azimuth by-pass handle to the **down** position, making the turret ready for power operation.

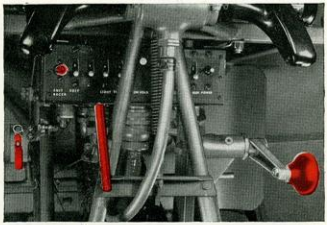
Put on the shoulder straps and fasten the safety belt. You will need them in this turret.

OPERATING THE TURRET

. . . Where to Find the Controls
. . . How to Use Them

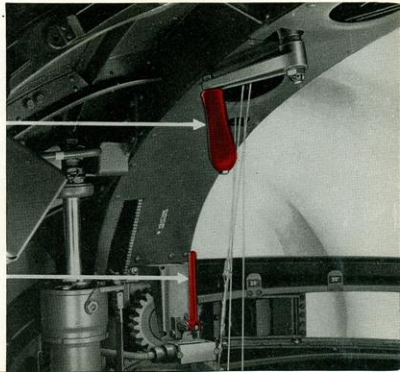


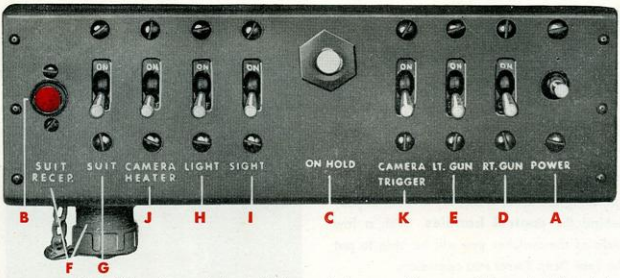
The **control panel** with all the switches for operating the turret is directly in front of you, behind the **control handles.** With a few clicks of the switches you will be able to put the Tear Drop Turret into operation.



First of all, check to determine if the **manual azimuth** and **elevation clutches** are disengaged before attempting power operation. This is very important as each clutch is equipped with a switch which cuts off the power to the turret when the clutch is engaged. The azimuth clutch is operated by a **red bar handle** next to your knee. Check to see that it is in a stowed position and that the turret will not move when you turn the **azimuth hand crank,** located next to the other knee. The elevation clutch has a **red handle lever** on the forward trunnion of the turret, which should be in the **up** position. To insure disengagement of the elevation clutch, operate the **elevation hand crank** in the top aft portion of the turret. The turret should not move.

With these checks made you are now ready to turn on the power. Hold down momentarily the





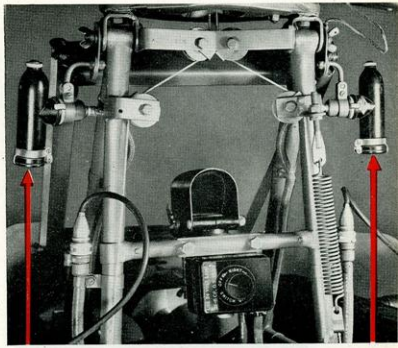
power switch (A) on the control panel; the **red indicator light** (B) should light up, as well as the one on the junction box outside of the turret. These lit-up indicator lights show you that the power is on in the turret.

To operate the turret, grasp the control handles in front of you, depressing the safety switches which start the pump motor. Turn the handles in the direction you desire to move the turret. For azimuth (right or left), the handles are operated like those of a bicycle. For elevation, move the upper part of the handle grips backwards, and for depression, move the top portion of the handles forward. Don't jerk the controls—move them smoothly and deliberately. If for any reason the power in the turret cuts out, it may be possible that the circuit breaker to the pump motor is overheated. As a measure of immediate action, depress with one hand the **on-hold** button (C) which will by-pass the circuit breaker. Operate the control handles with the other hand.

The guns may be fired singly or together. They are controlled by gun selector switches marked **right gun** (D) and **left gun** (E) on the control panel. The **triggers** are right under your index fingers on both control handles. Either trigger will fire both guns, together or singly, as you may determine by your gun selector switches. Under your thumb on the top front part of the control handles are the **red interphone buttons.** Press either or both buttons when you wish to speak.

In front of you, on each side, are the two caliber fifty machine guns with hand charging handles on the outboard side of each gun. Reach forward, palm up, and grasp the hand charging handle firmly. Give a quick pull backward; then release the charging handle smartly and let it slide forward by itself. Repeat the procedure for the other gun.

Using Auxiliary Units

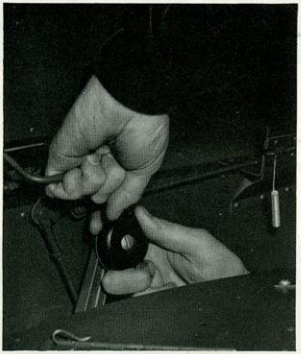


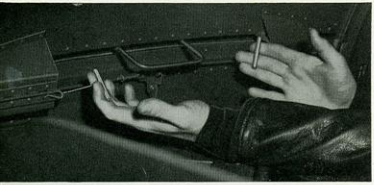
The turret is provided with a diluter demand type **oxygen system** fed into the turret through the aft trunnion from the airplane's main oxygen system. To control the amount of flow of oxygen to the oxygen mask, a regulator is mounted in the bracket in the top inboard side of the forward section of turret. The cord to your **heating suit** is plugged into the **suit receptacle** (F) in the bottom of control panel and is turned "on" and "off" by a **heating suit switch** (G) in the same panel.

Trouble lights, of the spotlight type, provided with swivel joints to direct their beams, are mounted at the top of the sight supporting structure. The **light switch** (H) to control these lights is on the control panel. To turn on the sight, flick the **sight switch** (I) to the **on** position on the control panel. No other switch in the turret need be on.

Provisions have been made for installing a **camera** in back of the armor plate in front of the bullet-proof glass face plate. To operate the camera turn on the **camera heater** (J) and **camera trigger** (K) switches on the control panel. Squeezing the triggers will put the camera into operation. The **interphone jack box** is located above your hip on the aft side of the seat. This is where you will plug in your interphone jacks for your head set and microphone. If the power fails, a **foot firing** mechanism is provided. Reach down by your knee and turn up the **red safety catch.** Then by depressing the **red bar** above your foot the guns are fired.

Manual elevation and azimuth hand cranks are provided to move the turret without power. To put them into use it is necessary to pursue the following procedure: Release the red azimuth clutch bar next to your knee; then reach in back of you and lift the azimuth by-pass lever. By operating the hand crank next to your other knee azimuth movement is obtained. For elevation manual operation, engage the elevation clutch on the front trunnion by turning down the red handle; then raise up the elevation by-pass lever in back of you. By turning the elevation hand crank at the top of the turret you will be able to move the turret up or down. If either of the clutches do not slip in easily, work the hand cranks back and forth until they do.





This manual method of operating the turret will be of little use to you as a gunner in combat. However, you will find this manual control very helpful in positioning the turret and in harmonizing the guns and sight when a small amount of carefully controlled movement is desired.

Getting Out

Get out of the turret just as carefully as you got in. Turn the turret to the stowing position —0° elevation and 80° aft of the beam in azimuth—guns pointing aft. Disconnect any auxiliary units you may have been using. Reach around in back of you and unlock the door latching handle. Grasp the handle on the upper section of the door and push out. With your other hand, grasp the bottom of the door, lift up, and stow the door in the channel catches provided. Move the turret to 0° elevation and to the beam in azimuth. Turn off all switches.

Unclamp the seat back and climb out of the turret. Reinstall the seat back.

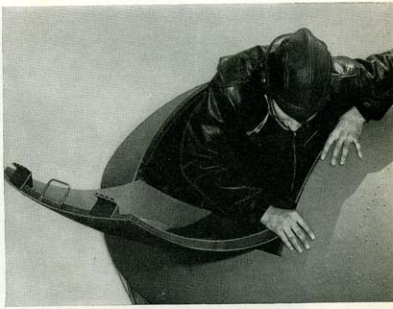
Reach inside the turret and lift the azimuth by-pass lever and shove the guns and seat around in azimuth by hand to the stowing position—0° elevation—guns pointing aft. Depress the azimuth by-pass valve lever.

Emergency Exit

It may be necessary to get out of the turret in a hurry. If that is the case, an emergency exit is provided through the entrance door, either

outside of the airplane or into the airplane. To escape outside of the airplane turn the turret down to its maximum depression to bring the upper section of the entrance door to the outside of the airplane. Pull out the two pins that hinge the two sections of the entrance door together and push up the upper section so that you can crawl out of the turret. To escape into the airplane run your turret to 0° elevation and to a right angle from the center line of the plane in azimuth. Pull out the hinge pins to the entrance door and push the door out.

If your plane is still in the air, don't forget to snap on the chest pack parachute which is stowed on the aft inboard side of the turret.

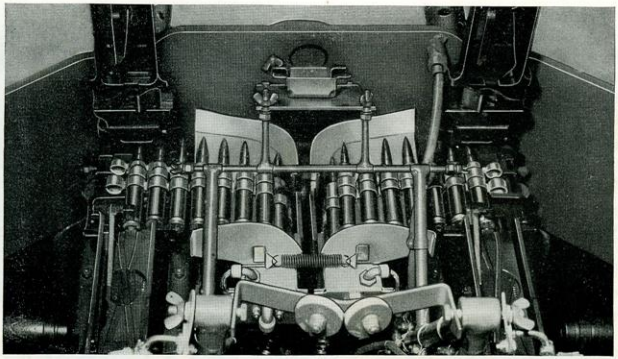


Preparing the Turret for Combat

The preceding pages have illustrated how you get in and operate the Erco Tear Drop Turret, and how to get out again. From this information, you could take over and operate the turret in combat. If you specialize in the Erco Tear Drop, however, that will only be part of your duties. The rest of your job—adjusting the sight and guns, harmonizing them, and loading the ammunition for a mission—is explained in the following pages.

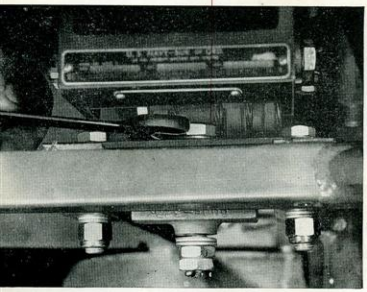
The Sight

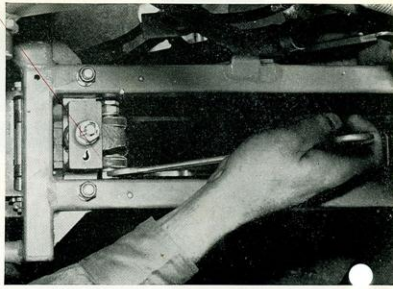
The Navy Mk 9 sight fits into the gunsight bracket directly behind the laminated bulletproof glass. To adjust the sight, as may be sometimes necessary in harmonizing it with the guns, make your adjustments on the sight head. For full instructions in making these adjustments see the section on the Mk 9 sight in the general introduction of this section.



Adjusting the Guns

The guns are mounted in the Erco Tear Drop Turret to feed from the inside—the right gun feeds from the left and the left gun feeds from the right. Each gun is mounted in a Bell Mount Adapter. The rear support of the adapter is provided with an assembly containing an elevation adjustment bolt and an azimuth adjustment bolt to move the gun up, down, or sideways. When boresighting, adjustment of the guns is accomplished by holding the proper adjustment bolt head with a wrench and after loosening the jam nut and nut, turning the bolt. On completing your boresighting don't forget to tighten both nuts on each adjustment bolt.





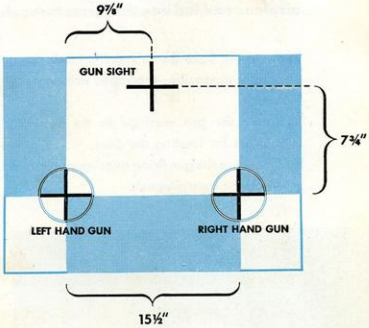
Harmonizing the Guns and Sight

There are a number of ways to harmonize the guns and sight of the Erco Tear Drop Turret. The exact procedure will be defined by the Squadron Gunnery Officer. A handy method is to line up the sight and boresight the guns on some small object, such as a tree or chimney, at least 1,000 yards from your plane. To do that remove the back plates and bolts from both guns—or use a boresight tool so that you can look through the gun barrels without removing the parts. Turn the turrets until the guns point at the object you have selected.

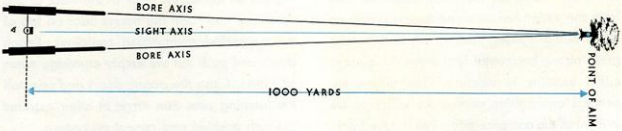
Then line up the sight, using the elevation and azimuth hand cranks to move the turret, until the dot of the sight is squarely on the object. Don't move the turret again.

Now boresight through each gun barrel to line up each gun. Adjust each gun by its rear mount adjustment bolts until the spot the sight is centered on is exactly in the center of each gun bore.

Sometimes, the amount of adjustment possible in the rear mounts of the guns may not be large enough to bring the guns to bear on the object. In that case boresight each gun independently on the small object selected. Then you must make an additional adjustment on the sight head, to line up the dot of the sight on the same object.



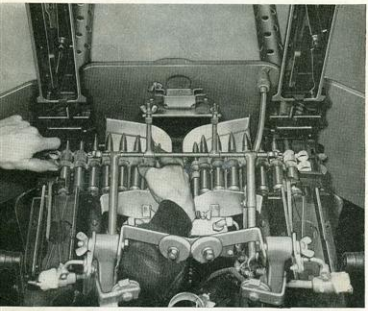
Another method of harmonization is to line up the sight and guns on a special pattern stand or template such as the one illustrated above. Set up the stand as level as possible at least 50 yards from the side of the plane. Center the guns in their mounts. Then boresight each gun on the pattern stand and center the sight on the sight cross, using the standard technique described in the Sights and Sighting Section of this manual. Both methods described here are called parallel harmonization.



Loading Ammunition

The ammunition magazines for the Erco Tear Drop Turret are located inside the airplane and fed into the turret through the aft trunnion. To load the ammunition:

1. Carefully flake the ammunition belt down in each magazine—projectiles pointing outboard.
2. Rotate the gun carriage to the beam in azimuth for loading the guns.
3. Make sure the gun firing switches are turned off on the control panel.
4. Push the ammunition belts through the tracks until the ends extend above the track bends between the foot armor plates.
5. Drop a wire down through each booster-feed channel and tie it to the ammunition belts. Pull the ammunition belts up over the boosters to ammunition feedway of guns.



Removing Empty Links and Cartridge Cases

To remove the empty cartridge cases and links from the expended ammunition containers on either side of the seat, roll the turret a few degrees above horizontal and move the guns to either extreme in azimuth. One of the expended ammunition containers will now be in front of the entrance door. Pull out the latching pin on the access door in the back of this container and raise the access door on top of the expended ammunition container. Reach down and push out the empty cartridge cases and links. Close the access doors and reinstall the latching pins. Run turret in other extreme azimuth position and repeat procedure.

Pre-Flight Routine

. . . Follow Step by Step

1. Install barrel and oil buffer groups in the guns, leaving out the bolts and back plates.
2. Check harmonization of guns and sight by boresighting on a pattern stand or some other object 1000 or more yards away.
3. While harmonizing the guns and moving the turret by the manual azimuth and elevation hand cranks, check and make sure the clutching arrangements are working satisfactorily.
4. Make sure the bolts are assembled properly to feed from the right for the left gun and from the left for the right gun. Then install the bolts and back plates on both guns.
5. Try to rock the guns in their mounts to make sure they are securely mounted. Check to determine if the jam nuts are up tight.
6. Operate the hand charging units on the outboard side of each gun.
7. Inspect the hydraulic system and lines carefully. This should be done with and without the pump operating. If there are any leaks —report them immediately.
8. Inspect electrical leads and flexible conduits (Breezes) to determine if they are frayed or damaged.
9. Check all Cannon plugs to see if they are properly fitted and screwed up tight.
10. Check carefully to determine if there is any foreign matter on the bottom of the turret so that they will not foul the drive bands which control the azimuth movement. Keep the safety belt up while operating the turret.
11. Check oxygen connections to be sure they are tight.
12. Make sure the plexiglass windows and bullet-proof glass are properly cleaned.
13. Check for ease of operation in elevation and azimuth. Stop turret with pump running (control handles in neutral) and check for creep.
14. Check for "line knock" (air and hydraulic system) while operating the turret in all extremes. If any is noticeable, report it to the maintenance man.
15. Operate the turret in extreme elevation, depression, and azimuth to determine if the limit stops are functioning properly.
16. Insert a test light in place of the electric triggers and with the triggers depressed, swing the turret across the portions of the ship into which the guns could fire. The test light will go out in this area. With a boresighting tool, check the distances from the surface that the interrupter cuts out.
17. Turn on sight switch and rotate the sight rheostat from dim to bright to adjust the brightness of the reticle, and make sure this rheostat is working properly.
18. Test both filaments of the sight bulb to determine if they are good. If either is burned out, replace the bulb. Check for spare sight bulbs in the stowage clips over the aft corner of access door inside turret.
19. Make sure the reflector plate of the sight is clean.
20. Turn on the power, charge the guns, and then depress your safety switches—squeeze either trigger—listen for the "click" of the firing pins in the guns. Both guns should fire from either trigger at the same time, pro-

viding that both gun selector switches are turned on. Test the other trigger by repeating the operation.

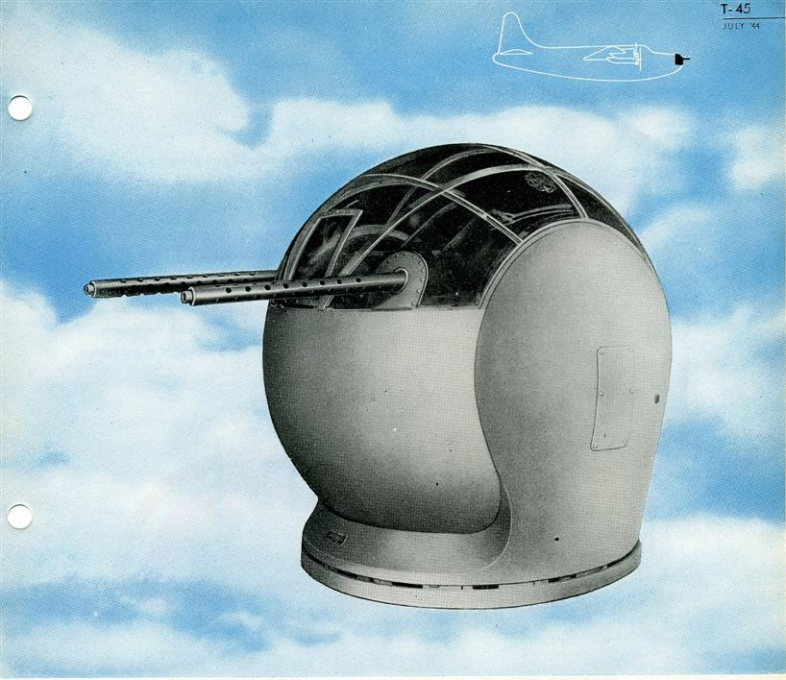
21. Put on the oxygen mask, connect it, and make sure you are getting the proper flow of oxygen. Check the regulator to determine if it is functioning correctly.
22. Plug in your headphones and microphone and test interphone system.
23. Plug in your heating suit and make sure it begins to heat.
24. Make sure the trouble lights operate. Replace any bulbs that fail to function.
25. Inspect all ammunition belts for condition and proper belting.
26. Check the booster motors by tipping them towards the guns. Make sure that they cut "on" and "off" sharply without lagging.
27. Load all four ammunition magazines in the airplane. Turn off power in turret. Feed the double link through the ammunition feeds into the turret and up over the booster motor's sprockets. Place the first round into the feedway of the gun. You will not charge the guns until in the air and ordered by the plane captain.

Before Landing

1. Run your turret into its stowed position—0° elevation and the guns in the extreme aft position in azimuth (80° from the beam).
2. Clear the guns by lifting the gun covers, removing the ammunition, and hand charging them twice.
3. Remove ammunition belts from feedways.
4. Open the entrance door.
5. Run the turret to 0° elevation and to a right angle from the center line of the ship, in azimuth. Turn off all switches.
6. Get out of the turret.
7. Lift up the azimuth by-pass valve lever and shove the turret to its stowed position. Depress the azimuth by-pass valve lever.
8. Close the entrance door.

After Landing

1. Remove all ammunition from chutes and magazines.
2. Open access door in the back of the expended ammunition containers on either side of the seat and clean out the cartridge cases and links. Relatch access door upon completing the job.
3. Field strip the guns.
4. Clean and inspect the gun receivers and detail strip the parts you have removed. Clean and check their condition.
5. Do not leave excess oil or cleaning fluid in the turret.
6. Report any malfunction of the guns or turret noted on the mission.



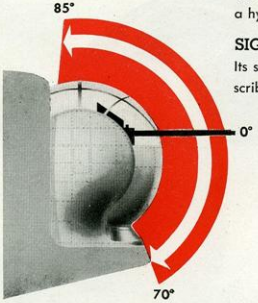
Erco Ball Turret

ERCO 250SH—2, 2A or 3

The Erco Ball Turret is the bow installation in the Navy PB4Y-1 and PB4Y-2 airplanes. It serves a double purpose in taking care of any bow attacks on the Liberator besides being used for strafing, in anti-submarine warfare. Inasmuch as this turret is of the ball type, the gunner moves with his guns and sight in elevation and azimuth as he moves his control handles. It is a relative of the Martin 250SH Bow Turret of the PBM-3 airplanes and has many points of similarity in design and action.

There are several models which for the most part are the same—the Erco 250SH-2 or 2A used in the bow position of the PB4Y-1 airplane and the Erco 250SH-3 used in PB4Y-2 airplane.

Facts and Figures



POWER

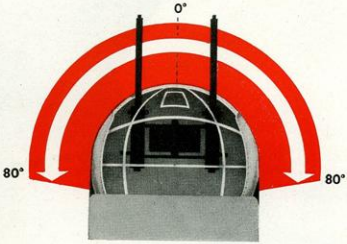
The Erco 250SH operates hydraulically on pressure built up by a hydraulic pump driven by a constant speed electric motor.

SIGHT

Its sight is the standard Navy Mk 9 reflector sight, fully described in the introduction of this section.

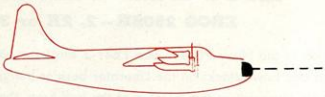
ELEVATION

From the horizontal position the turret ball, and consequently the guns, may be depressed a maximum of 70° and elevated a maximum of 85°.



AZIMUTH

This type of turret is capable of revolving 360° in azimuth, but for the installation in the bow of the PB4Y-1 or PB4Y-2 airplanes, its motion is restricted to 80° either side of the center line of the plane.



STOWING

The stowing position is 0° azimuth and 0° elevation, guns pointing straight forward.

ARMOR

The armor plate of the turret consists of three parts to protect the gunner from enemy fire and flak:

(1) 1½″ laminated bullet proof glass to protect his face.

(2) ½″ armor plate in front to protect the gunner's body, no matter where his guns are pointed.

(3) ¼″ armor plate bolted to the floor to protect his feet.

Getting In . . .

Now that you are becoming acquainted with the Erco Ball Turret, you should realize that, like all other bow turrets, it is no place to be during a take-off or landing. Your additional weight in the bow would put undue stress on the airplane, besides making the ship unbalanced; therefore, never enter the turret until the plane is in full flight.

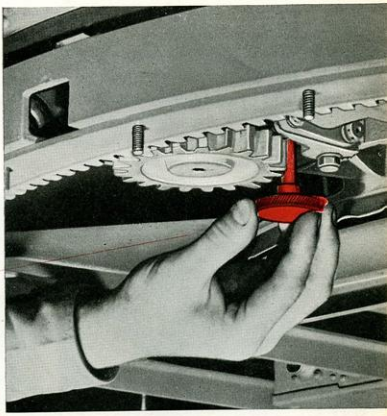
Getting into the Erco Ball Turret is a relatively easy job if you will pursue the following steps: First of all, make sure the **azimuth clutch** is engaged. The small round **red handle** on the bottom of the turret saddle on the azimuth gear box, must be in the **down** position. Then make sure that the **red handled elevation clutch** on the back of the saddle below the right hand corner of the entrance door has not been pulled out. Never try to get into the turret if the clutches are disengaged, as the turret ball will roll under your weight. This could be very dangerous to you besides damaging the turret.

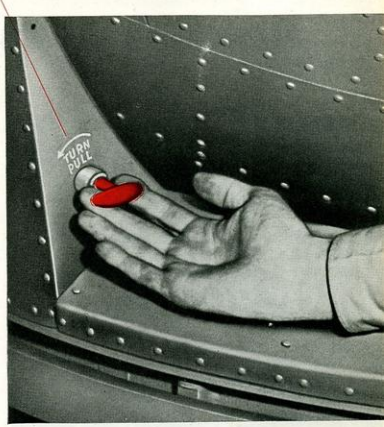
Before entering the turret, throw the **main power switch** to the **on** position. This switch is located in a junction box mounted on the left bulkhead in the Liberator's nose, almost directly under the turret.

Open the entrance door in the back of the turret by turning the handle clockwise.

Check the control panel, which is located front center in the turret directly above the control handles, to make sure that all the switches are off. This will prevent the turret from moving and trapping you while you are in the doorway.

With both hands grasp the bar handle installed above the entrance door. Raise both feet simultaneously and swing into the turret,

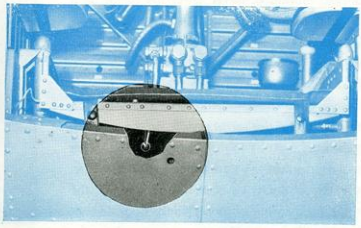




placing your feet on the foot armor plates below the front magazines.

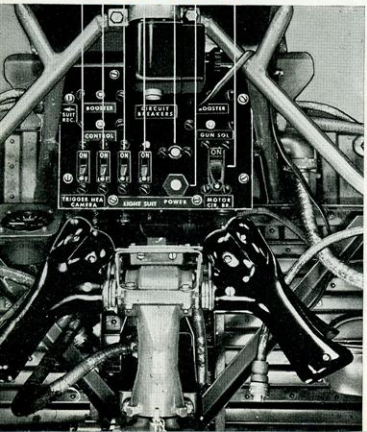
Slide forward in the seat so that your head will clear the top of the door opening and swing forward to get your head inside of the turret. Close the door by a sharp pull on the bottom portion and secure the door latch by pulling down on the inner handle.

Check the door latch to see if it is secured by leaning back against it. Look through the sight and determine if you are at the proper level to see through it. If not, reach down between your legs and grasp the **seat adjustment lever** so that you may raise or lower the seat. Fasten the safety belt as you will need it. You are now ready to operate the turret.



Operating the Turret

F E G D C B A



. . . Where to Find the Controls
. . . How to Use Them

The **control panel,** which you checked before entering, is above the **control handles** directly in front of you. All the switches which will put the turret to work are on the control panel. Be sure to turn them on in the proper order.

First, turn the **motor circuit breaker** (A) switch to the **on** position. Then, push and release the **power switch button** (B). A **red indicator light** (C) on the turret control panel should light up, showing you that the power is **on** in the turret.

To start the pump motor use the bottom edges of your hands to press down the two **safety**

switches. When the motor is running, the handles will automatically go to neutral position. For this reason it is best to press the safety switches down before grasping the hand grips of the control handles.

If this is done, the control handles will move to neutral position without moving the turret. If the control handles are held in any other position than neutral and the safety switches are closed, the motor will start, causing immediate and possibly violent motion of the turret. Either safety switch will put the motor in operation.

Depressing the safety switches also turns on the sight and provides power to the **booster motors** so that they will operate when guns are fired.

To adjust the brightness of the **sight** to lighting conditions use one hand to hold the control handles, keeping the safety switch depressed, and turn the sight rheostat with the other hand.

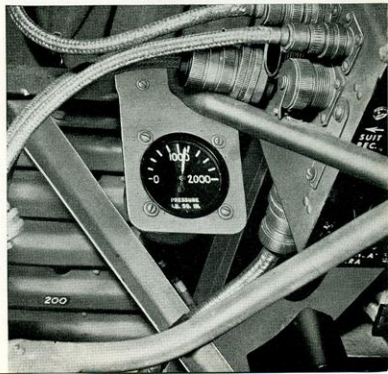
To operate the turret turn the handles in the direction you desire the turret to move. For azimuth (right or left) the control handles are operated exactly like those of a bicycle. For elevation, move the upper part of the handgrips backward, and for depression, move the top portion of the control handles forward. Don't jerk the controls—move them smoothly and deliberately.

At the left of the control panel is the **hydraulic pressure gauge.** As soon as the pump is operating, check to see if it reads the desired **1150** lbs. pressure. While operating the turret, check this gauge from time to time to see if the proper pressure is maintained.

Directly under your index fingers on both control handles are the **triggers.** Either trigger will fire both guns.

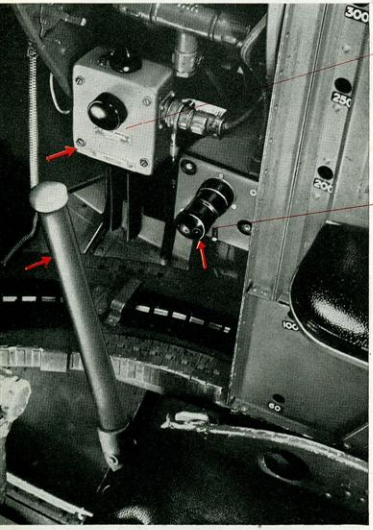
On each side of you at shoulder level are the levers for hand-charging the guns. Grasp the

charging handle of one gun with both hands, one above the other, and give a quick, hard pull back. Then release the handle smartly and let it slide forward by itself. Repeat the procedure for the other gun.



Using the Auxiliary Units

The **oxygen system** in the turret is a complete self-contained unit, consisting of two oxygen cylinders and a regulator, which are located in the locker in the entrance door behind the back-rest. A hose connects the regulator to the oxygen mask. In the older type turrets, three cannisters are provided in individual brackets—one in the entrance door and one on each side magazine. Newer turrets are provided with oxygen equipment which makes the cannisters unnecessary.



The **heated suit** cord is plugged into an outlet on the left side of the control panel and is turned on by a **suit switch** (D) on the same panel. A **camera** is mounted in front and a little below the bullet-proof glass face plate. To put the camera into operation it is necessary to have the **camera heat** (E) and **camera trigger** (F) switches in the **on** position on the control panel and either of the safety switches and either of the trigger switches depressed. The **interphone jack box** is located on a bracket next to your right knee. This is where you plug in the jacks for your headphones and throat microphone. Installed on the front of the box is a **push-to-talk** button which operates the interphone system when you wish to speak.

A **light switch** (G) on the control panel operates an extension type **trouble light** mounted on the right side of the ball structure next to your right knee.

In the event that the electric drive motor fails, the turret can still be operated by working the **emergency hand pump.** Work the hand pump with the right hand and hold the left hand grip of the control handles turned in the direction you desire the turret to move. This hand pump will facilitate harmonizing the guns and sight when a small amount of carefully controlled movement is desired.

In the latest turrets an auxiliary foot firing mechanism is provided if the power to the guns fail. To put it into operation release the **red safety catch** over your right foot; then depress either **red bar** found above your feet and the guns will fire.

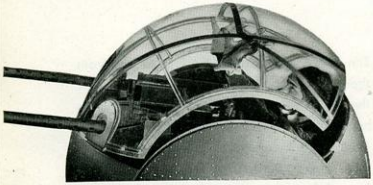
Getting Out

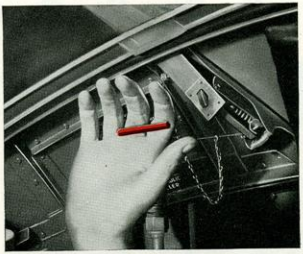
When you get out of the turret—before landing, if you are on a flight—be as careful as you were when getting in. Remember that the doors can trap a careless gunner on the way out as well as on the way in.

First, move the guns to stowing position—guns at zero elevation and zero azimuth; then, turn off all switches in the turret.

Disconnect any auxiliary units you have been using.

Reach around and open the door. Ease your body out of the turret by grasping the bar handles installed in the airplane above the entrance door.





Emergency Exit

In the event that it is necessary for you to get out of the turret in a hurry, an emergency exit is made possible by removing the plastic canopy. This is done by releasing the latch mechanisms in the upper structure of the turret. Pull out the four red painted handles and push the canopy up and forward with both hands.

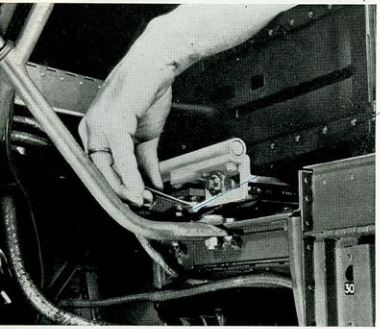
The Sight

The Navy Mk 9 sight fits into the gunsight bracket directly behind the laminated bulletproof glass. To adjust the sight as may be sometimes necessary in harmonizing it with the guns, make the adjustments on the sight head. For full instructions in making these adjustments see the section on the Mk 9 sight in the general introduction of this section.

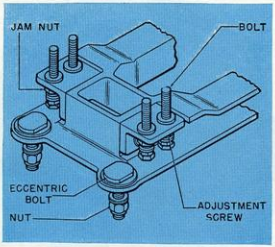
Preparing the Turret for Combat

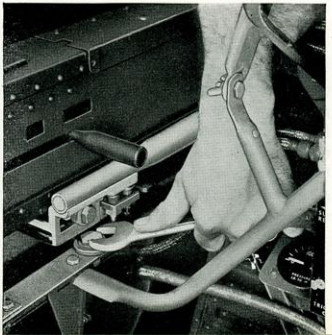
The preceding pages explained how to get in, operate, and get out of the Erco Ball Turret. From this information you could take over and operate the turret in combat. If you specialize on the Erco, however, that will be only part of your job. Other duties such as adjusting the sight and guns, and loading the ammunition for a mission, are explained in the following pages.

Adjusting the Guns



The guns are mounted in the Erco to feed from the inside; the right gun feeds from the left and the left gun feeds from the right. Each gun is bolted into a Bell Mount Adapter and adjusted in elevation by means of adjustment screws on both sides of the rear gun mount support. All four of these screws must be set with the jam nuts to secure the gun in position. The guns are adjusted horizontally in either direction by turning the eccentric bolts in the rear of the gun mount supports. The two rear bolts must be set tight with their elastic stop nuts in order to secure the guns in position. The front bolts should be loose enough to allow all boresighting to be done from the rear.



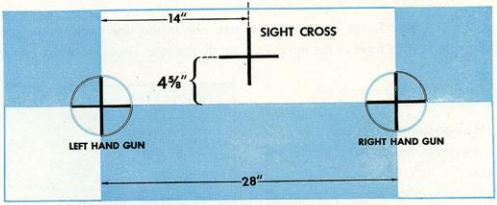


Harmonizing the Guns and Sight

There are a number of ways to harmonize the guns and sight of the Erco Ball Turret. The exact procedure will be defined by the Squadron Gunnery Officer. A handy method is to line up the sight and boresight the guns on some small object, such as a tree or chimney, at least 1,000 yards from the plane. To do that remove the back plates and bolts from both guns—or use a boresight tool so that you can look through the gun barrels without removing the parts. Turn the turret until the guns point at the object you have selected.

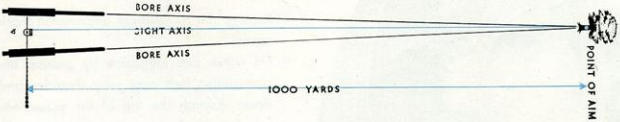
on is exactly in the center of each gun bore. Sometimes the amount of adjustment in the rear mounts of the guns may not be large enough to bring the guns to bear on the object. In that case, boresight each gun on the object selected. Then make the necessary adjustment on the sight head to line up the sight dot on the same object.

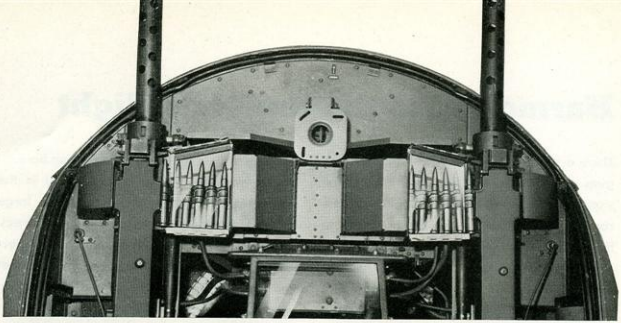
Another method of harmonization is to line up the sight and guns on a special pattern stand or template, such as the one illustrated here. Set up the stand as level as possible at least



Then line up the sight, using the emergency hand pump to move the turret until the dot of the sight is squarely on the object. Don't move the turret again. Now boresight through each gun barrel to line up each gun. Adjust each gun by its rear mount adjustment screws and bolts until the spot the sight is centered

50 yards in front of the plane. Center the guns in their mounts. Then boresight each gun on the pattern stand and center the sight on the sight cross using the standard technique described in the Sights and Sighting Section of this manual. Both methods described here are parallel harmonization.





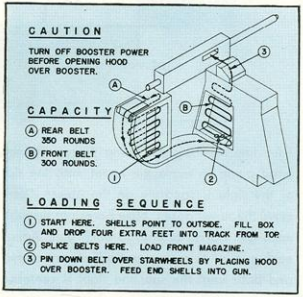
Loading Ammunition

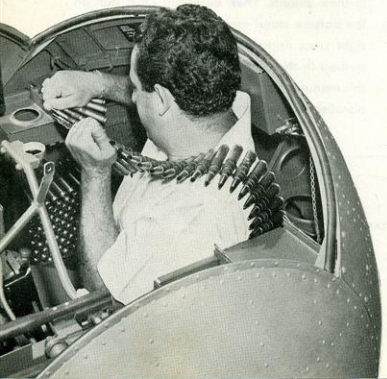
Each gun in the Erco Ball Turret has two magazines, one in the side beneath the gun which it feeds, and the other at the front of the turret ball. In all, the total capacity of the four magazines is 1200 rounds.

First of all, make sure the power is off.

To load the magazines:

1. Get into the turret, but do not close the entrance door.
2. Pull out the pins on the access doors of all four magazines, and slide the doors off.

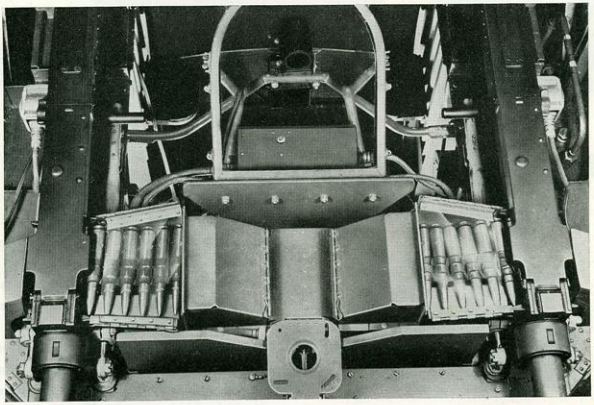




3. Remove the transparent ammunition track covers.
4. Fill either side magazine by passing the ammunition belt over your shoulder and down through the top of the magazine,

single link first, projectiles pointing outboard. Flake the belt down until the magazine is full.

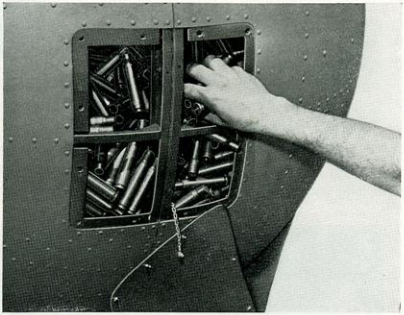
5. Pass the free end of the ammunition belt down through the ammunition track at the rear of the side magazine and up around the rollers to the bottom of the corresponding front magazine. About six feet of belted ammunition will be required to reach the front magazine.
6. Fill the corresponding front magazine by passing the ammunition belt over your shoulder and down through the top of the magazine, single link first, projectiles point ing forward.
7. Splice the ends of the ammunition belts of the front and side magazines.
8. Flake down the ammunition belt in the front magazine.
9. Run the end of the ammunition belt up over the booster sprockets. Lift the gun cover and insert the double link end of the belt into the gun.
10. Repeat the procedure for the other side.
11. Replace magazine access doors and transparent ammunition track covers.



Removal of Empty Cartridge Cases and Links

The empty cartridge cases are removed from the empty cartridge case chamber in the front of the turret through an access door located on the outside lower front portion of the turret bail. After cleaning out this chamber, be sure to replace the access door securely.

The empty links drop into canvas bags held under the empty link chute on each gun. These bags are equipped with zipper openers to provide easy removal of the links.



Pre-Flight Routine ... Follow Step by Step

1. Install the barrel and oil buffer groups in the guns, leaving out the bolts and back plates.
2. Check the harmonization of the guns and sight by boresighting on a template or some small object 1000 or more yards away.
3. While you are harmonizing the guns and moving the turret by the emergency hand pump, make sure the hand pump is operating properly.

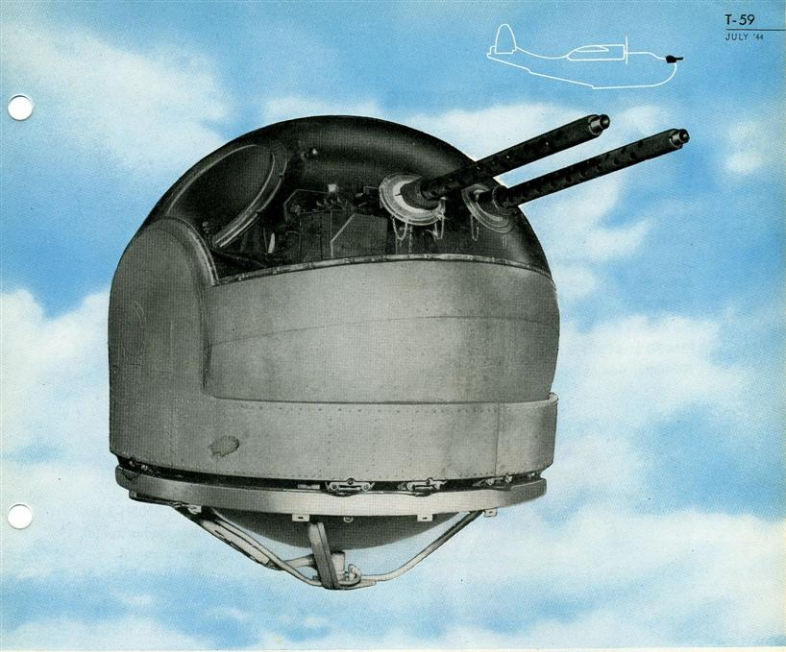
4. Make certain that the bolts are assembled properly to feed from the right for the left gun, and from the left for the right gun. Install the bolts and slide the back plates on both guns.
5. Try to rock the guns in their mounts to make sure they are securely mounted. Check to determine if the jam nuts are up tight.
6. Operate the hand charging handles on the inboard side of each gun.
7. Inspect the hydraulic system and lines carefully. This should be done with and without the pump operating. If there are any leaks, report them immediately.
8. Inspect the electrical leads and flexible conduits (Breezes) to determine if any are frayed or damaged.
9. Check all Cannon plugs to see if they are properly seated and screwed up tight.
10. Put on the oxygen mask, connect it, and make sure you are getting a flow of oxygen. Check the gauge to make sure there is the proper pressure as determined by your crew chief.
11. Check oxygen connections to be sure they are tight.
12. Make sure the plexiglas dome and bullet-proof glass are properly secured and cleaned.
13. Operate the turret to determine if the pressure gauge reads the required 1150 lbs. pressure.
14. Check for ease of operation in elevation and azimuth. Stop turret with pump running, (control handles in neutral). Check for creep.
15. Check for "line knock" (air in hydraulic system) while operating turret in all extremes. If any is noticeable, report it to the maintenance man.
16. Operate the turret in all extremes to determine if the limit stops are properly functioning.
17. Turn on the sight switch and rotate the sight rheostat from dim to bright to adjust the brightness of the reticle, and make sure the rheostat is working properly.
18. Test both filaments to make sure the sight bulb is good. If either is burned out, replace the sight bulb.
19. Make sure the reflector plate of the hood assembly on the sight is clean.
20. Turn on the power and charge the guns. Then, depress the safety switch and squeeze either trigger and listen for the "click" as the firing pins in the guns release. Both guns should fire from either trigger at the same time. Test both triggers by repeating the operation.
21. Plug in your headphones and microphone to test if your crew mates can hear you and if you can hear them.
22. Plug in your heating suit and make sure that it begins to heat.
23. Make certain that the trouble light operates. Pull the light out of its cord, making sure the retractable reel is working properly.
24. Inspect all ammunition belts to determine if the rounds are in good condition and properly belted. Check booster motors by tipping them toward the guns. Make sure that they cut on and off sharply without lag.
25. Load all four ammunition magazines. Feed the double link ends up over the booster motors' sprockets and press the first round into the feedway of each gun. You will not charge the guns until you are in the air and so ordered by your plane captain.
26. Make a last visual check of the whole turret.

Before Landing

1. Run the turret into its stowing position, zero elevation and zero azimuth, guns pointing straight forward.
2. Clear the guns by raising the gun covers, removing the ammunition, and hand charging the guns twice.
3. Remove all ammunition from feedway. Check all switches and make sure they are off.
4. Get out of the turret and close and latch the door.

After Landing

1. Remove all ammunition from chutes and magazines. Open access door in front lower portion of the ball and clean out expended cartridge cases. Replace this access door securely on completing the job. Remove used links from canvas bag held under the empty link chute on each gun. A zipper is provided to open the bag.
2. Field strip the guns by removing their working parts.
3. Clean and inspect the gun receivers, then detail strip the parts you have removed from the guns, cleaning them and making a thorough check of their condition. Do not leave excess oil or cleaning fluid in the turret.
4. Report any malfunction of turret or guns noted on the mission.



MARTIN BALL TURRET

MARTIN 250SH – 1A & 2

The Martin 250SH Ball Turret is found on all Navy flying boats using bow turrets. It is a complete self-contained unit with everything at your finger tips to make it hot for an enemy fighter flying a bow attack on your plane. In addition, you will find those two caliber .50 machine guns mighty efficient in cleaning a gun crew off the deck of a submarine. In this turret the gunner moves with his guns and sight in elevation and azimuth. Its appearance and operation is very similar to the Erco 250SH Turret.

The Martin 250SH Turret has been produced in two models, which are, for the most part, the same; the Martin 250SH-1A used in the bow of the PBM-3D, and the Martin 250SH-2 used in the same position on the PB2Y-3 airplane.

Facts and Figures

POWER

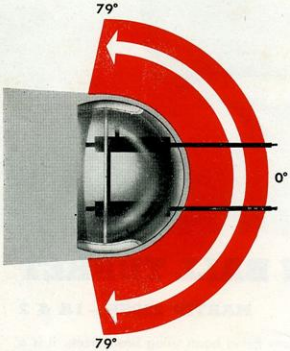
The Martin 250SH operates hydraulically on pressure built up by a hydraulic pump driven by a constant speed electric motor.

SIGHT

Its sight is a standard Mk 9 reflector sight, fully described in the introduction to this section.

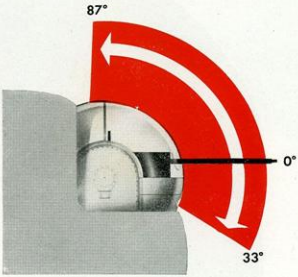
AZIMUTH

The Martin Ball Turret in its installation in the PBM-3D and PB2Y-3 has an azimuth motion of 79° either side of the center line of the plane.



STOWING

The stowing position is 0° elevation and 0° azimuth, guns pointing straight forward.

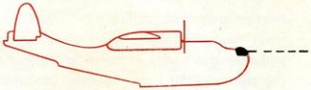


ELEVATION

Both the Martin 250SH-1A and 250SH-2 turrets can be elevated 87° above the horizontal, and depressed 33° below the horizontal.

ARMOR

The armor plate in the turret protects the gunner from enemy fire in any direction in which he trains his guns. It consists of three groups: ⅝" steel armor plate in front of his face, ⅝" steel armor plate to protect the booster motors and ammunition chutes and ½" armor plate to protect his body and ammunition boxes.

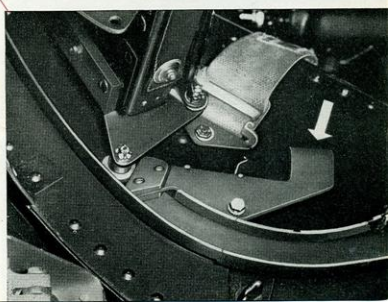


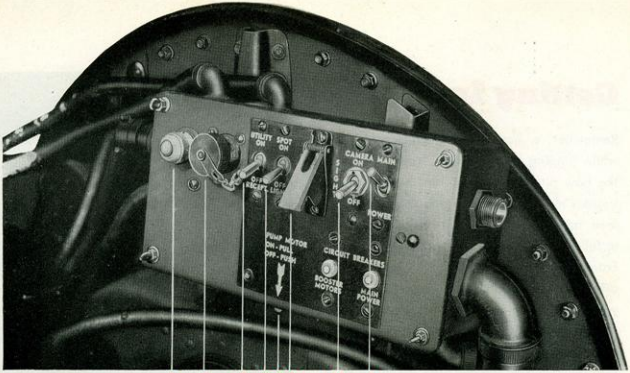
Getting In

Remember, a bow turret is no place to be while landing or taking off. Your weight in the bow puts undue stress on the airplane—besides making the plane unbalanced; therefore, never enter the turret until the plane is in full flight.

Entering the Martin Ball Turret presents little difficulty if you take the following steps. Before you get in, have your flight engineer turn on the **bow turret switch** on the flight engineer's panel. Outside the turret in a junction box, conveniently located near the turret on a bulkhead, is a **red indicator light** and a **turret switch,** which turns the power to the turret **on** and **off.** In the turret is a similar switch marked **main power** with a **red indicator light** off to the side. Wait until you are in the turret to turn on the current, as the switch on the outside junction box is to be used for emergency purposes only.

Facing forward, enter the turret through the opening in the bottom and reach up, grasping the top of the face armor plate to assist in pulling yourself in. Once inside, reach down on your left side and release the **seat lock,** allowing the seat to follow the track to its seated position. Seat yourself and look through the sight to determine if you are at the proper height. If not, reach down under the seat with your right hand and grasp the **seat-adjustment handle.** With your thumb release the catch on the handle freeing the seat, and by moving the seat-adjustment handle up or down the seat will raise or lower. When you are at the proper height, allow the catch to spring back and re-engage; this locks the seat at the height you have selected. Adjust and fasten the safety belt. You will need it in this turret.





B E F GCD H A

Operating the Turret

. . . Where to Find the Controls
. . . How to Use Them

First of all, check the **low pressure gauge,** which is located to the side of your right ankle. This gauge should read **25** to **30** lbs. It is very important that this pressure be maintained as it insures smooth operation of the turret.

Unlock the **elevation landing lock,** which is on the forward left hand side of the ball, by pulling out and rotating the handle **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.

On your upper right-hand side, you will find the **control panel.** Click on the **main power switch** (A), and the **red indicator light** (B) on the panel will light up as well as the red indicator light on the outside junction box, showing that the power is on in the turret.

Located on the bottom of the control box is another switch marked **pump motor** (C).

Flick this to the **on** position.

Lift the little red plastic cover on the control panel marked **gun and sight switch** (D) and raise the switch under it to the **on** position.

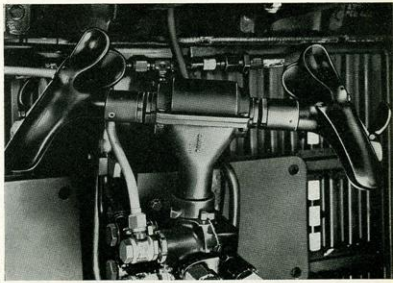
The **control handles** to operate the turret are located in front and above your knees.

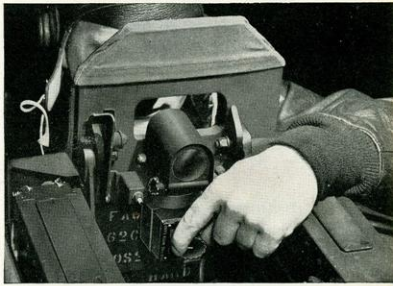
To start the pump motor, use the bottom edges of your hands to press down the two **safety switches.** When the motor is running the handles will automatically go to neutral position. For this reason it is best to press the safety switches down before grasping the hand grips of the control handles. If this is done the control handles will move to the neutral position without moving the turret. If the control handles are in any other position than neutral and the safety switches are closed, the turret will start, causing immediate and violent action. Either safety switch will operate the turret.

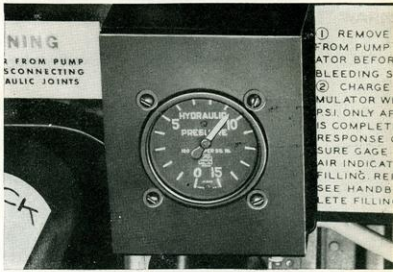
Depressing the safety switches also turns on the **sight** and provides power to the **booster motors** so that they will operate when the guns are fired.

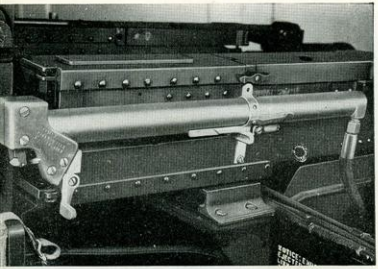
To adjust the brightness of the sight use one hand to hold the control handles, keeping the safety switch depressed, and with the other hand turn the rheostat on the sight.

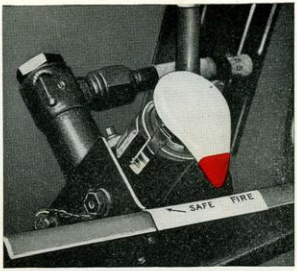
To operate the turret turn the control handles in the direction you desire the turret to move. For azimuth (right or left)—the control handles are operated exactly like those of a bicycle. For elevating the turret move the upper part of the control grips backward; and for depressing the turret move the top portion of the control handles forward. Don't jerk the controls—move them smoothly and deliberately. Right under your index finger on both control handles are the **triggers.** Either trigger can fire both guns. In front of you on the left is the **high pressure gauge.** As soon as the pump is operating, the











high pressure gauge should register **960** to **1000 lbs.** pressure. While operating the turret, from time to time check this gauge to see that proper pressure is maintained.

Next to your left knee is the **hydraulic gun charger control knob,** which operates the **gun chargers** located on the outboard side of each gun. To charge the guns turn the control knob to the **Fire** position. Depress the control knob sharply. Both guns will be charged at once and ready to fire. If the control knob is turned to the **Safe** position before depressing, the gun bolts will remain in the retracted position which provides access for removing a jam. Remember, the pump motor must be operating before you can charge the guns.

Using Auxiliary Equipment

The **oxygen system** of the turret is completely self-contained. It consists of an oxygen cylinder and a regulator valve mounted on the left seat support and a rebreather mounted to the left side of the ammunition boxes in front of you. A spare cannister is mounted on the left side of the ball structure.

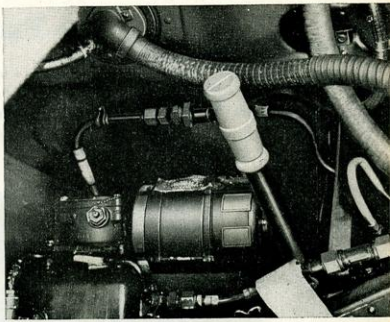
Plug your **heating suit** into the **utility plug outlet** (E) on your control panel and turn on the **utility switch** (F), which is also on the control panel. The **interphone jack box** is located on the top left side of the ball structure. This is where you plug in your interphone jacks for your head set and throat microphone. On the front side of the box is the **push-to-talk** button which enables you to talk with your crew mates.

The **trouble spotlight** is mounted on a rib which is part of the plexiglas dome. A ball-swivel joint enables you to direct the light where you desire. The **spotlight switch** (G) is found on the control panel.

Provisions have been made for mounting a **gun camera** below and parallel to the guns just above the ammunition boxes. To put it in

operation, it is necessary to have the **camera switch** (H) and the main power switch in **on** position on the control panel. In addition you must depress either safety switch and either trigger switch.

A hydraulic **emergency hand pump** is provided to operate the turret in case the pump or the electric power fails. For manual operation hold the lefthand grip of the control handles turned in the desired direction and work the hand pump with your right hand. This hand pump will be of great assistance to you in seating the elevation stowing pin and boresighting the guns when a small amount of carefully controlled movement is desired.



Getting Out

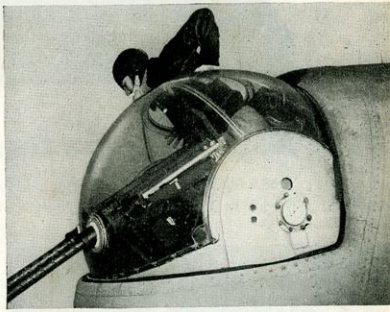
In getting out of the turret before landing, it is of the utmost importance that you pursue the following steps carefully:

Move the turret to stowing position—guns at 0° elevation and 0° azimuth and turn off all switches. With the hand pump rock the turret slightly until you can slip the elevation landing lock pin into position. Then reach down on the lower left-hand side of the ball and turn the azimuth position lock to **on.**

IT IS EXTREMELY NECESSARY THAT THESE LANDING LOCKS BE SECURED. IF THEY ARE NOT, THE TURRET IS LIKELY TO SWING AROUND FREELY IN LANDING, CAUSING DAMAGE TO THE SHIP AND TO ITSELF.

Disconnect all auxiliary units you have been using. Brace yourself against the back of the turret seat rest and lift up on the seat, pushing it back and up, allowing it to follow the seat track until it is in the locked position out of the way.

To get out, all you have to do is grasp the top of the face armor plate and swing down and out of the opening in the bottom of the turret.

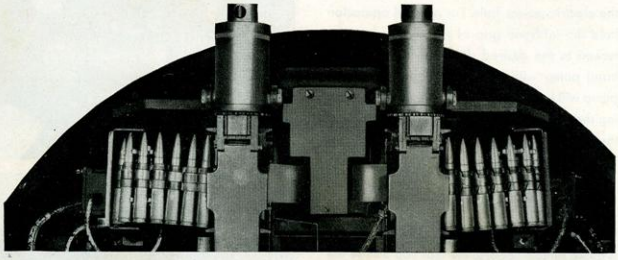


Emergency Exit

It might be possible that you will want to get out of the turret in a hurry. For such an emergency, an escape hatch is provided in the plexiglas dome directly above you. Two plastic handles are located on either side of the hatch, and by turning them a quarter turn the hatch will fall inboard. If you stand on the seat you will find it an easy job to crawl out of the top of the turret.

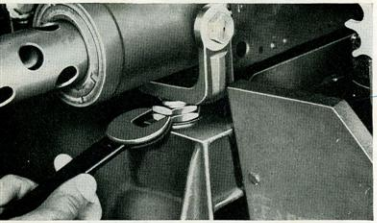
Preparing the Turret for Combat

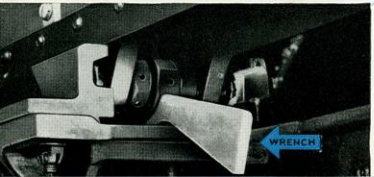
From the preceding information you now know how to get into the turret, operate it, use its auxiliary equipment, and how to get out. But this is not the entire job which will qualify you as a specialist in the Martin 250SH Turrets. You still have to learn how to adjust the guns and sight, harmonize them, and load ammunition. All this will be found in the following pages.



Adjusting the Guns

In the Martin Ball Turret, two caliber .50 machine guns are mounted to feed from the outboard side. The right hand gun feeds from the right and the left hand gun feeds from the left.





Provisions are made for adjustment of the guns both up and down and sideways. Vertical adjustment is obtained by nuts provided on the front yoke where it attaches to the front mount support. Jam nuts are provided on both top and bottom so that the yoke can be firmly held in position. Azimuth adjustment is obtained by a coupling located directly under the gun at the rear mount. Turning the hexagon-shaped portion of this assembly results in the gun being shifted sideways. Locking is obtained by forcing the jam nuts against the gun frame.

The Sight

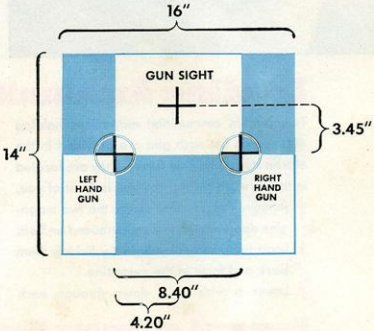
The Navy Mk 9 sight is mounted between the rear gun mount castings in front of the face armor plate. To adjust the sight, as may be sometimes necessary in harmonizing it with the guns, make your adjustments on the sight head. For instructions in making these adjustments see the section on the Mk 9 sight in the general introduction to this section.

Harmonizing the Guns and Sight

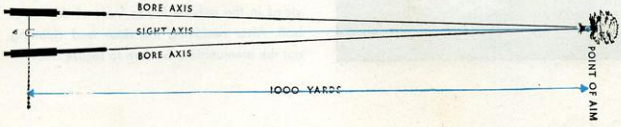
There are a number of ways to harmonize the guns and sight of the Martin Ball Turret. The exact procedure will be defined by the Squadron Gunnery Officer. A handy method is to line up the sight and boresight the guns on some small object, such as a tree or chimney, at least 1,000 yards from your plane. To do that remove the back plates and bolts from both guns —or use a boresight tool so that you can look through the gun barrels without removing the parts. Turn the turret until the guns point at the object you have selected. Then line up the sight, using the emergency pump to move the turret until the dot of the sight is squarely on the object. Don't move the turret again.

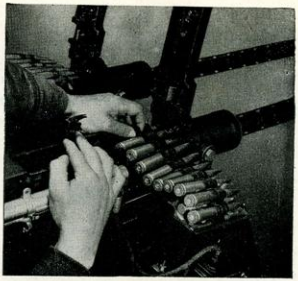
Now boresight through each gun barrel to line up each gun. Adjust each gun by its front and rear mount adjustments until the spot the sight is centered on is exactly in the center of each gun bore.

Sometimes the amount of adjustment in the front and rear mounts of the guns may not be sufficient to bring the guns to bear on the object. In that case boresight each gun on the object selected. Then you must make an adjustment on the sight head to line up the dot on the same object.



Another method of harmonization is to line up the sight and guns on a special pattern stand or template, such as the one illustrated above. Set up the stand as level as possible at least 50 yards in front of the plane. Center the guns in their mounts. Then boresight each gun on the pattern stand and center the sight on the sight cross—using the standard technique described in the Sights and Sighting Section of this manual. Both methods described here are parallel harmonization.





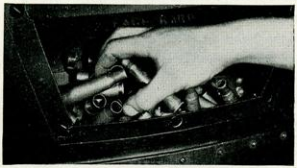
Loading Ammunition

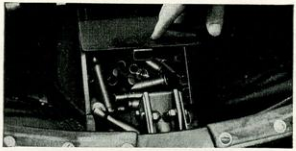
Two built-in ammunition magazines holding 400 rounds for each gun are provided in the Martin Hydraulic Bow Turret. They are located in the forward part of the ball in front of you.

1. Remove the pins that secure the two magazine doors and slide them outboard and aft.
2. Load the ammunition belts by flaking them back and forth in the magazine.
3. Lower a wire hook down through each booster feed into the magazine and attach the hook to the end of the ammunition belt.
4. When the magazines are full, reinstall the doors, pull the loaded belts up through the booster feeds until one or two rounds of ammunition are engaged in the booster sprockets. Lift the gun covers and pull up enough ammunition to be loaded into the guns. Close the gun covers.

Removal of Empty Cartridge Cases and Links

The empty cartridge cases and links are collected in a chamber located in the front part of the turret between the ammunition box and the ball structure. To remove the empty links and cartridge cases release the catch holding the door at the bottom of the ammunition box,





allowing the door to fly up. The empty cartridge cases and links will then drop out in the turret. In older model turrets an access door is provided in the outside lower front of the turret ball. After removing the door and cleaning out the ammunition, be sure to secure door.

Pre-Flight Routine

. . . Follow Step by Step

1. Check and reinstall all the mechanisms in both guns so they feed left for left gun and right for right gun.
2. Check harmonization by boresighting on a pattern stand or some other object 1000 or more yards away.
3. Try to rock the guns in mounts to make sure they are securely mounted. Check to see if adjustment and jam nuts are safetied.
4. Inspect hydraulic system and lines carefully. This should be done with and without pump operating. If there are any leaks report them immediately. Check filler valve to see that it is in "run" position and safety wired.
5. With the pump in operation operate your gun charger valve knob in both "safe" and "fire" position.
6. Turn on main power and pump motor switches. Depress safety switches and charge guns. Squeeze either trigger and listen for "click" of firing pins in guns. Test the other trigger by repeating operation.
7. Inspect electrical leads and conduits (Breezes) to determine if they are frayed or damaged.
8. Check all Cannon plugs to see that they are properly seated and screwed up tight.
9. Check oxygen connections to make sure that they are tight.
10. Make sure plexiglas dome and escape hatch are properly secured and clean.
11. Check low pressure gauge to determine that you have the 25 to 30 lbs. pressure required.
12. Operate the turret to determine if pressure gauge reads the 960 to 1000 lbs. pressure required.
13. Check for ease of operation in elevation and azimuth.
14. Stop turret with pump running, (control handles in neutral) and check for creep.
15. Check for "line knock" (air in hydraulic system) while operating turret in all extremes. If any is noticeable, report it to maintenance man.
16. Operate the turret to extreme elevation, depression, and azimuth to determine if the limit stops are functioning properly.
17. Turn on sight and gun switch; depress safety switch, and rotate sight rheostat from dim to bright to adjust the reticle to existing light conditions. Make sure the rheostat is working properly. Try both filaments of the sight bulb. If either are burned out, replace the bulb. Make sure the reflector plate of the sight is clean.
18. Plug in your headphones and microphones to test if your crew mates can hear you and you can hear them.
19. Plug in your heating suit and make sure it begins to heat.
20. Make sure trouble spotlight is operating.
21. Inspect all ammunition belts. See that they are in good condition and properly belted.
22. Check booster motors by tipping them toward the guns. Make sure they cut on and off sharply without lagging.
23. Load ammunition magazines. Feed the double link up over the booster motor sprockets and press the first rounds into the feedway of each gun. You will not charge the guns until you are in the air and so ordered by your plane captain.

Before Landing

1. Run turret to its stowing position—zero elevation and zero azimuth, guns pointing straight forward.
2. Engage elevation and azimuth landing locks.
3. Clean the guns by lifting gun covers, removing the ammunition, and charging them twice.
4. Remove ammunition from feedways. Check all switches and make sure they are off.
5. Unfasten safety belt and get out of turret.

After Landing

1. Remove all ammunition from chutes and magazines. Open the access door under ammunition magazines, or the exterior access door in the front lower portion of the ball, and clean out empty links and cartridge cases. Replace access door securely on completing the job.
2. Field strip the guns by removing their working parts.
3. Clean and inspect the gun receivers; then detail strip the parts you have removed from the guns, cleaning them and making a thorough check of their condition. Do not leave excess oil or cleaning fluid in the turret.
4. Report any malfunction of the turret or guns noted on the mission.

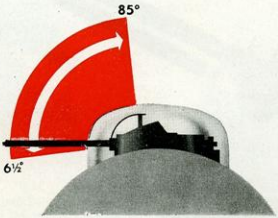
The Martin Electric Upper Deck

MARTIN 250CE-7 through 21

The Martin Electric is one of the most widely used of all turrets. It is designed for quick action and easy operation. It has no gadgets. Everything is made for action and placed where it can be reached quickly when the chips are down.

There are several models. Some of them are improvements over old models, like a new automobile which is better than last year's. Some are simply designed for different kinds of bombers; for example, the model which goes on the PV-1 is not quite the same as the one in the PB4Y-1. But if you can operate one Martin, you can operate them all.

Facts and Figures



POWER

The Martin turret operates on power supplied from the bomber's central electrical system.

SIGHT

The turret is equipped with the standard Navy MK 9 reflector sight, fully described in the Sights and Sighting section of this manual.

ELEVATION

In elevation, the turret guns can be lowered and raised from a little below horizontal (–6½ degrees) to almost straight up (85 degrees).

SPEED

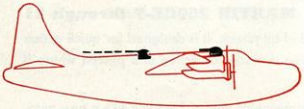
The turret has two speeds—normal tracking speed and high speed.

ARMOR

Armor plate is ½ inch thick. It protects the gunner in front, no matter where he aims his guns.

AZIMUTH

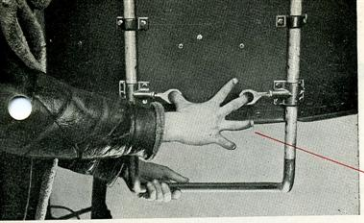
The turret can move 360 degrees—a full circle —in azimuth.



STOWING POSITION

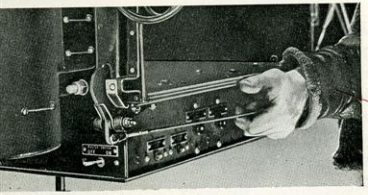
The stowing position for turret and guns is 0 degrees elevation and 180 degrees azimuth—guns pointing straight back toward the tail.

Getting In

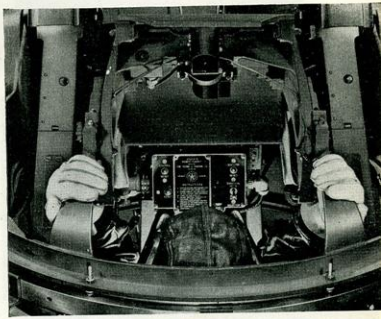


To start getting acquainted with the Martin Upper, step in. The Martin is easy to get into, simple to operate, and easy to get out of. Only one special precaution is necessary.

First turn on the main power switch—a toggle switch on the fuselage near the turret. Then adjust the footrest to fit your own height. Try it a few times to get the right position.



If you need more room to slip up into the turret, drop the bottom of the seat by pulling on the small cable stretched across the front.



Stoop and squirm up into the middle of the turret, face the front, grasp the two main supports curving about your head, and hoist your body up.

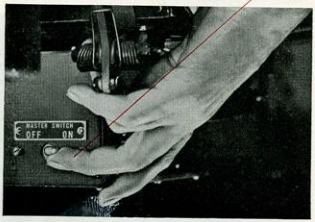
Don't pull yourself up by the sight cradle or the two nearby link rods. Your weight on the cradle may throw off the whole sight adjustment, or bend the link rods and throw the sight out of line with the guns.

Finally, stand on the footrest and brace your body against the back of the seat. If you've dropped the seat, use your heel to draw it up until the latches on each side of the seat click. Sit down. Use spare seat cushions to adjust your height until your eye is level with the sight. Snap on the safety belt—and you are ready to go.

Operating the Turret

. . . where to find the controls
. . . how to use them

Close at hand, as you sit in the Martin Upper, are all the clutches, switches, and controls. They are easy to get at and easy to use—a few clicks and the turret is ready to operate. But be sure to engage the clutches and turn on the switches in the order shown here.



1

Make sure the **azimuth clutch** is engaged: the small lever, under the control handles and to the right, must be pushed **Down.** Then make sure the **elevation clutch,** a lever above the control panel and to the left, is pushed in to the engaged position to the **Left.**

2

Reach down on the right side of your seat and turn on the **master switch.** This is like the ignition switch on a car.

Never try to operate without engaging these power clutches. It is like trying to drive your car with the clutch down. You don't get anywhere, and you may wreck the turret.

3

Raise the red plastic cover on the right side of the control panel (opposite page) and flip on the **master gun switch** (A).

4

Turn the **gun selector switch** (B) to **Both Guns.** With the switch in this position, both guns will fire when either trigger is pulled. (In the **Individual Guns** position, each gun is fired only by its own trigger. Use this only when one gun is out of action.)

5

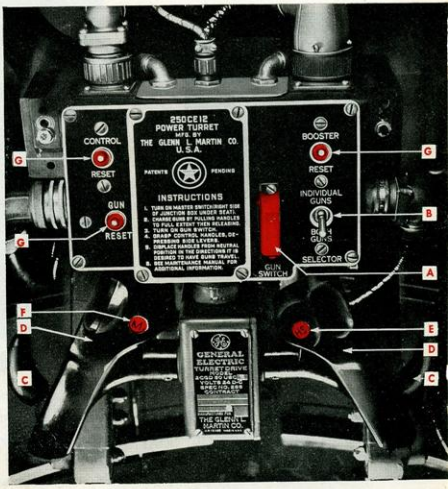
Turn on the **sight switch** on your sight located in a clamp on the face armor plate. To adjust the brightness of the sight reticle to suit lighting conditions, twist the rheostat button from dim to bright.

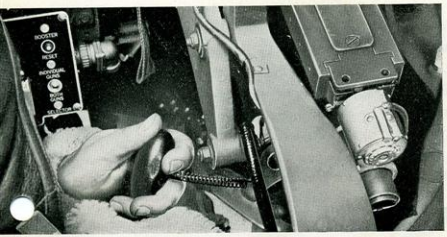
6

Finally, grasp the control handles so that the bottom edges of your hands depress the two **safety switches** (C). With these switches down, the turret is ready to go.

To move the turret, turn the handles just as you would steer a bicycle—to the right to go right, left to go left. Press down on the handles to raise the guns. Pull up on them to lower the guns. The slightest movement of your wrists regulates the turning, raising, or lowering.

The other controls you will need in combat are right at your fingertips. Right under your index finger on both handles are the **triggers** (D). On the top of the right control handle, by your thumb, is the **high speed button** (E) that throws the turret into high speed for changing quickly from one target to another. At your left thumb is the **push-to-talk-button** (F) that opens the interphone system for you to speak. On the main control panel are also **reset buttons** (G) for the control unit, and booster motor circuits. Down on the front panel of your seat, behind your legs, are resets for the major electrical circuits—auxiliary power, azimuth, elevation, and firing circuits. Depress these reset buttons in emergencies when your power fails.



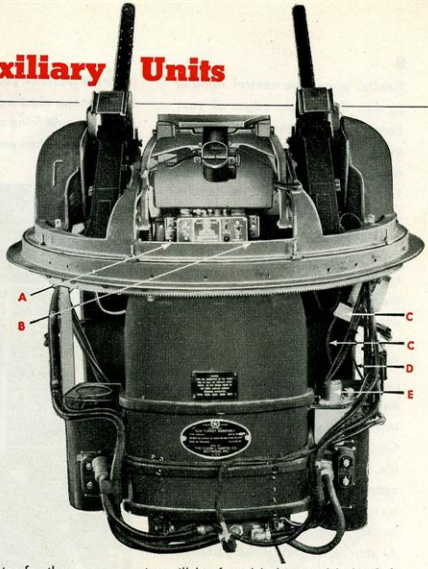


7

To charge your guns, pull cross-arm on the **charger handles** beside your shoulders—grasping the right handle with the left hand, and the left handle with the right hand. Pull them out sharply as far as the charger cables will go. Don't ride the cables on the return action; keep your hold on the handles but allow them to spring back under their own power.

Using the Auxiliary Units

A Elevation and azimuth hand cranks (Below Control Unit)



B Heated suit unit
C Interphone jack box and jacks
D Oxygen regulator and gage (On some turrets, regulator is below control unit, gage on left side)
E Trouble light

You will find a demand type regulator for the oxygen system on your right arm rest—or, in a few Martin turrets, just below the control unit. The oxygen flow and pressure gage is on the left or right, just off your shoulder.

The source of oxygen supply depends on the plane. In the Liberator the supply is contained in two bottles bolted to the bottom of the seat. In the Marauder the supply comes from the plane's central tanks by tubing which enters a swivel joint in the floor below your turret.

In all Martins the heated suit plug-in is above the left arm rest. The interphone jack box is to the right of your right elbow. The trouble light is at the back of the right arm rest, and the gun camera bracket is just to the left of the sight.

Hand cranks for manual operation in emergencies will be found below and behind the control handles: the right crank for azimuth movement, the left crank for elevation. A trigger switch in the handle of the right crank fires both guns. (Some late models have a foot-firing pedal mounted on the left side of the footrest.)

To change to the manual system: 1) Shut off the turret's master power switch. 2) Engage each crank handle by pulling it from its catch. 3) Hold on to the azimuth handle while disengaging the azimuth power clutch, then to the elevation handle while disengaging the elevation power clutch.

Before going back to power operation, be sure the cranks are disengaged and hooked back up on their catches. If you leave them engaged, they will whirl around and may break your leg.

Getting Out

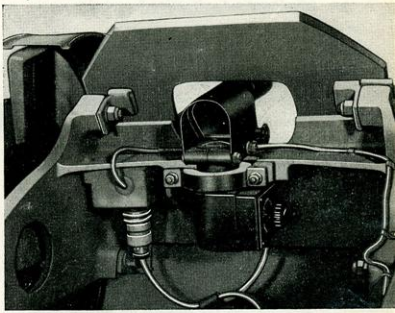
Before leaving the turret, move it to stowing position—guns pointing straight back on the tail. Then turn off all the switches. Make sure the azimuth and elevation power clutches are **engaged.** Disconnect any auxiliary units you have been using. Then brace yourself against the back of the seat and ease your body out of the turret. Drop the seat, if you wish, by pulling its cable.

Preparing the Turret For Combat

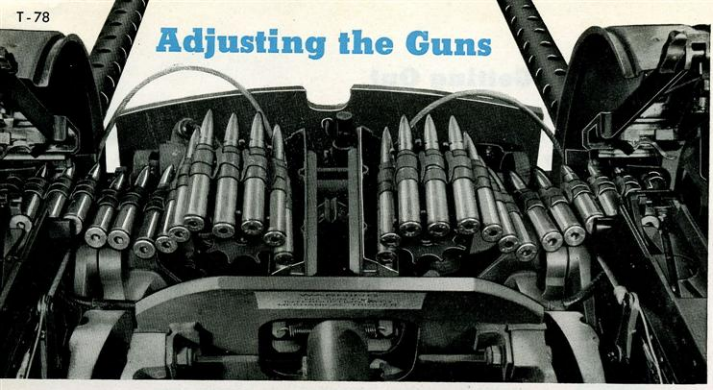
With the practical, working information contained in the preceding pages, you could easily take over and operate the Martin in combat. If you specialize in the Martin, however, that will be only part of your job. The rest of your job—adjusting your sight and guns, and loading the ammunition for a mission—is explained in the following pages.

Adjusting the Sight

The Navy Mark 9 sight fits into the gun sight bracket directly behind a ½" face armor plate which protects your face. To adjust the sight, as it may be sometimes necessary in harmonizing it with the guns, make the adjustments on the sight head. For full instructions in making these adjustments see the section on the MK 9 sight in the general introduction.



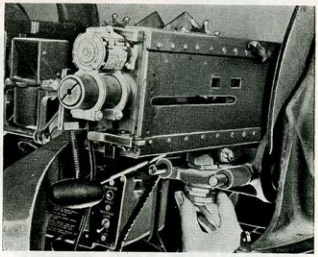
Adjusting the Guns



The guns are mounted in the Martin to feed from the inside—the right gun feeds from the left and the left gun feeds from the right.

The guns are bolted into front and rear mounts in the gun cradles; the two mounting bolts on each gun must have cotter pins. Special charging units are installed on the inside plates of the guns; their mounting bolts must be safety wired. Special ejection chutes are installed on the outside of the guns to carry links away.

The guns may be adjusted up, down, or sideways in their cradles by means of a lock and adjustment nut unit on each rear gun mount.



To make adjustments on either gun:

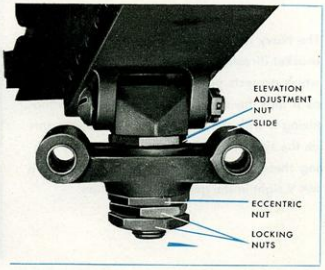
1 Loosen the two bottom lock nuts.

2 Turn the elevation adjustment nut left or right to raise or lower the back of the gun.

3 Turn the eccentric nut left or right to move the back of the gun from side to side.

4 Tighten and safety wire the lock nuts.

By means of these adjustments the guns can be centered in their mounts. Turn the elevation nut until there is a space of about 3/32 inch between the nut and the slide. Then turn the eccentric nut until the thinnest side of its wall faces toward the rear—a mark on the edge of the nut will tell you which is the thinnest side.

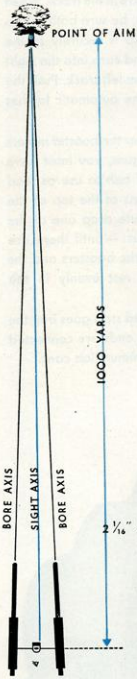


Harmonizing the Guns and Sight

There are a number of ways to harmonize the guns and sight in the Martin 250CE Turret. The exact procedure will be defined by the Squadron Gunnery Officer. A handy method is to line up the sight and boresight the guns on some small object, such as a tree or chimney, at least 1,000 yards from your plane. Remove the backplates and bolts from both guns, or use a boresight tool so that you can look through the gun barrels without removing the parts. Turn the turret until the guns point at the object you have selected.

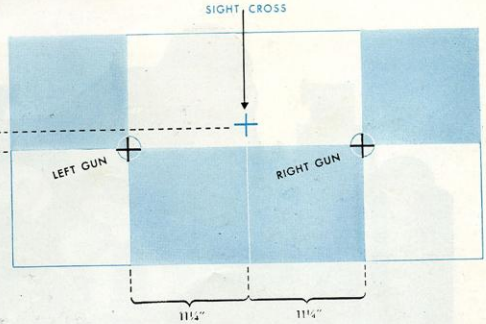
Now line up the sight, using the hand cranks to move the turret until the dot of the sight is squarely on the object. Don't move the turret again. Then boresight through each gun barrel to line up each gun. Adjust each gun by its rear mount adjustment nuts until the spot the sight is centered on is exactly in the center of each gun bore.

Sometimes the amount of adjustment in the rear mounts of the guns may not be enough. In that case, boresight each gun on the small object selected. Then you must make adjustments on the sight head to line up the dot on the same object.



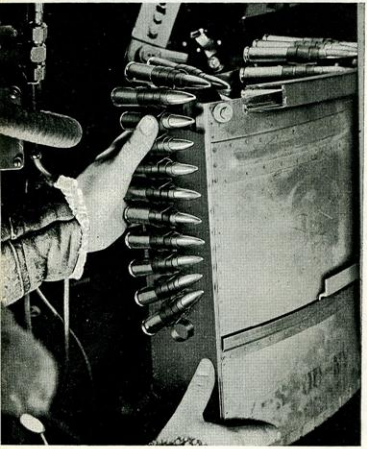
Another method

of harmonization is to line up the sight and guns on a special pattern stand, or template, such as the one illustrated here. Set up the stand as level as possible at least 50 yards from the side of the plane. Center the guns in their mounts. Then boresight each gun on the pattern stand and center the sight on the sight cross, using the standard technique described in the Sights and Sighting section of this manual. Both methods described here are parallel harmonization.



Loading Ammunition

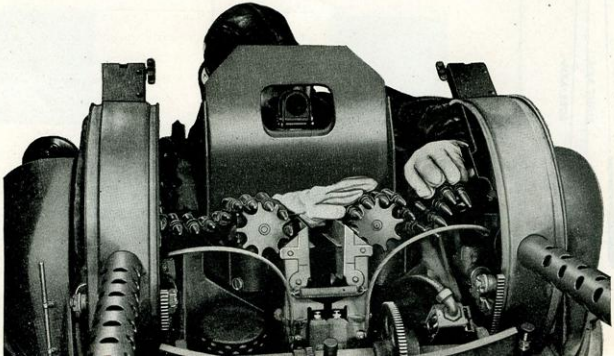
The Martin carries four ammunition cans, holding about 200 rounds each. When you fold in the ammunition belts, load two cans for the right-hand feed gun by starting with the single-link end at the right edge of the can; the double-link end will then come out the left side of the can at the top. Load the other two cans for the left-hand feed gun just the opposite.



← The ammunition cans ride on a semi-circular track beneath the guns. Each is held in place by two rollers and a strip which fits into a groove in the track. When you put the cans into the turret, be sure both rollers are in the tracks and the strip is securely in the groove. Load the two right-hand cans into the right track, the left-hand cans into the left track. Push the cans all the way in, so that the automatic latches catch in slots in the cans.

↓ To feed the ammunition belts over the booster motors which help lift them into the guns, you must have two extra 35-round lengths of belt to use as feed strips. Open the hinged sections at the top of the booster chutes. Down each chute drop one of the feed strips — single-link end first — until there are about 10 rounds left between the boosters and the guns. Make sure the rounds rest evenly in the sprocket wheels.

The double-link end of each feed strip goes into the guns' feedways. The single-link ends are connected to the belts in the two inside ammunition cans.



Pre-Flight Routine

. . . follow step by step

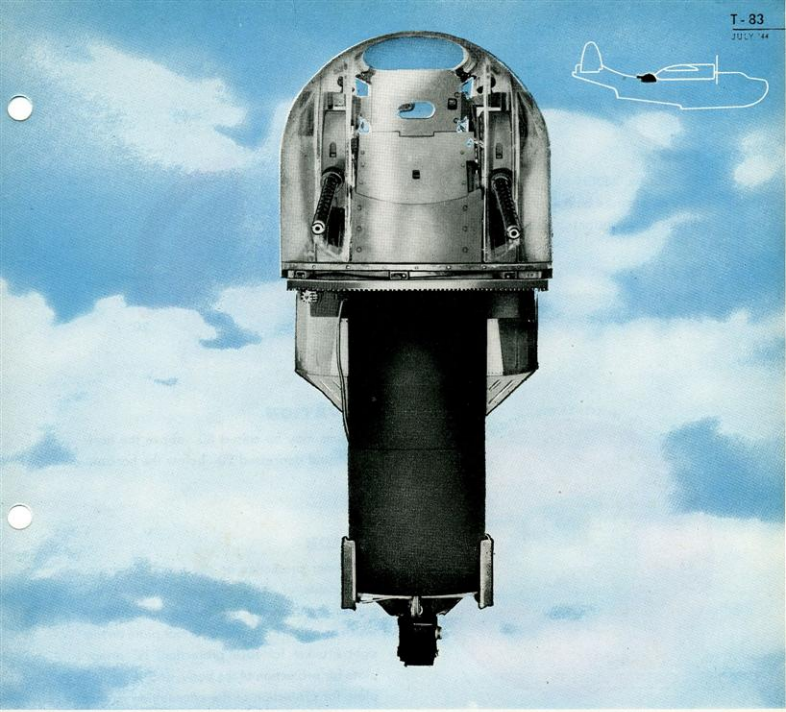
1. Install the barrel and oil buffer groups in the guns—leaving out the bolts and backplates.
2. Check harmonization by boresighting the guns on some small object at least 1,000 yards away or on a template.
3. While you are harmonizing the guns, make sure the manual system of operation is working properly.
4. Still using the manual system, check operation of the mechanical limit stops which keep your guns from bumping against the fuselage when pointed toward the side.
5. Make sure the bolts are assembled properly, to feed from the right on the left gun and from the left on the right gun. Then install the bolts and slide the backplates on both guns.
6. Inspect the ammunition belts to make sure the rounds are in good condition and properly belted.
7. Load the ammunition cans and place them in the turret tracks. Make sure the automatic latches lock them in place.
8. Inspect the electrical cables. Make sure all Cannon plug connections are tight. Report any frayed or damaged cables.
9. Check the oxygen and interphone connections. In some planes this means checking connections to oxygen bottles attached to the seat, and long interphone leads from the wall of the plane. In other bombers it means checking the swivel joint through which both oxygen and interphone lines enter from the floor. Watch for loose connections or failure to swivel.
10. Try to push the turret around by hand to make sure the azimuth clutch is properly engaged. If the turret moves easily the clutch is not properly engaged; push its lever all the way down.
11. Turn on the main power switch. Adjust the footrest and get into the turret. Pull the seat up into place, making sure that both latches on each side catch.
12. Try to push the guns up and down by hand to make sure the elevation clutch is properly engaged. If the guns move easily the clutch is not in place; push its lever all the way to the left.
13. At the same time make sure the gun mounts are secure—you should not be able to rock the guns in their cradles. Make sure cotter pins have been installed in the front and rear mounting bolts.
14. On the charging units, make sure all three nuts on each charger plate have been safety wired. Make sure the charging cables have been properly attached to their levers.
15. Make sure the dome is clean.
16. Turn on the master switch.
17. Turn on the sight rheostat and turn it from dim to bright to adjust the brightness of light in your sight and to make sure it is working properly. Try both filaments of the sight bulb; if either is burned out, replace the bulb. Make sure the optic head is clean.
18. Turn on the master gun switch.
19. Flip the gun selector switch to Individual Guns. Charge the guns by pulling cross-arm on the gun charger cables. Check the guns' headspace. Then pull one trigger at a time and check the electric triggers for adjust-

ment—listen for a "click" as the firing pin of the gun releases. Then turn switch to Both Guns and make sure both guns fire properly from either trigger.

20. Test the booster motors by tilting the boosters toward the guns. Make sure the motors cut on and off sharply without lag.
21. Run the turret under power in azimuth and elevation at normal speed and then with the high speed button held down, to check on ease of operation. Make sure the turret operates with either safety switch held down. Test the limit stops which cut off the turret power to prevent the guns from striking the fuselage when pointed forward or backward. Then stop the turret and check for creep.
22. Check the fire cutoff system by swinging the turret and guns to the tail section of your bomber and attempting to fire. Make sure the guns cut off with the proper amount of margin—your crew chief will tell you how much.
23. Put on your oxygen mask, connect it, and make sure you are getting a flow of oxygen. Check the gage to make sure there is proper pressure in the tanks, as determined by your crew chief.
24. Plug in your headphones and microphone, to test whether your crew mates can hear you and you can hear them.
25. Plug in and test your heated suit and the rheostat.
26. Make sure your trouble light operates. Flip the switch to make sure the bulb lights. Pull the light out on its cord to make sure the retractable reel is working properly.
27. Turn off all switches. Drop two 35-round feed strips of ammunition down the booster chutes, leaving about 10 rounds extending from the booster sprocket wheels to the guns. Make sure the rounds rest evenly in the sprockets. Connect the feed strips to the belts in the inner cans, making sure the connecting rounds are pushed in evenly.
28. Make a last visual check of the whole turret, inside and out.
29. Just before the takeoff, push the first rounds of ammunition into the guns' feedways over the belt holding pawl. In flight, charge both guns on order of the flight commander.

Post-Flight

1. Run the turret to its stowing position—guns pointing straight back toward the tail. Make sure both power clutches are still in their engaged position.
2. Remove the ammunition belts from the feedways.
3. Clear the guns by opening the gun covers and hand charging them twice.
4. Take the ammunition cans out of the turret.
5. Field strip the guns.
6. Clean up all brass and links around the deck near the turret.
7. Clean the gun casing groups, thoroughly inspecting the condition of their parts — as described in the post-flight check in the Guns section of this manual.
8. Then detail strip the parts you have removed from the guns, cleaning them and making a thorough check on their condition—also described under the post-flight check in the Guns section.
9. Report any malfunctions of turret or guns noted on the mission.



Martin Hydraulic Upper Deck

MARTIN 250CH—1 & 3

The Martin Hydraulic Upper Deck Turret is the standard Navy installation for many flying boats. It can swing its guns a full 360° and protects the whole upper area of the plane with its deadly efficient cone of fire. There are several models, which for the most part are the same. The Martin 250CH-1 is used in a Martin "Mariner", and the Martin 250CH-3, in the Consolidated "Coronado". The Martin 250CH-2, which is almost identical with the 1 & 3, is the tail turret of the PBM-3D, and will be covered in a supplement to this section.

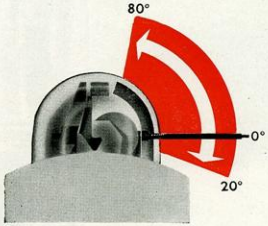
Facts and Figures

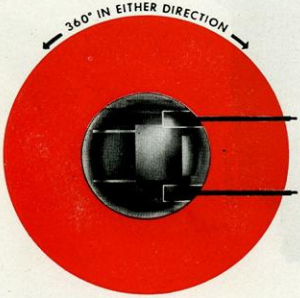
POWER

The Martin 250CH turrets operate hydraulically on pressure built up by a hydraulic pump driven by a constant speed electric motor.

SIGHT

Its sight is a standard MK 9 sight, fully described in the introduction of this section.





ELEVATION

The guns may be raised 80° above the horizontal and depressed 20° below the horizontal.

ARMOR

The armor protection on the front of the turret consists of three sections to shield the gunner from enemy fire in any direction in which he points the guns: ½" armor plate on the sight bracket for face protection, ½" armor plate for protection of the body, and ⅜" armor plate for protection of the ammunition magazines.

AZIMUTH

The turret can move 360°—a full circle—in azimuth.

STOWING POSITION

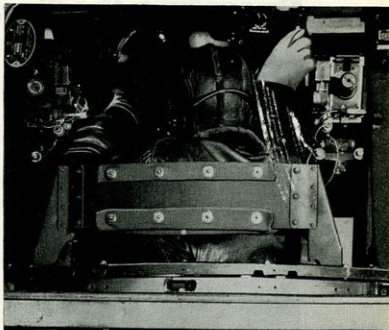
The stowing position is 0° elevation and 180° azimuth, guns pointing straight aft.

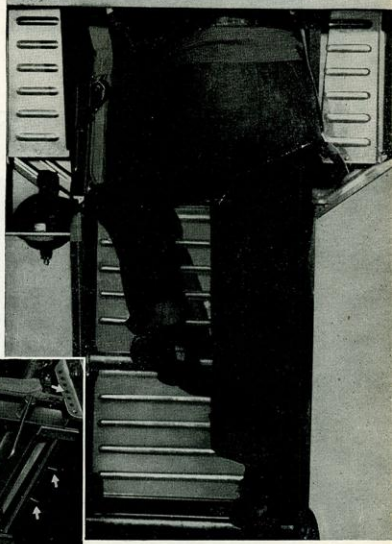
Getting In

The Martin Hydraulic Upper Deck Turret is one of the easiest to enter. First of all, before you get in make sure that the **deck turret switch** has been turned to the **on** position on the flight engineer's panel. Just outside the turret on a junction box, conveniently located on a bulkhead, is a **switch** and a **red indicator light,** which provides for turning "on" or "off" the power to the turret. In the turret is a similar switch marked **main power** with a **red indicator light** directly below it. In turning on the power it is best to wait until you are in the turret, as the switch on the outside junction box is to be used for emergency purposes only.

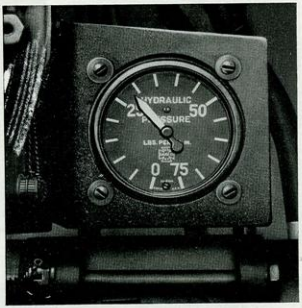
Now enter the turret head-first from the rear of the ammunition box by climbing up the two steps, using a convenient portion of the structure of the turret as a hand grip to help you.

While standing on the top of the ammunition box covers, reach down and pull the seat up until it locks over the right hand seat support bar. Then look through the **sight** to see if you are at the proper height. If you are not, get out of the turret and adjust the seat. This is accomplished by pinching together the **pins** in the seat support bars, which are located on each side of the seat, and raising them to the next holes above or below. On completion of this, climb back into the turret. Fasten the safety belt and you are now ready to operate.





Operating the Turret

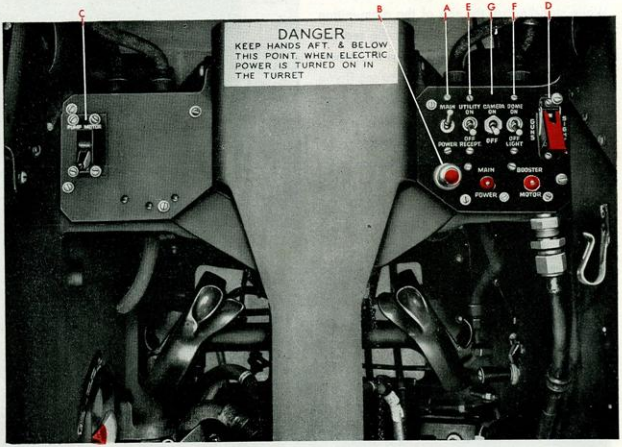


. . . Where to Find the Controls
. . . How to Use Them

Putting the Martin 250CH Turret into operation is a relatively simple job.

First of all, look down over your right foot and you will see a **low-pressure gauge** which should read **25 lbs.** to **30 lbs.** pressure. It is very important that this pressure be present as it insures smooth operation of the turret.

Directly in front of you on the right side is the **control panel.** On it you will see a switch marked **main power** (A) with a **red indicator light** (B) below it. Flick this switch to the **on** position and the red light will light up on the control panel and on the junction box just outside of turret, indicating the power is on.



On the left side of the control panel you see another switch all by itself, marked **pump motor switch** (C). Raise this to the **on** position. Lift the little red plastic cover on the right side of the control panel and flick the **gun-and-sight switch** (D) to the **on** position.

The **control handles** are located below and back of the breast plate in which the control panel is mounted.

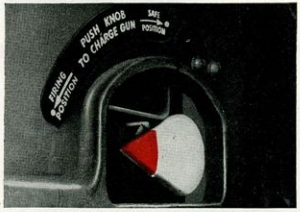
To start the pump motor use the bottom edges of your hands to press down the two **safety switches.** When the motor is running, the handles will automatically go to neutral position. For this reason it is best to press the safety switches down before grasping the hand grips of the control handles. If this is done, the control handles will move to the neutral position without moving the turret. If the control handles are in any other position than neutral and the safety switches are closed, the turret will start, causing immediate and violent action. Either safety switch will operate the turret.

Depressing the safety switches also turns on the **sight** and provides power to the **booster motors** so that they will operate when the guns are fired.

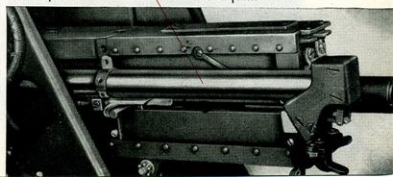
To adjust the brightness of the **sight** to light conditions use one hand to hold the control handles, keeping the safety switch depressed, and turn the rheostat on the sight.

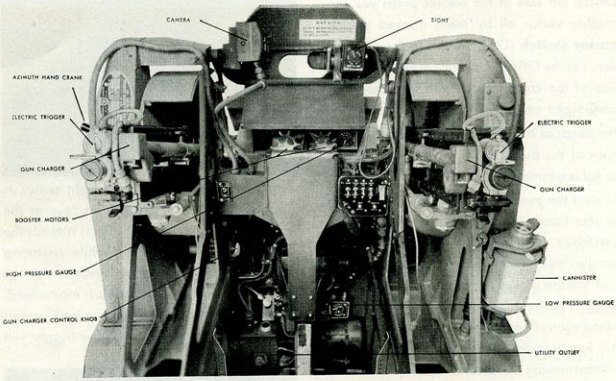
To operate the turret turn the control handles in the direction you desire the turret to move. For azimuth (right or left) the control handles are operated exactly like those of a bicycle. For elevating the guns move the upper part of the control grips backward; and for depressing the guns, move the top portion of the control handles forward. Don't jerk the controls—move them smoothly and deliberately.

Above the control panel, and right center, is the **high pressure gauge.** As soon as the pump is operating, check to see if it reads the desired **750 lbs.** pressure. While operating the turret, from time to time check this gauge to see that the proper pressure is maintained. Right under your index finger on both control handles are the **triggers.** Either trigger will fire both guns.



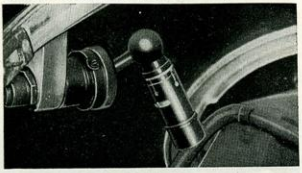
Next to your left knee is the hydraulic **gun charger control knob,** which operates the **gun chargers** located on the inboard side of each gun. To charge the guns turn the control knob to the **Firing** position. Depress the control knob sharply. Both guns will be charged at once and ready to fire. If the control knob is turned to **Safe** before depressing, the gun bolts will remain in the retracted position, which provides access to remove a jam.





Using Auxiliary Equipment

The turret **oxygen system** is connected to that of the airplane through a swivel joint in the base of the turret. The system consists of a rebreather unit, a cannister, and a nose piece. The rebreather is mounted on the right side of the magazine under the expended ammunition container. The cannister is located on the outboard side of the right ejection chute casting and is connected by a flexible hose to the oxygen mask. However, you will find in many of the existing PBM and PB2Y airplanes that the oxygen system has been done away with, because it is not necessary for these airplanes to fly at high altitudes while on patrol.

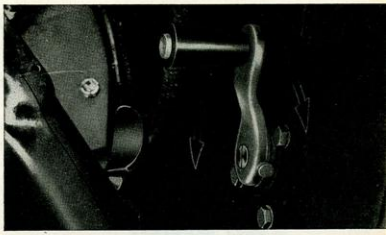


The cord to the **heating suit** is plugged into an outlet on the junction box, which is located directly above your left foot. This is turned on at the control panel by the **utility switch** (E). The **inter-phone jack box** is attached to the right ejection chute casting. This is where you plug in your jacks for your headphones and throat microphone. On the front of the box is the "push-to-talk" button that operates the inter-phone system when you wish to speak.

Two **trouble lights** of the spotlight type are mounted on ribs from the top of the dome, one on either side of the escape hatch. A ball swivel joint on each light enables you to direct the light in any direction desired. The **dome light switch** (F) is located on the control panel.

Provisions have been made for installation of a **gun camera** on the left side of the sight. To put the camera into operation it is necessary to have the **camera switch** (G) and the main power switch "on", and the trigger and safety switch depressed.

In the event that the power fails, a **manual azimuth drive** is provided so that you may rotate the turret. The **drive crank** is stowed on a spring clip mounted on the aft face of the left ejection chute casting. Remove the crank from the clip and insert it in the hole on the right inboard side next to your right knee. This ties the crank directly into the azimuth gear mechanism. Turning the crank one way or the other moves the turret in azimuth. You will find the crank extremely helpful in testing the fire interrupter and boresighting the guns when a slow, carefully controlled amount of azimuth movement is necessary.



Before going back to power operation be sure to remove this azimuth manual crank. If you have it engaged it will whirl around and may break your hand or leg.

No manual elevation mechanism is provided in this turret. However, in models which are about to be produced, manual operation will be provided for both elevation and azimuth.

Getting Out

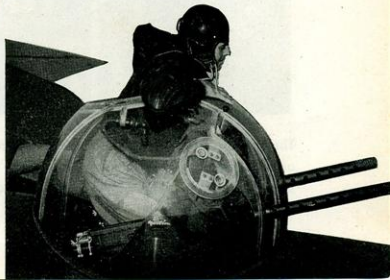
Getting out of the turret you will find just as simple as getting in. First of all, move the guns to the stowing position—guns at zero elevation and 180° azimuth, pointing straight aft.

Turn off all switches. Disconnect all auxiliary units you have been using.

Brace yourself against the back of the seat and reach down on your right side and depress the seat release. The seat will then swing down out of the way. All you have to do now is to climb down two steps and you are out of the turret.

Emergency Exit

If it is necessary for you to get out of the turret in a hurry, an emergency exit is possible through an escape hatch in the plastic dome. Two plastic handles are located on either side of the hatch and by turning them a quarter of a turn, the hatch will fall inboard. By standing on the seat you will find it an easy job to crawl out of the top of the turret.

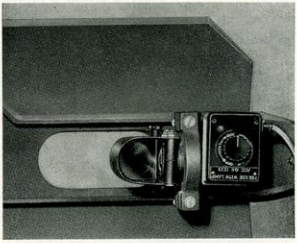


Preparing the Turret for Combat

You have now read how to get into the turret, how to operate the controls and auxiliary units, and how to get back out. With this information you should have no trouble in taking over the turret and operating it in combat.

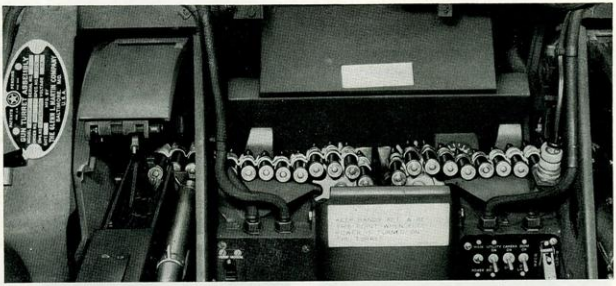
To be a specialist in the Martin 250CH you will need additional instruction on how to get the sight and guns ready for a mission, harmonize them, and load ammunition. You will find this information in the following pages.

The Sight



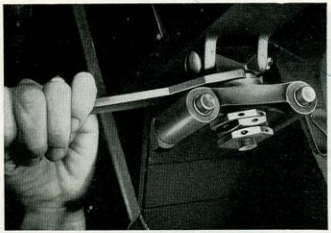
The Navy Mk 9 sight fits into the gun sight bracket directly behind a ½" armor plate which protects your face. To adjust the sight, as it may be sometimes necessary in harmonizing it with the guns, make the adjustments on the sight head. For full instructions see the section on the Mk 9 sight in the general introduction.

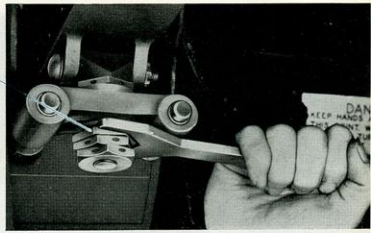
Adjusting The Guns



The guns are mounted in the Martin Ball to feed from the inside—the right gun feeds from the left and the left gun feeds from the right. Each gun is installed with an Edgewater E-10 adapter and is bolted to the front and rear mounts in the gun cradles.

The guns may be adjusted up, down, or sideways in their cradles by means of an adjustment nut assembly which is locked into place by jam nuts. An elevation adjustment nut controls the up and down movement. An eccentric nut controls the sideways motion.

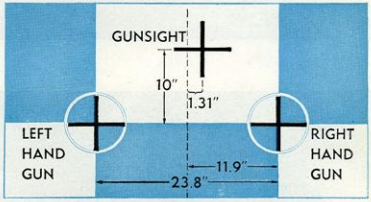




Harmonizing the Guns and Sight

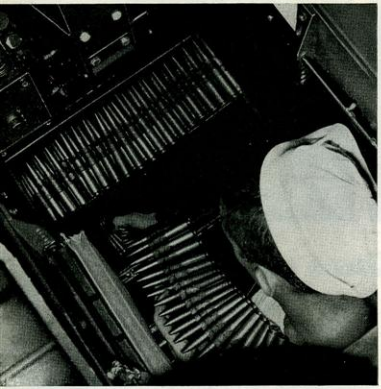
There are a number of ways to harmonize the guns and sight in the Martin Hydraulic Deck Turret. The exact procedure will be defined by the Squadron Gunnery Officer. A handy method is to line up the sight and boresight the guns on some small object, such as a tree or chimney, at least 1000 yards from your plane. To do that remove the back plates and bolts from both guns, or use a boresight tool so that you can look through the gun barrels without removing the parts. Turn the turret until the guns point at the object you have selected.

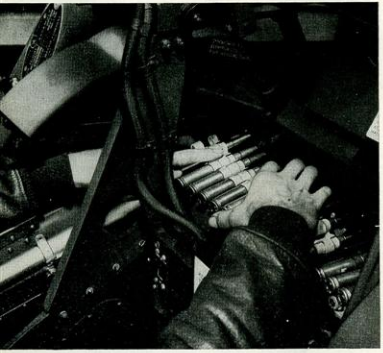
Now line up the sight, using the azimuth hand crank to move the turret until the dot of the sight is squarely on the object. Don't move the turret again. Now boresight through each gun barrel to line up each gun. Adjust each gun by its rear mount adjustment nuts until the spot the sight is centered on is exactly in the center of each gun bore. Sometimes the amount of adjustment in the rear mounts of the guns may not be enough. In that case, boresight each gun on the small object selected. Then you must make adjustments on the sight head to line up the dot on the same object.



Another method of harmonization is to line up the sight and guns on a special pattern stand, or template, such as the one illustrated here. Set up the stand as level as possible at least 50 yards from the side of the plane. Center the guns in their mounts. Then boresight each gun on the pattern stand and center the sight on the sight cross, using the standard technique described in the Sights and Sighting section of this manual. Both methods described here are parallel harmonization.

Loading Ammunition



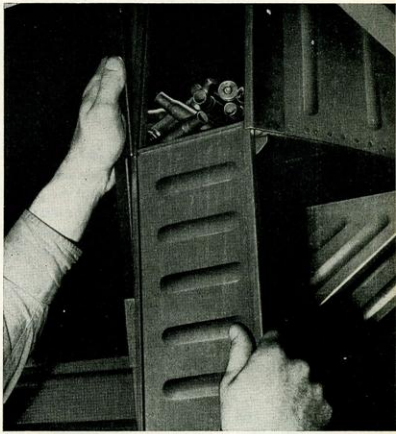


The Martin Hydraulic Upper Deck carries its ammunition in two built-in magazines, separated by a steel partition and mounted under the feet of the gunner. These double magazines are loaded through sliding removable doors on top and hold 600 rounds of .50 cal. ammunition for each gun. The top of the ammunition box and the removable doors also serve as a foot-rest for the gunner. To load the magazines:

1. Remove the foot plates at the top of the ammunition box. This is done by pulling the spring-like pin under the foot-rest panels and then skidding the foot plates aft and off.
2. Remove the forward and aft pins of the feed chute. Remove the chute.
3. Load the ammunition belts by flaking them back and forth across the magazine.
4. When ammunition boxes are full reinstall the feed chute and its pins.
5. Lower a wire hook or an ammunition thread sling down the top of the booster feed and through the feed chute attaching it to the ammunition belt in the magazine.
6. Reinstall foot plates at the top of ammunition box.
7. Pull each ammunition belt up through the chutes until one or two rounds of ammunition are engaged in the booster sprockets.
8. Lift the cradle cover and gun cover. Pull enough ammunition to be loaded into the guns.
9. Close the gun covers and cradles.

Removal of Empty Cartridge Cases and Links

On either side of the seat, attached under the azimuth track, are the expended ammunition containers—one for each gun. To remove the empty links and cartridge cases, slide down the access doors on the back of each container after pushing in the latching catches on the access doors. Clean out the empty cartridge cases and links. Replace the access doors.



Pre-Flight Routine

. . . Follow Step by Step

1. Install the barrels and oil buffer groups in the guns—leaving out the bolts and back plates.
2. Check harmonization of the guns and sight by boresighting on pattern stand or some other object 1000 or more yards away.
3. Make sure the bolts are assembled properly to feed from the right for the left gun and from the left for the right gun. Install bolts and replace back plates on both guns.
4. Try to rock the guns in their mounts to make sure they are securely mounted. Check to see if the adjustment and jam nuts are properly safetied.
5. Check filler valve. It should be in the "RUN" position and safety wired.
6. With the pump in operation, operate the gun charger valve knob in both "SAFE" and "FIRE" positions.
7. Inspect the hydraulic system and lines carefully. This should be done with and without the pump operating. If there are any leaks, report them immediately.
8. Inspect electrical leads and flexible conduits (Breezes) to determine if they are frayed or damaged.
9. Check all Cannon plugs to see that they are properly seated and screwed up tight.
10. Check oxygen connections to be sure they are tight.
11. Make sure plexiglas dome and escape hatch are properly secured and clean.
12. Check low pressure gauge to see if you have 25 to 30 lbs. pressure required.
13. Operate the turret to determine if the high pressure gauge reads required 750 lbs.
14. Check ease of operation in elevation and azimuth. Stop turret with pump running (control handles in neutral). Check for "creep."

15. Check for "line knock" (air in hydraulic system) while operating turret in all extremes. If any is noticeable, report it to maintenance man.
16. Operate the turret in elevation to determine if the limit stops are functioning properly.
17. With the guns completely depressed, carefully rotate the turret to determine if the structural interrupter keeps the guns from swinging into the fuselage.
18. Insert a test light in place of electric trigger control, and with triggers depressed, rotate the turret across the portions of the plane into which the guns could fire. The test light will go out in this area. With a boresighting tool, check the distance from the surface the interrupter cuts out.
19. Turn on the sight and gun switch, depress the safety switch, and rotate the sight rheostat from dim to bright to adjust the brightness of the reticle to existing light conditions. Make sure the reflector plate of the sight is clean.
20. Plug in your headphones and microphones to test if your crew mates can hear you and you can hear them.
21. Plug in your heating suit and make sure it begins to heat.
22. Make sure both trouble lights are operating.
23. Inspect all ammunition belts to determine that the rounds are in good condition and properly belted.
24. Check booster motors by tipping them toward the guns. Make sure they cut on and off sharply without lagging.
25. Load ammunition magazines. Feed the double link up over the booster motors' sprockets, and press the first round into the feedway of each gun. You will not charge your gun until you are in the air and so ordered by your plane captain.

Before Landing

1. Run the turret to its stowed position—0° elevation and 180° azimuth, guns pointing straight back.
2. Clear the guns by lifting the gun covers, removing ammunition and charging them twice.
3. Remove all ammunition from feedway; check all switches and make sure they are off.
4. Disconnect any auxiliary equipment that you have been using.
5. Get out of the turret.

After Landing

1. Remove all ammunition from chutes and magazines.
2. Open access doors on the expended ammunition containers on either side of the turret and clean out empty cartridge cases and links. Replace the access door on completing the job.
3. Field-strip the guns by removing their working parts. Clean and inspect gun receivers, then detail-strip the parts you have removed from the gun, cleaning them and making a thorough check of their condition. Do not leave excess oil or cleaning fluid in turret.
4. Report any malfunction of turret or guns noted on the mission.

Martin Hydraulic Tail

MARTIN 250CH-2

There is little difference between the Martin 250CH-1 and 250CH-3 Deck Turrets and the Martin 250CH-2 Turret used in the tail position of the PBM-3D airplane. Both types are operated exactly the same. The information on the following page will outline the major differences between the two types.

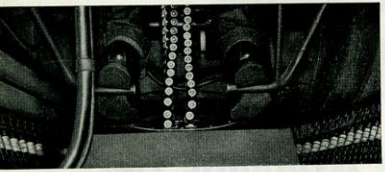
AZIMUTH

The Martin 250CH-2, being a tail turret, is provided with an azimuth movement of 75° on either side of the center line of the ship.

MARTIN TAIL TURRET

As the Martin 250CH-2 is a tail turret, never remain in it during takeoffs and landings. Your additional weight in the tail would put undue stress on the plane besides making it unbalanced.

To enter the turret crawl in on your hands and knees. When you are inside, straighten up, and pull the seat up until it locks over the right

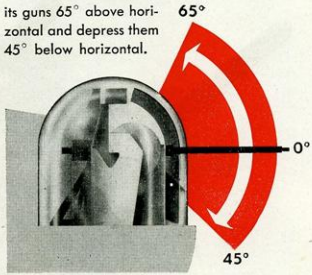


hand seat support bar. Look through the sight to see if you are at the proper height. If not, adjust the seat as you would in the Martir 250CH-1 or 3 Deck turret. In this turret you do not place your feet on the top of the magazines as you would in the deck turret, but on foot brackets.

Keep your feet on these foot brackets

ELEVATION

In elevation it can raise its guns 65° above horizontal and depress them 45° below horizontal.



at all times while operating the turret or it is possible that you may get them jammed between the turret and the structure of the ship.

To get out of the turret first run it to its stowing position — 0° elevation and 180° azimuth — guns pointing straight aft. Then crawl out of the turret in a manner similar to that used in entering. No magazines are provided in the turret, but they are located in the hull of the airplane, one on either side. Each of these magazines holds 1000 rounds. The ammunition travels along both sides of the hull on roller tracks and enters the turret between the gunner's feet. The empty cartridge cases and links are carried overboard through chutes.

The check off routine for PRE-FLIGHT on both Martin Deck and Tail Turrets for the most part is the same with the following substitutions:

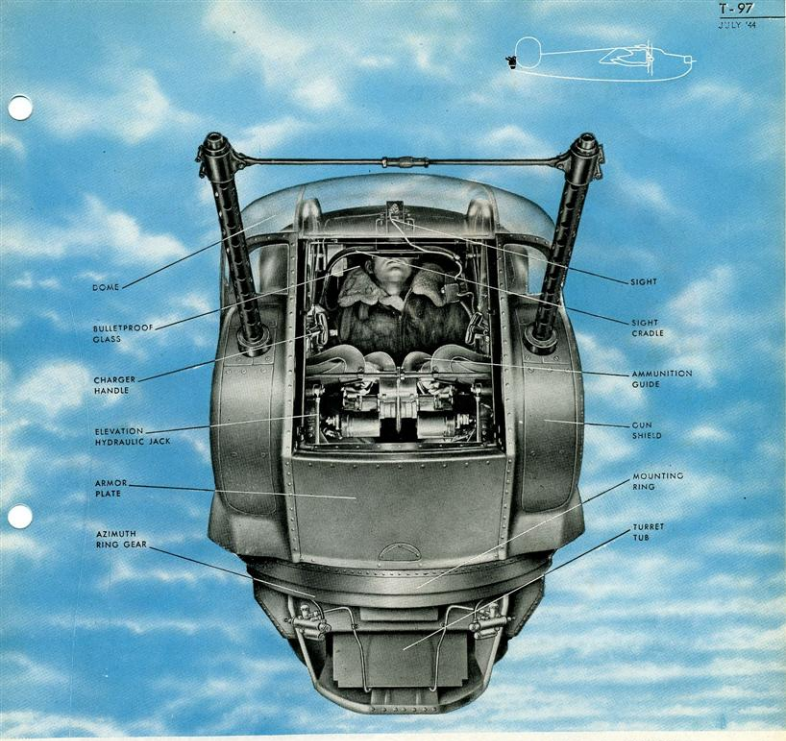
Pre-flight

16. Operate the turret in both extremes of elevation and azimuth to check the limit stops.

17. Disregard this check, as no structural interrupter is provided in the tail turret.

18. Disregard this check, as no fire interrupter is provided in the tail turret.

BEFORE-LANDING and AFTER-LANDING procedures are exactly the same.



THE CONSOLIDATED TAIL

CONSAIR 250CH-3 OR M.P.C. 250CH-6

The Consolidated tail turret is a double stinger in the tail of the PB2Y-3 Coronado and the PB4Y Liberator. In some Liberators it is also used as a bow turret. It is a versatile gun mount providing a large cone of fire.

There are two models—the original Consair 250CH-3 and the new MPC 250CH-6, which is now in general use and has some marked mechanical improvements.

In operation the two models are basically the same.

Facts and Figures

POWER

The Consolidated Tail operates hydraulically, on pressure built up by a hydraulic pump driven by a constant speed electric motor.

AZIMUTH

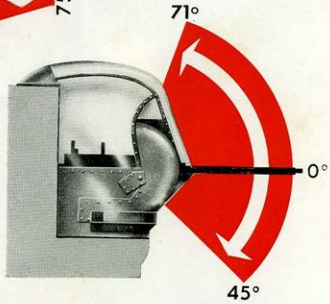
The turret moves in azimuth about 75 degrees to either side of the ship's centerline — from almost straight out to the left to almost straight out to the right.

SIGHT

Its sights is the MK 9 reflector described fully in the Sights and Sighting section of this manual.

ARMOR

A bulletproof glass panel, 2⅛ inches thick, protects the gunner in front. Directly below it is a ⅞-inch armor plate panel, and to the right and left of the gunner's knees are two more small panels, ⅜ inch thick.



ELEVATION

In elevation, the turret guns can be lowered and raised from 45 degrees below the horizontal level to 71 degrees above horizontal.

STOWING POSITION

The stowing position for turret and guns is 180 degrees in azimuth and 60 degrees in elevation—guns pointed back from the tail and two-thirds of the way between level and straight up.

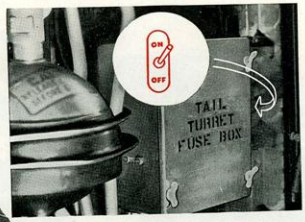
Getting In

When you step into the Consolidated Tail for the first time, approach it with care. Unless the turret is properly locked, it may swivel and trap a man trying to go through the doorway. The method of getting in illustrated on this page is the only safe way—follow it step by step.

And remember, as you get into the turret for your first look around, that ordinarily you would enter only after the bomber is in full flight, and would get out before the landing. Quick changes of speed during takeoffs and landings make any tail turret an extremely dangerous place to be at those times.

1

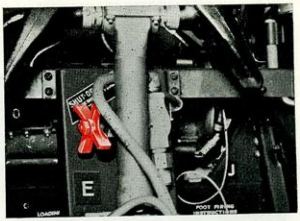
Turn on the **main power switch** just outside the turret on the fuselage of the plane.

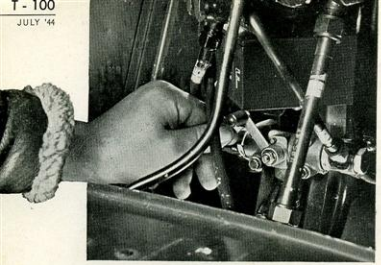


2 Open the turret doors.

3

Reach into the turret and make sure that the **main shutoff valve,** a red spindle knob to the left center, is closed. The valve should be turned all the way in. If it is open, a mere touch on the control handles might set the turret moving and trap you in the doorway. Always make sure the main shutoff valve is closed before entering or leaving the turret.





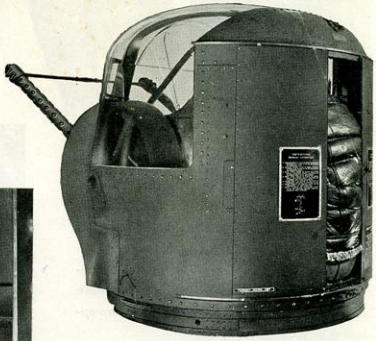
4

Make sure the **azimuth emergency release valve** under the seat is closed.

5

Make sure the **elevation bypass valve,** a small handle below and to the left of the control unit, is closed. The handle should be up.

6 Grasp the two handles just above the doorway, and, chinning yourself, swing both feet straight into the turret pit. Then get into the seat.

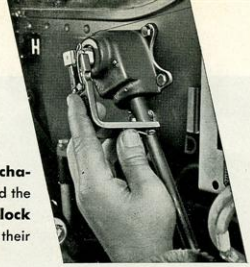


7

Pull down on the door cable, by grasping the red knob on your right, to close and lock the doors behind you. Be sure the doors are tightly latched.

8

Remove the **azimuth mechanism lock** on your right and the **elevation mechanism lock** on your left. Put the locks in their clips on the turret wall

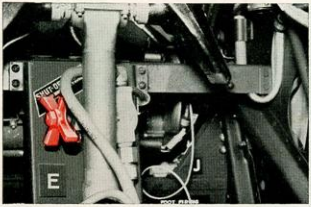


Operating the Turret

. . . where to find the controls
. . . how to use them

Close at hand, as you sit in the Consolidated Tail, are all the switches, valves, and controls. They are easy to get at and easy to use. But be sure to turn on the switches and open the valves in the order shown here.

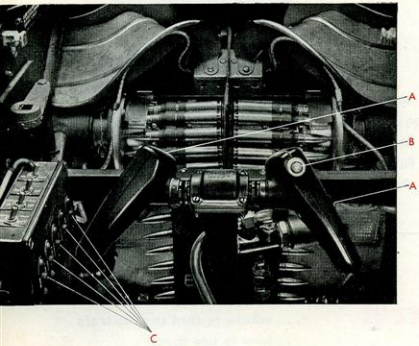
1 Open the **main shutoff valve.**



2 Turn on the **power switch** (A) on the junction box beside your left knee.

3 On this same panel flip on the **booster motor switch** (B) and the **trigger switch** (C). If you are using a gun camera, flip on the **gun camera switch** (D).

4 Turn on the **sight rheostat,** near your left shoulder, and rotate it to adjust the brightness of the light in your sight.



5

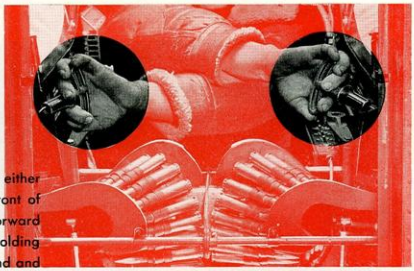
Grasp the control handles directly in front of you, and you are all set to go. To move the turret, turn the handles just as you would steer a bicycle—to the right to go right, left to go left. Press down on the heels of the handles to raise the guns. Pull up on them to lower the guns.

The other controls you will use in combat are close at hand.

The **triggers** (A) are on the control handles, right under your index fingers.

The **push-to-talk button** (B) that opens the interphone system for you to speak is on the right handle, under your thumb.

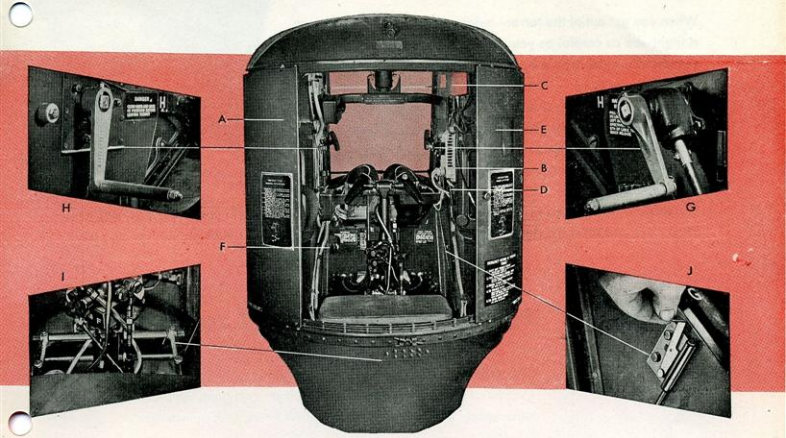
A set of **reset buttons** (C) protecting the main electrical circuits is mounted on the side of the junction box—each button labeled with the name of the circuit.



6

The **charging handles** are on either side of the bulletproof glass in front of you. To charge the guns, reach forward and grasp the handles cross-arm, holding the left handle with your right hand and the right handle with your left hand. Pull back on them sharply as far as they will go. Don't ride the cables on the return action. Still holding the handles, allow them to snap back on their own power.

Using the Auxiliary Units



You will find a demand type oxygen regulator (A), with hose connection for your mask, near your left shoulder. The oxygen supply is drawn from the ship's central tanks.

The heated suit plug-in (B) is mounted on the right wall of the turret enclosure near your right shoulder. The interphone jack box (C) is on the right wall of the turret, too, near your cheek; from it lead the interphone jacks (D).

A trouble light and switch (E) fit in a holder in the upper right-hand corner of the turret enclosure. A warning bell (F) on the left forward wall of the turret is connected with the pilot's compartment—he will ring it when he wants to land, notifying you to get out of the turret.

Shafts for manual operation of the turret in emergencies are on the right and left side of the turret seat—the right shaft (G) for azimuth movement, the left (H) for elevation. The two hand cranks are stored in clips on either side. At your feet are two foot-firing pedals (I), with a foot-firing mechanism lock (J), which allow you to fire the guns in manual operation.

To change to manual operation:

1. Close the main shutoff valve. Open the bypass and emergency release valves.
2. Slip the hand cranks on the manual shafts.
3. Pull the foot-firing mechanism lock up into its OPEN position.

Always push the foot-firing mechanism lock DOWN into its locked position after manual operation. **Never charge the guns unless this lock is down.**

Getting Out

When you get out of the turret—before the landing if you are on a flight—be as careful as you were when you got in. Remember that the doors can trap a careless gunner on the way out as well as on the way in.

First move the turret to stowing position—guns pointed back and to 60 degrees elevation. Then turn off the sight, trigger, booster motor, and main power switches on the junction box. Close the main shutoff valve, and replace the azimuth and elevation mechanism locks which you removed when you got in.

The turret is now locked in place. Open the doors by pulling the cable on your right and step out. Then close and latch the doors behind you and turn off the main power switch on the fuselage wall.

Preparing the Turret for Combat

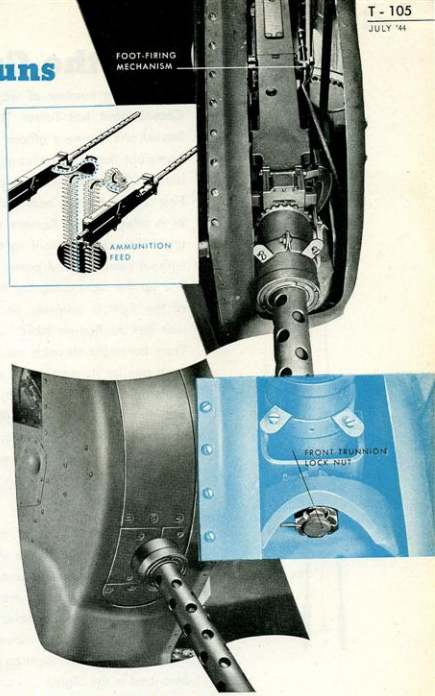
With the practical data in the preceding pages, you could take over the Consolidated in combat. However, that will be only part of your job.

The rest of your job—harmonizing the sight and guns, and loading ammunition ready for a mission—is explained in the following pages.

Adjusting the Sight

The Navy MK 9 reflector sight fits into a bracket mounted on top of the sight cradle directly in front of you. To adjust the sight as it may be sometimes necessary in harmonizing it with the guns, make the adjustments on the sight head. For full instructions in making these adjustments, see the section on the MK 9 sight in the general introduction.

Adjusting the Guns

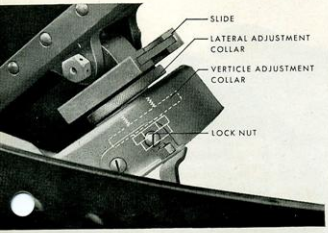


The guns are mounted in the Consolidated Tail to feed from the inside—the right gun from the left, the left gun from the right. Each gun is held in its cradle by a rear trunnion block and slide and a front trunnion stud bolted into a mounting hole in the cradle. The rear trunnion block, attached to the gun, dovetails into the slide mounted on the cradle; check to make sure the block fits. The front trunnion stud is held by a lock nut and cotter pin.

Special charging units are installed on the inside plates of the guns' receivers, and link ejection chutes on the outside. Make sure that the bolts mounting the charging units are safety wired, and that the cable connections have cotter pins.

Special foot-firing mechanisms are mounted on the outside of the guns and connected to two foot-firing pedals. The pedals operate plungers which trip the sears in the guns. When you assemble the bolts for the guns, make sure the square ends of the sear slides are on the outside of each gun. Mounting bolts on the foot-firing mechanisms must be safety wired.

The guns are adjusted up, down, or sideways in their cradles by rear mount adjustment collar and lock nut assemblies.

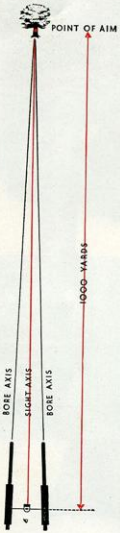


To make the adjustments:

1. Loosen the front and rear trunnion lock nuts.
2. Turn the top lateral adjustment collar right or left to move the rear of the gun from side to side.
3. Turn the bottom vertical adjustment collar right or left to move the rear of the gun up or down.
4. Tighten the lock nuts.

By means of these adjustments the guns can be centered in their mounts. Simply turn the collars to the approximate centers of their lateral and vertical adjustment movements. A little practice will enable you to do this quickly and accurately.

Harmonizing the Guns and Sight

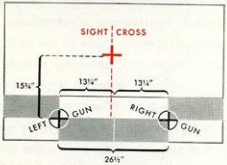


There are a number of ways to harmonize the guns and sight in the Consolidated Tail Turret. The exact procedure will be defined by the Squadron's Gunnery officer. A handy method is to line up the sight and boresight the guns on some small object such as a tree or chimney at least 1,000 yards from your plane.

First remove the two access plates from the rear of the turret. Simply press in to release them. Remove the backplates and bolts from both guns or use a boresighting tool so that you can look through the gun barrels without removing the parts. Then center the guns in their mounts. Now line up the sight using the hand cranks to move the turret until the dot of the sight is squarely on the object. Lock the turret in this position with the mechanism locks.

Then boresight through each gun barrel to line up each gun. Adjust each gun by its rear mount adjustment collars until the spot the sight is centered on is exactly in the center of each gun bore.

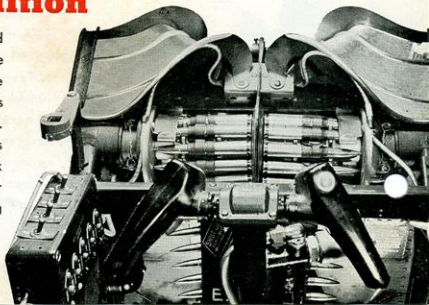
Sometimes the amount of adjustment in the rear mount of the guns may not be enough. In that case, boresight each gun on the small object selected, then you must make adjustments on the sight head to line up the dot on the same object.



Another method of harmonization is to line up the sight and guns on the special pattern stand such as the one illustrated here. Set up the stand as level as possible at least 50 yards from the turret. Center the guns in their mounts. Then boresight each gun on the pattern stand and center the sight on the sight cross using the standard technique described in the Sights and Sighting section of this manual. Both methods described here are parallel harmonization.

Loading Ammunition

The ammunition cans, one for each gun, hold about 400 rounds each. They are outside the turret in the fuselage of the plane, and the ammunition belts feed through flexible guides up through the floor of the turret to the guns. To load the guns, first pull the ammunition belts up through the floor of the turret, double-link end up. Drape them forward over the booster motor cylinders and sprocket wheels, making



sure the rounds rest evenly in the sprockets. Then twist the belts slightly and curve them up over the feed chutes to the guns' feedways. Just before the takeoff, press the first links of each belt into its feedway, and the guns are ready to be charged and fired.

Pre-flight Routine

. . . follow it step by step

1. Install the guns' barrel and oil buffer groups —leaving out the bolts and backplates.
2. Check harmonization of the guns and sight by boresighting on some small object 1,000 or more yards away, or on a pattern stand.
3. While harmonizing the guns, make sure the manual system is working properly.
4. Make sure the gun bolts are assembled properly, to feed from the right in the left gun and from the left in the right gun. Also make sure that the square ends of the sear slides face the outside of the guns. Then install the bolts and backplates in both guns. Replace the gun access plates.
5. Try to rock the guns in their cradles to make sure they are securely mounted. Check to make sure that the front and rear trunnion mounting studs and bolts are safety wired.
6. Check the hand charging units on the inside of the guns and the foot-firing mechanisms on the outside of the guns to make sure they are securely attached and their mounting bolts safety wired. The cable connections to the charging units must have cotter pins.
7. Inspect the hydraulic system and lines. If there are any excessive leaks, report them.
8. Inspect the electric cables. Make sure all cannon plug connections are tight. Report any frayed or damaged cables.
9. Check the oxygen connections.
10. Make sure the plexiglas dome and bulletproof glass are clean.
11. Check the hydraulic fluid level gage on the reservoir in the actuator unit mounted on the fuselage wall. If the oil is below the FULL line, notify turret maintenance.
12. Turn on the main power switch on the fuselage wall. Listen for the hum of the electric motor in the actuator unit, and watch the pressure switch in the unit to see that it is working properly.
13. Open the turret doors. Look in and make sure the main shutoff valve, azimuth emergency release valve, and elevation bypass valve are closed. Then get in the turret.
14. Turn on the sight switch and rotate the sight rheostat from dim to bright to adjust the brightness of the light and make sure the rheostat is working properly. Flip the sight filament switch to both positions. If either filament is burned out, replace the bulb. Make sure the optic head is clean.
15. Turn on your trigger switch. Check headspace in the guns. Then pull one trigger at a time, charging the guns each time, and check electric triggers for proper adjustment—listen for a "click" as the firing pins of the guns release. Both guns should fire from either trigger.
16. Turn on the booster motor switch. Test the

booster motors by tilting the boosters toward the guns. Make sure the motors cut on and off sharply, without lag.

17. Turn off the trigger switch and test the foot-firing system by opening the foot-firing mechanism lock and stepping on the foot-firing pedals. Listen for a click as the plungers operate the guns' sear slides.
18. Remove the azimuth and elevation mechanism locks from the shafts and place in their clips. Make sure these locks are removed before trying to run the turret.
19. Open the main shutoff valve, turn on the power switch, and run the turret under power in azimuth and elevation, to check on ease of operation. Make sure the turret operates with either safety switch held down. Run the turret as far to the left and right as it will go to make sure the limit stops halt the guns before striking the plane. Stop the turret and check for creep.
20. Put on your oxygen mask, connect it, and test by turning on the direct flow valve. Check the gage to make sure there is proper pressure, in the tanks, as determined by your crew chief. Close valve.
21. Plug in your headphones and microphone to test whether your crew mates can hear you and you can hear them.
22. Plug in and test your heated suit and the rheostat.
23. Make sure your trouble light operates. Pull the light out on its cord to make sure the retractable reel is working properly.
24. Check operation of the warning bell by having the pilot ring it from his position.
25. Close all valves, turn off all switches, and get out of the turret.
26. Inspect the ammunition belts to make sure the rounds are in good condition and properly belted.
27. Load both ammunition cans. Feed the belt through the flexible guides; pull them up through the chutes in the turret, over the booster sprockets, and press the first rounds into the guns' feedways.
28. Make a last visual check of the turret.
29. Move the turret by hand crank into stowing position—guns pointing straight back and raised two-thirds of the way between level and straight up. Replace the azimuth and elevation mechanism locks on their shafts in locked position, get out and close the turret doors—ready for the takeoff.

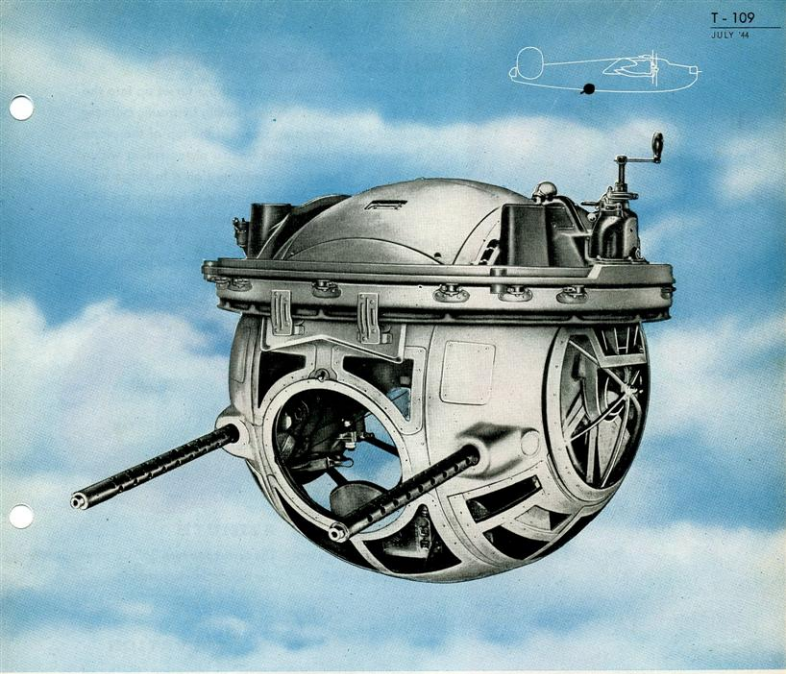
Post-Flight

Before Landing

1. Clear guns by opening the gun covers and hand charging the guns twice. Remove ammunition from feedways and upper chutes.
2. Run the turret to stowing position.
3. Close the main shutoff valve and turn off the switches. Replace both mechanism locks.
4. Get out of the turret and fasten the doors.
5. Turn off the main power switch.

After Landing

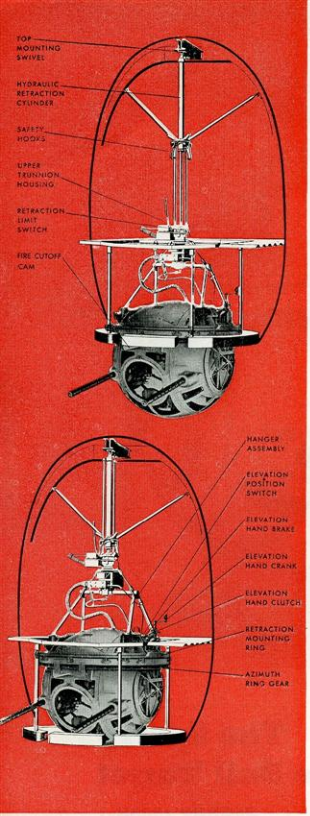
1. Remove all ammunition from the flexible guides and ammunition cans.
2. Remove gun access plates and field strip guns.
3. Clean the gun casing groups, inspecting their condition as outlined in post-flight checks in the Guns section of this manual.
4. Then detail strip the parts removed from the guns, cleaning and inspecting them as outlined in the Guns section.
5. Report any malfunctions of turret or guns noted on the mission.



The Sperry Retractable Ball Turret

SPERRY 250SH-1

The Sperry Lower Retractable Ball mounted in the belly of the PB4Y-1, is the deadly and efficient defender of the bomber's once soft underside. It was built especially for the PB4Y-1 whose ground clearance calls for a ball turret that can be kept out of the way on takeoffs and landings. Its guns sweep in a full circle and offer protection from any fighter who dips below the bomber's level. Its sight, the Sperry K-4, computes deflections automatically even when the gunner, swinging around below the plane, is unable to tell exactly which way he is facing.



FACTS AND FIGURES

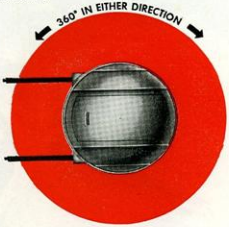
The retractable mechanism to pull the turret up into the belly of the bomber is simple. The big hydraulic cylinder is secured to a supporting beam in the top of the plane and the turret is suspended from a piston riding within the cylinder. A hand pump mounted on a fuselage wall supplies hydraulic pressure to force the piston up and raise the turret, which can be locked in place with safety hooks on the upper trunnion housing. A valve on the fuselage releases the hydraulic pressure and permits the piston and turret to slide down.

POWER

The Sperry Lower Ball operates hydraulically on pressure built up by a hydraulic pump driven by constant speed electric motor.

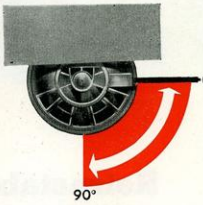
SIGHT

Its sight is the K-4 Sperry automatic computing sight, described in the Sights and Sighting section of this manual.



AZIMUTH

The turret can turn 360 degrees —a full circle—in azimuth.



ELEVATION

In elevation, the turret guns can be lowered and raised from level (0 degrees) to straight down (—90 degrees).

ARMOR

An armor plate panel forms the bottom of the seat and extends up to the hinge of the door, protecting the gunner's trunk in battle position.

STOWING POSITION

The stowing position for the turret and guns after they have been retracted is 180 degrees azimuth and —22 degrees elevation.

Getting In

To start getting acquainted with the Sperry Ball, get in. You will have to be careful—men have been injured and even killed because they did not know the right way to get in, or were careless about it. The turret ball is heavy and yet delicately balanced; unless it is locked in place, it may swivel and break a man's leg or snap him almost in two as he attempts to enter.

Remember also, as you step into the turret for the first time, that on combat missions you will never get in until your bomber is in full flight, and will always get out before the landing. The ball turret, hanging down beneath the plane, is no place to be when the bomber is moving along the ground. As you get in, take these steps carefully and in proper order. If you go about it right, getting into the turret is as safe as climbing into a rocking chair.

1
Be sure the elevation hand clutch is in the *IN* position. Remove the elevation hand crank from its clip on the outside of the turret. Slip it on the elevation hand control shaft.

2
Loosen the elevation hand brake—a small lever beside the elevation hand control shaft.

3
Keep your left hand firmly on the hand crank. Take the outside elevation power clutch handle from its clip, put it on the outside elevation power clutch shaft, and move it to the *OUT* position. This disengages the elevation power gearing, allowing free up and down movement of the turret. Unless you keep a tight hold on the hand crank, the weight of the guns will spin the turret down.

4
By turning the elevation hand crank with your left hand, move the turret until the guns are pointing straight down at —90 degrees. This will bring the turret into position so that you can open the entrance door.

5
Keep your grip on the hand crank. Unfasten and lift the door. **Don't let the door fall back.** To prevent springing the hinge, never put excess weight on the door.

6

Still keep your grip on the hand crank. Reach down inside the turret, forward and behind the big elevation gear housing on the left, and move the inside elevation power clutch lever up to engage it. You will have to rock the elevation hand crank back and forth as you push the clutch in place. This re-engages the elevation power gearing, locking the turret firmly in gear.

7

Move the outside elevation hand clutch to *OUT*. Remove the hand crank and outside power clutch handle and replace in their clips.

8

Close the turret entrance door and prepare to lower the turret by closing the hydraulic valve.

9

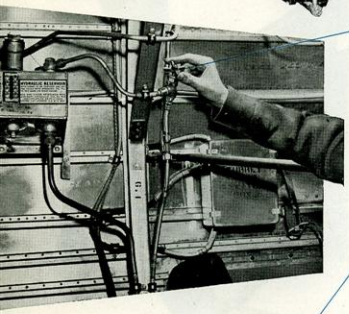
Work the hand pump to lift the turret just enough to release the safety hooks.

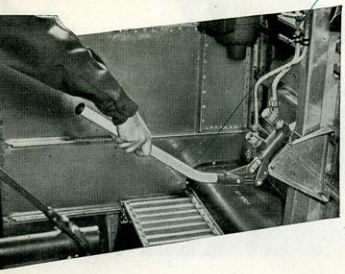
10

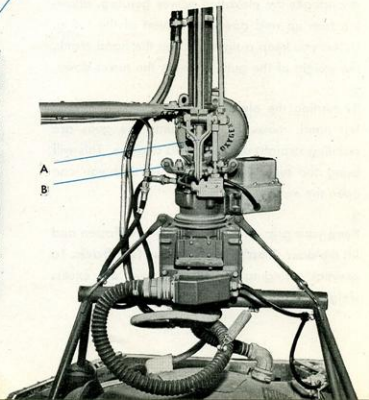
Open the safety hooks (A) to disengage them from the upper trunnion housing (B).

11

Open the hydraulic valve slowly, letting the turret ease down. Don't open the valve too fast.







12

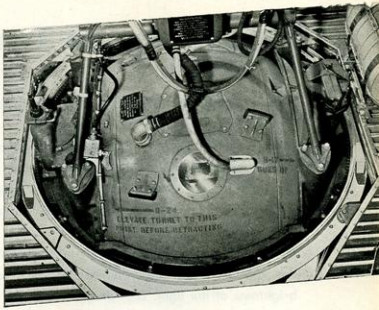
Make sure that the turret is properly seated at its lowest position. Tapered bushings, mounted on the azimuth ring of the turret, should sit squarely in holes provided for them in the plane's floor ring. If they don't, jockey the turret until they do.

13

Make sure the master switch on the support beam is o.

14

Open the turret entrance door. Test the turret by grasping the supporting structure and putting your right foot on the seat. Try to work the turret with the pressure of your foot. There should be no movement. If there is movement, the elevation gearing is not engaged.

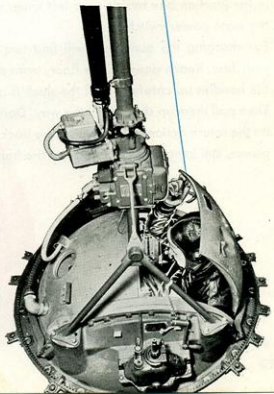


15

Lower yourself into the turret by grasping and swinging down on the support frame. Put your right heel on the right foot rest, then your left heel in the range pedal—being careful not to throw your whole weight on the range pedal.

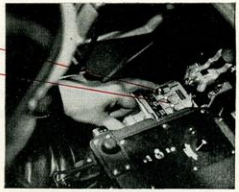
16

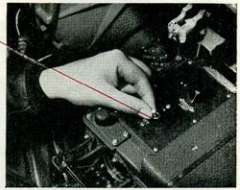
Fasten the safety belt. Close and fasten the entrance door. Make sure that the door latches are securely closed. Then you are ready to go.



Operating the Turret . . . Where to Find the Controls . . . How to Use Them

Once you are seated, the controls and switches of the turret are spread before you. Check clutches and turn on the switches in exactly the order shown here.





1 Make sure the **azimuth power clutch** is engaged—the lever at the upper right should be down.

2 Flip on the **main power switch**—a toggle switch under a wire guard on the junction box beside your left knee.

3 Right beside the power switch are two **gun selector switches** for firing the guns separately or together. Flip both of them on.

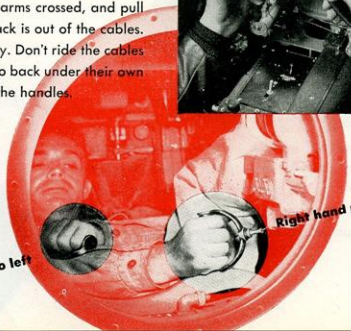
4 Turn on the **sight switch** directly in front of your nose on the sight. Turn the sight rheostat beside it to adjust the brightness of the light. **Never operate the turret under power with the sight switch off.**

5 Finally, grasp the two handgrips. Don't worry about safety switches—the turret has none. But, notice that in azimuth the controls work exactly opposite to all other turrets. To move the turret **right,** swing the handgrips to the left; to turn **left,** swing them to the right. Pull back on them to tilt the turret and guns up, and press forward to turn the turret and guns down. Don't jerk. Steady, smooth tracking is especially important in using the Sperry sight.

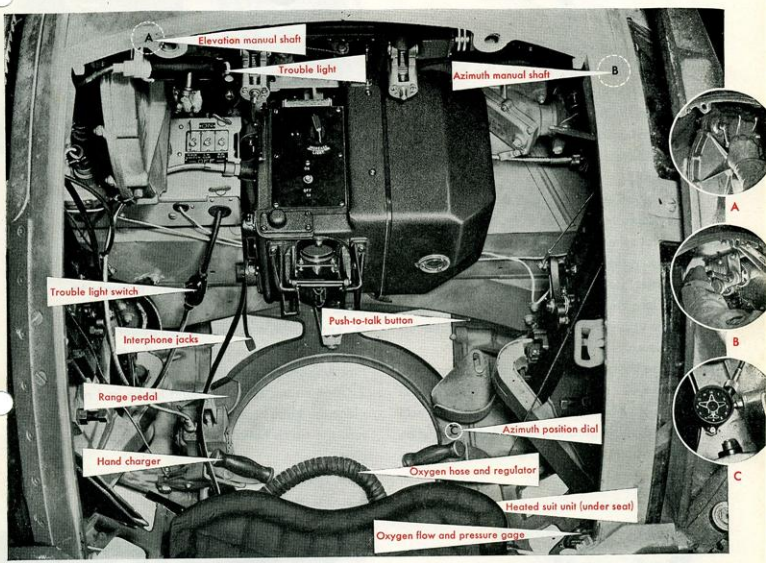
The other controls you will use in combat are right at hand. On the top of each handgrip, under your thumbs, are **firing buttons,** used instead of triggers on the Sperry Ball.

The fuses which protect the Sperry's electrical circuits are in the junction box beside your left knee, where you found the main power switch.

For charging the guns, you will find two handles next to your feet. Reach down to the floor, arms crossed, and pull the handles up carefully until the slack is out of the cables. Then pull them up sharply all the way. Don't ride the cables on the return action; allow them to go back under their own power, still keeping your hands on the handles.



Using the Auxiliary Units



You will find a demand type regulator with a hose connection for your oxygen mask right under your seat. Alongside your right ear is the flow and pressure gage. The oxygen is drawn from the plane's central tanks in most models. The heated suit plug-in is also under your seat. The interphone jacks for your headphone and throat microphone lead out of the junction box. A trouble light is clamped in a clip just under top rim of the ball to the left of your head. By your right foot is a new azimuth turret position dial, in which a cut-out of your guns rotates upon a clock face and shows you your azimuth position at all times. For manual operation of the turret in emergencies, shafts designed for use with removable hand cranks are on the right and left side of the turret—right for azimuth, left for elevation. The hand cranks are stored in clips above your head.

To change to manual operation:

1. Turn off the main power switch.
2. Remove the hand cranks from their clips and place them on the shafts.
3. Disengage azimuth and elevation clutches.

Getting Out

1. To get out of the turret, drive it to—90 degrees in elevation, so that the guns point straight down; this will bring the doorway into place in the floor of the bomber. At the same time, drive the turret to 180 degrees in azimuth—six o'clock on your azimuth turret position dial.

Turn off all switches. Open the door and step out. Close the entrance door.

2. Close the hydraulic valve.

3. Using the hand pump raise the turret until the safety hooks can be closed.

4. Close the hooks. They must catch the flange on the upper trunnion housing to hold the turret securely.

5. Use the elevation hand crank to crank the guns to —22 degrees elevation. (The turret will already be at 180 degrees azimuth.) You will know that the guns are at —22 degrees when the elevation switch cam, a raised metal plate

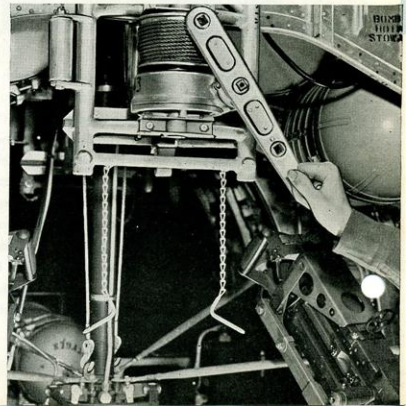
fastened to the upper curve on the ball, moves up as you turn the ball in elevation, and presses against the elevation retraction position switch, throwing it on. This switch flashes a light in the pilot's compartment to tell him when the ball turret is retracted and the plane is ready to land.

6. Engage the outside elevation power clutch, using the handle in the clip on the trunnion ring support. Replace the handle in the clip.

7. Tighten the elevation hand brake and replace the hand crank in its clip. Always make sure the clutch handle and crank are in their clips.

Emergency Retraction

Don't worry about the possibility that the hydraulic retraction gear might get out of order in flight—if it does, you can still raise the turret by means of the plane's bomb hoists. These hoists are two winch, cable, and pulley units mounted on the top structure of the plane on either side of the turret position. Use them only in an emergency when the retracting mechanism won't work.



1

Run the guns to 180 degrees azimuth and —90 degrees elevation and get out of the turret.

2

Unwind the winch cables and feed them over their opposite pulleys—the rear winch cable over the front pulley, the front cable over the rear pulley. Hook the ends of the cables into the top of the turret hanger assembly.

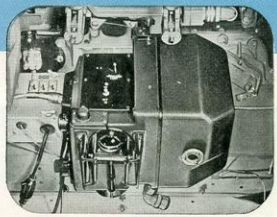
3

With the assistance of one of your crew mates, crank both winches at the same time, evenly and slowly, until the turret is raised enough for the retraction safety hooks to catch and support the turret. Close the safety hooks. Then crank the guns up into their stowing position—about –22 degrees elevation—just as you do after normal retraction of the ball.

Preparing the Turret for Combat

With the working information contained in the preceding pages—and sufficient practice tracking with the Sperry sight—you could easily take over the Sperry Ball in combat. If you specialize in this turret, however, that will be only part of your job.

The rest of your job—adjusting sight and guns and loading ammunition for a mission—is explained in the following pages.



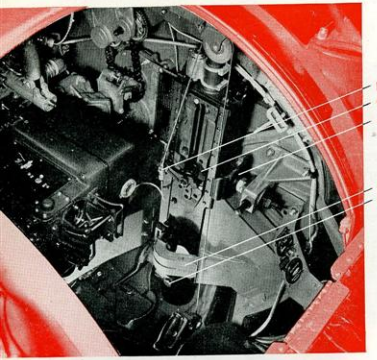
The Sight

The K-4 is an upsidedown type of automatic computing sight built especially for the Sperry Ball. Held by a single long mounting pin, it hangs down from the sight cradle on a level with your head. Connected to the sight are three flexible shafts which bring it the turret movement and range data needed for computing deflections. The upper shaft entering the top rear of the sight revolves as the turret moves in azimuth. The lower shaft at the top rear revolves as the turret moves in elevation. The third shaft, on the left side, leads to the range pedal, which you move with your left foot to frame the target in the sight reticles.

Adjusting the Guns

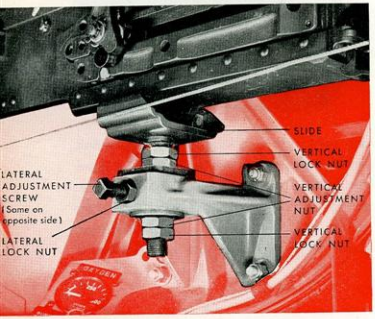
The guns are mounted in the Sperry Ball to feed from the outside—the right gun feeds from the right and the left gun from the left.

The guns are held in their cradles by a rear trunnion block and slide (A) and two front trunnion studs (B). The rear trunnion block, attached to the rear mounting holes of the gun, dovetails into the rear trunnion slide—merely check it to make sure that it rides snugly in the slide. The front trunnion studs, which screw into the front mounting yoke of the cradle and into threaded holes in both sides of the gun adapters, must be safely wired.



Special charging units (C) are installed on the inside plates of the guns, with mounting bolts which must be safety wired. The cable connection to each unit must have a cotter pin (D). Special link ejection chutes (E) are installed on the inside of the guns, where they are held by the guns' belt feed pawl pins and cotter pins.

The guns can be adjusted up, down, or sideways in their cradles by using an adjustment screw and bolt assembly provided on each rear trunnion.



To make the adjustments:

1

Loosen the vertical lock nuts and adjustment nuts.

2

Loosen the lateral lock nuts.

3

Turn the lateral adjustment screws on each side of the mount right or left to move the back of the gun from side to side.

4

Turn the vertical adjustment nuts right or left to raise or lower the back of the gun.

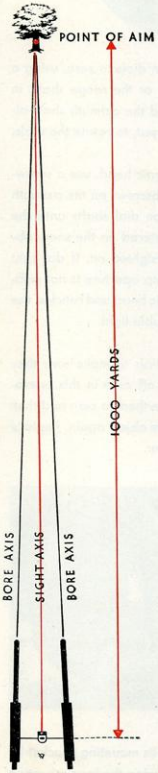
5

When the gun is in its proper position, tighten all lock nuts.

By means of these adjustments the guns can be centered in their mounts.

To center them you will have to move the adjustment screws and nuts back and forth until you find the approximate center of both the lateral and vertical adjustment movements. With practice, you will be able to center a gun quickly and with little error.

Harmonizing the Guns and Sight



There are a number of ways to harmonize the Sperry Ball's guns and sight. Because of the Ball's computing sight and compact construction, they are more complicated than the procedures for other turrets. In all cases the sight must be removed and re-installed in the turret to do a good job.

The handiest method for gunners is to boresight the guns and line up the sight on some small object, such as a tree or a chimney, at least 1,000 yards from your plane. This is known as the field, or distant object, method of harmonization.

First move the guns to zero elevation. Get out of the plane, remove both gun access plates from the ball, and the backplates and bolts from both guns. (Or you can use a boresight reflector to enable you to sight through the barrels without removing the parts.) Open the turret door.

Then center one gun in its mount, as directed on the preceding page—and you are ready.

1

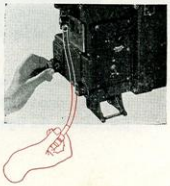
Disengage the azimuth and elevation power clutches. Line up the centered gun on the object selected, using the handcranks to move the turret until the object is exactly in the center of the gun bore. Then lock the turret in this position by re-engaging the azimuth and elevation power clutches.

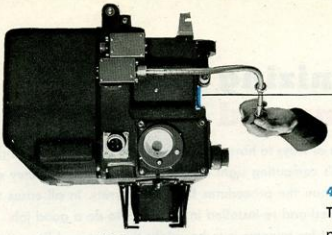
2

Line up the other gun on the same object by turning its vertical and lateral adjustment screws and nuts. Don't move the turret as you do this. When you have the object exactly in the center of the gun bore, tighten all lock nuts.

3

Disconnect the electric cable and all flexible shafts at the sight—except the azimuth rate shaft, which can be disconnected more easily from the turret gearing, leaving it attached at the sight. Remove the lamp and slip out the deflection dial cover. Then set the target dimension dial on the sight at 20 feet and the range dial at 1,000 yards, using a flexible shaft to rotate the range dial.





4

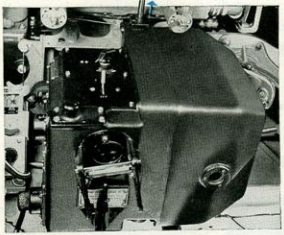
Then set both deflection dials to zero, using a piece of flexible shaft, or the range shaft, in the elevation input, and the azimuth shaft already in the azimuth input, to rotate the dials.

5

Sighting through the optic head, use a screwdriver to turn the thumbscrews on the azimuth and elevation deflection dial shafts until the reticles are exactly centered on the same object the guns are boresighted on. If daylight shining through the lamp aperture is not sufficient to light up the optic head and reticles, use a flashlight or your trouble light.

6

Check the deflection dials to make sure they have not been moved off zero in this operation. If they have, return them to zero and then center the reticles on the object again. Replace the deflection dial cover.



7

Move the turret by handcrank to zero azimuth and zero elevation and lock by reengaging the azimuth and elevation power clutches.

8

Remove the sight from its mounting bracket by unlocking and withdrawing the long mounting pin. Handle the sight carefully.

9

Set the azimuth and elevation position dials to zero, using the azimuth shaft to rotate the azimuth dial and a piece of flexible shaft to turn the elevation dial.

10

Connect the electric cable and install the sight in the turret.

11

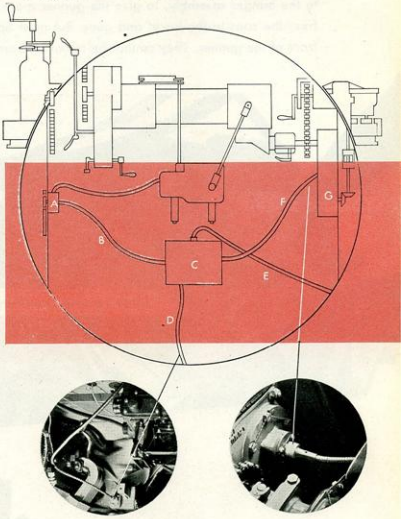
Connect the elevation shaft to the elevation input on the sight—and the azimuth shaft, which was left connected to the sight, to the turret. Make sure you do not move the azimuth and elevation dials off zero in doing this, and make certain all connections are secure.

12

Connect the range shaft to the sight's range input and disconnect it from the range pedal. Rotating the shaft with your fingers, turn the range dial as far past zero as it will go, then back it off a quarter turn of the flexible shaft. With the range pedal all the way up, connect the range shaft to the range pedal again.

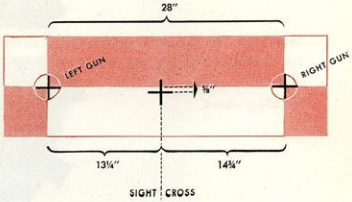
Flexible Shaft Connections

A Elevation gear unit
B Elevation rate input shaft
C Sight
D Range shaft to range pedal
E Electric cable
F Azimuth rate input shaft
G Azimuth gear unit



Another method

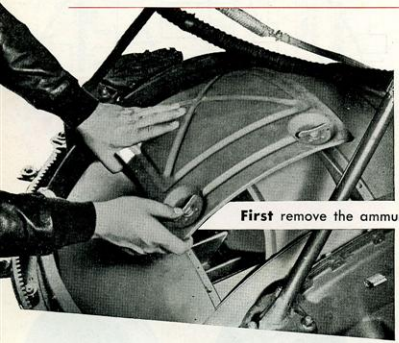
Another method of harmonizing the Sperry Ball is to line up the guns and sight on a special pattern stand, such as the one illustrated here. Set up the stand as level as possible at least 50 yards from the plane. Then boresight each gun on the pattern and line up the sight on the sight cross, using the same procedure as outlined above.



Loading Ammunition

Two ammunition cans, which are a permanent part of the turret ball, one for each gun, hold approximately 500 rounds of belted ammunition apiece.

In some late modifications of the turret the ammunition cans are placed outside the turret, mounted to the hanger assembly, to give the gunner more room; flexible chutes carry the ammunition belts from the cans to the turret and guns. But most Sperry Ball turrets still have cans installed right in front of the gunner. They cannot be removed from the turret and must be loaded from the outside.



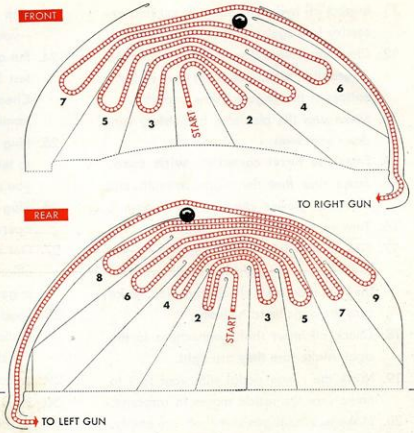
The method:

First remove the ammunition can cover—a plate in the turret surface held by four Dzus fasteners, or by two cover latch screws in later models.

Note that the cans are equipped with baffle plates to insure positive feeding and to keep the ammunition from tumbling about.

Start with the single-link end of the belt first, so that the double-link end will feed up into the gun, and fold the belts into the cans in the pattern shown in the diagram. Force the belts down through the chutes to the guns. By putting pressure on the ammunition in the chute, the first round will move into the feedway, over the belt holding pawl.

Caution: Fasten the ammunition can cover securely after loading.



Preflight Routine ... follow it step by step

(The plane should be over a testing pit to allow normal movement of guns.)

1. Install the guns' barrel and oil buffer groups —leaving out bolts and backplates.
2. Check harmonization of sight and guns by boresighting on an object at least 1,000 yards from the plane, or a pattern stand.
3. While harmonizing the guns, make sure the manual system is working properly.
4. Make sure the gun bolts are assembled properly, to feed from the right in the right gun and from the left in the left gun. Then install bolts and backplates in both guns.
5. Try to rock the guns in their cradles to make sure their mounts are secure. Check to make sure the rear trunnion blocks fit securely in the rear trunnion slides, and that the front trunnion studs are safety wired.
6. Make sure the bolts mounting the charging units to the inside of the guns are safety wired and cable connections have cotter pins.
7. Inspect the electric cables. Make sure all cannon plug connections are tight. Report any frayed or damaged cables.
8. Make a visual check of the fuses in the junction box, using your trouble light. If any are burned out, have them replaced. (The spare fuses carried in the spare parts box should be saved for combat emergency.)
9. At the same time, check your trouble light. Turn on the switch and make sure the bulb is bright.
10. Check oxygen and interphone connections in the turret.

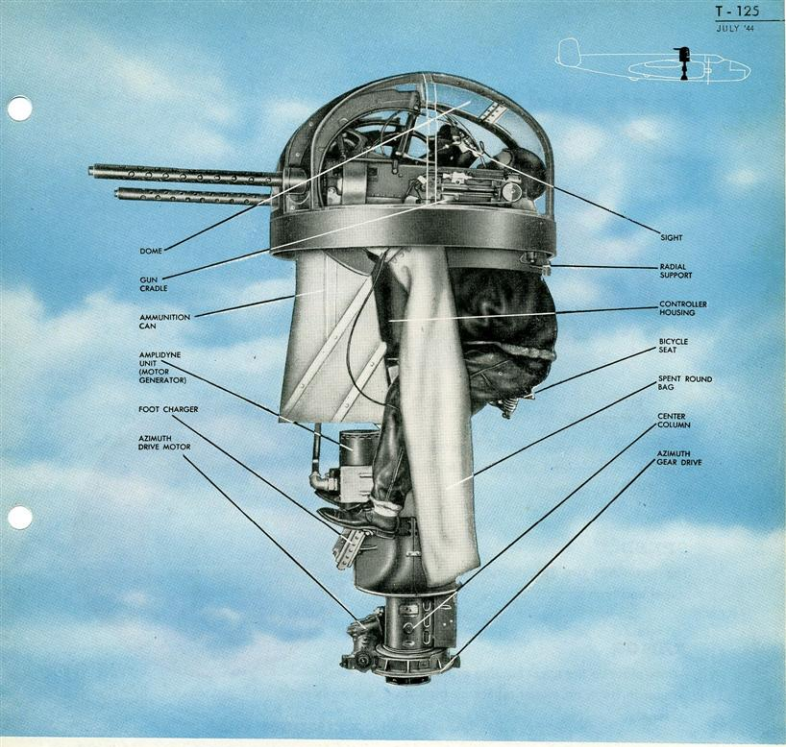
11. Inspect all hydraulic lines. If you find excessive leakage, report it immediately.
12. Check the round gage on the side of the oil breather tank. If oil is not level with the bottom of the gage window, report it.
13. Make sure the plexiglas and safety windows are clean.
14. Enter the turret correctly—**with care.**
15. Make sure that the inside azimuth and elevation power clutches are engaged.
16. Turn on the main power switch.
17. Flip on the sight switch. The sight motor should start, the sight bulb light up. Turn the sight rheostat to check operation. Make sure the optic head is clean.
18. Check all input shaft connections to the sight. Make sure they are tight.
19. Work the range pedal with your foot to make sure the reticle moves in response.
20. Make sure both gun chambers are empty. Then turn on both gun selector switches. Check the guns' headspace. Pull one trigger at a time, charging the guns each time, and check the Electric Triggers for proper adjustment—listen for a "click" as the firing pins of the guns release.
21. Turn off right gun selector switch, and make sure either trigger operates the left gun's Electric Trigger. Then turn on right gun selector switch and turn off left gun selector switch. Make sure that each trigger sets off the right gun's Electric Trigger.
22. Run the turret under power in azimuth and elevation, to check on ease of operation. Run the guns up to the fuselage to make sure the limit stops are working. Then stop the turret and check for creep.
23. Check the fire cutoff system by swinging the guns on the propeller and antenna loop areas of the plane and attempting to fire. Make sure the guns cease firing with the proper amount of safety margin—your crew chief will tell you how much.
24. Put on your oxygen mask, connect it, and test by turning on the direct flow valve. Check gage for proper pressure, as determined by your crew chief. *Close valve.*
25. Plug in your headphones and microphone to test whether your crew mates can hear you and you can hear them.
26. Plug in and test your heated suit and operation of the rheostat.
27. Get out of the turret and inspect ammunition belts to make sure the rounds are in good condition and properly belted.
28. Load both ammunition cans and feed the double-link end of the belts down through the chutes into the feedways of the guns.
29. Make a last visual check of the turret.
30. From outside, move the turret to stowing position so that it is ready for the takeoff.

Before Landing

1. Clear the guns by opening the gun covers and then hand charging the guns twice.
2. Run the turret to 180 degrees azimuth and —90 degrees elevation. Turn off all switches. Then get out and retract the turret up to stowing position for landing.

Post-Flight

1. Remove the ammunition can cover and clear all ammunition from cans and chutes.
2. Field strip the guns.
3. Clean the gun casing groups, inspecting their parts as outlined under the post-flight check in the Guns section of this manual.
4. Then detail strip the parts removed from the guns, cleaning and inspecting them as outlined in the Guns section.
5. Report any malfunctions of turret or guns noted on the mission.



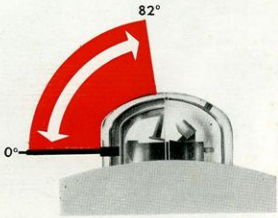
THE BENDIX UPPER DECK

BENDIX 250CE-3 & 4

The Bendix Upper Deck Turret is an all electric turret used exclusively in the PBJ Mitchell bomber where it protects the upper area of the plane.

There are two basic models: the Bendix 250CE-3 and the Bendix 250CE-4. The Bendix 250CE-3, used only on early models of the PBJ, is mounted just back of midship. When waist guns were introduced to the PBJ, the Bendix 250CE-4 was designed for mounting just aft of the pilot's compartment. The two models are essentially alike. The description of the Bendix 250CE-4 in the following pages will also enable you to operate the Bendix 250CE-3.

Facts and Figures



POWER

The Bendix Upper operates electrically on power supplied by the bomber's central system.

SIGHT

Its sight is the N-6A or N-8 optical, fully described in the Sights and Sighting section of this manual.

ELEVATION

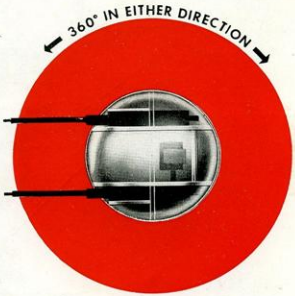
In elevation, the turret can be lowered and raised from horizontal (0 degrees) to almost straight up (82 degrees).

SPEED

The turret has two speeds—normal tracking speed and high speed.

ARMOR

Armor plate on the turret housing protects the gunner in front, no matter where he aims his guns.



AZIMUTH

The turret can move 360 degrees—a full circle—in azimuth.

STOWING POSITION

The stowing position is 0 degrees elevation and 180 degrees azimuth—guns level and pointing straight back toward the tail.

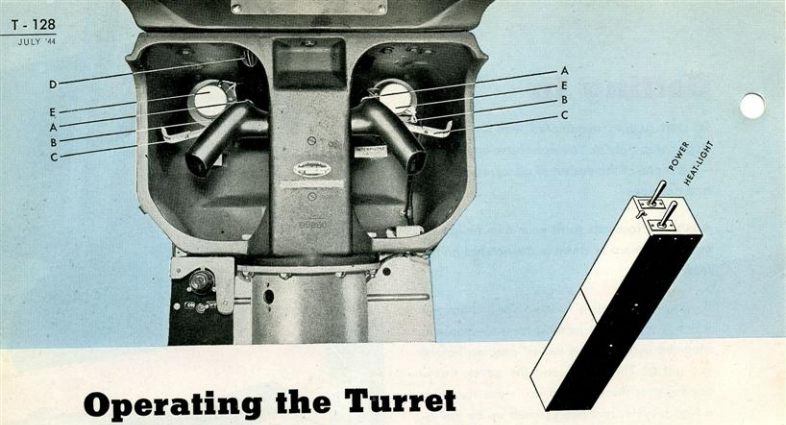
Getting In

To start getting acquainted with the Bendix Upper, step right in. You won't have any trouble —this is one of the easiest of all turrets to enter and operate.

Adjust the footrests to fit your own height by moving them up or down in the notches on the foot slide.

If you prefer—and a few trials will show you if this is the easiest method for you—you can snap the seat up to its locked position before you get in. Then stoop into the turret, throw one leg over the seat as if you were mounting a high bicycle, and pull yourself up by the inner turret supports.

Or you can leave the seat down, step up on the footrests, pull yourself up by grasping the inner turret supports, brace one elbow over one of the supports, and with your free hand pull up the seat to its locked position beneath you. When you are seated, your eye should be level with the sight. If not, adjust the height of the seat by turning the small handle and swivel on the right side of the seat support, loosening the band that holds the seat to the central column. Slide the seat up or down on the column until you have it just where you want it. Then reverse the handle, tightening the seat in place, and you are **ready to go.**



Operating the Turret

. . . where to find the controls
. . . how to use them

You can get the turret into action about as quickly as you could start an automobile on a warm summer day. First reach outside the turret to the left wall of the fuselage; there you will find a long, narrow box with two switches mounted on it. One is the **main power switch;** turn this one on first. Then flip on the **heat-light switch** right beside it, which shoots power to the sight bulb, trouble light, and heated suit unit.

Use the **sight rheostat** (D), on the controller housing just above the left handle, to adjust the brightness of your sight bulb to outdoor lighting conditions.

Then grasp the control handles so that the bottom edges of your hands press down the two **safety switches** (C). As long as either one of these switches is held down, the turret is ready to operate. With the switches up, the turret won't move.

Turn the handles just as you would steer a bicycle—to the right to go right, left to go left. Press down on the heels of the handles to raise the guns. Pull up on them to lower the guns. Move the controls smoothly and deliberately, and you will be able to track any target closely and with deadly aim.

The other controls you will need in combat are practically at your fingertips.

Right under your index fingers on both control handles are the **triggers** (B).

On top of each handle, by your thumbs, are the **high speed buttons** (A) that give you extra speed for changing quickly from one target to another.

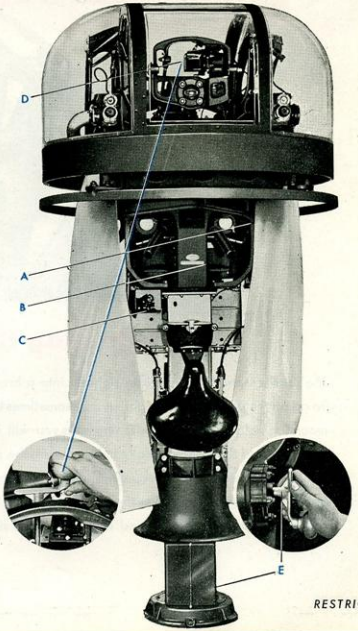
In front of your hands at the back of the controller housing are two shiny metal disks that are your **push-to-talk buttons** (E). Pressure on either disk opens the interphone system for you to speak.

The **charging units** are your footrests. To charge the guns, draw the footrests up as far as they will go in their slides with the toe of your shoe, then step down on them sharply.

Using the Auxiliary Units

Because the Bendix is used only in the PBJ, a low-level bomber, it has no oxygen system. But it has all the other standard auxiliary units. The heated suit plug-in (A) is mounted on the right side of the controller housing. The interphone jacks (B), for connecting your earphones and throat microphone, lead right out of the controller housing. The interphone selector switch is mounted on the fuselage near your turret. The trouble light (C) is on the front lefthand corner of the controller housing.

The Bendix Upper's manual system can be used only for moving the turret to make repairs and adjustments: it is not designed for operating the turret in combat emergencies. A single crank with a flexible shaft, stored at the base of the turret, is used to move the turret in either azimuth or elevation. To move the guns up or down, put the crank on the elevation shaft (D) in front of the sight cradle. To rotate the turret, you will have to get down in the turret and put the crank on the pinion shaft (E) in the azimuth gearing at the base of the main support column.



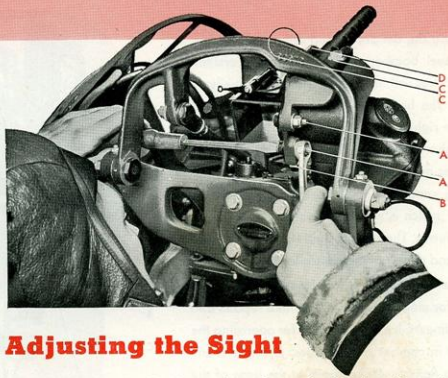
Getting Out

Before leaving the turret, move it to stowing position—guns pointing straight back toward the tail. Turn off all the switches. Then slide down off the seat and back out of the turret. Once you are out, unlatch and stow the seat.

Preparing the Turret for Combat

The preceding pages have illustrated how to get into the Bendix Upper, operate it, and how to get out again. With this information, you could easily take over the turret in combat.

If you specialize in the Bendix, however, you will have to adjust the sight and guns for a mission, and load ammunition. The method of getting the turret ready for action is explained on the following pages.



Adjusting the Sight

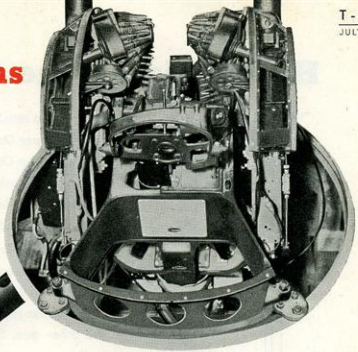
The Bendix Upper's N-8 or N-6A sight fits into a bracket in the sight cradle directly in front of you. To adjust the position of the sight, as may sometimes be necessary in harmonizing the guns, loosen the mounting bolts and turn the adjusting bolts you will find nearby. The two mounting bolts directly in front (A) hold the sight vertically in its bracket; the adjusting bolt (B) directly beneath them moves the sight up or down. The two mounting bolts at the top (C) hold the sight in place laterally; the adjusting bolt (D) in front of them moves the sight from side to side.

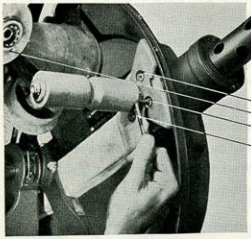
For full instructions on care and checking of the sight, see the Sights and Sighting section.

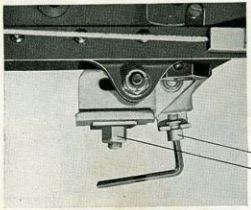
Adjusting the Guns

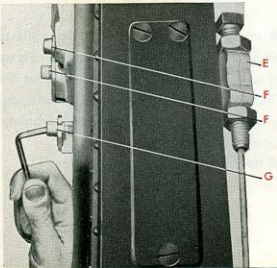
The guns are mounted in the Bendix Upper to feed from the inside—the right gun feeds from the left and the left gun from the right.

Each gun is held in its cradle by a front gun yoke and rear bracket. The front is held by two studs that must be safety wired. A recoil guide stud, bolted to the rear of the gun, fits into a hole in the rear mounting bracket, held underneath by an elastic stop nut.









Special charging units (E) operated by your footrests, are mounted on the outside of the guns' receivers; their mounting bolts must be safety wired. Special case ejection chutes are installed on the outside of the guns to carry used links away from the guns; the hollow pins holding the chutes in the guns must have cotter pins. Special ammunition feed rollers (B) are mounted on top of each gun and held by the gun cover pin, which must have a cotter key.

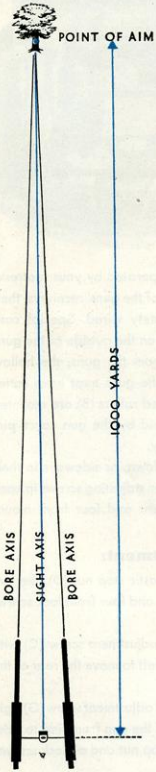
The guns are adjusted up, down, or sideways in their cradles by means of two Allen adjusting screws in each rear mount, held by two rear and four front mount lock screws.

To make the adjustment:

1. Loosen the rear mount elastic stop nut (D), the two rear Allen lock screws (F), and four front lock screws (A) with an Allen wrench.
2. Turn the bottom vertical adjustment screw (C) with the Allen wrench right or left to move the rear of the gun up or down.
3. Turn the inside rear lateral adjustment screw (G) right or left to move the rear of the gun from side to side.
4. Tighten the rear elastic stop nut and all lock screws, front and rear.

By means of these adjustments the guns can be centered in their mounts. Turn the adjustment screws to the centers of their vertical and lateral adjustments.

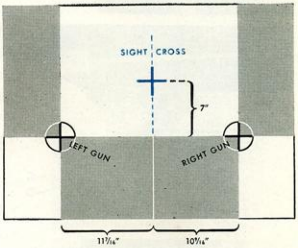
Harmonizing the Guns



There are a number of ways to harmonize the sight and guns in the Bendix Upper Deck Turret. The exact procedure will be defined by the Squadron Gunnery Officer. A handy method is to line up the sight and boresight the guns on some small object such as a tree or chimney, at least 1,000 yards away. You will need an assistant in the turret and a muzzle-type boresight tool to do this.

FIRST, have your assistant move the turret until the dot of the sight is centered on the object. Place the boresight tool in one gun, and have your assistant adjust its rear mount until the same object is exactly centered in the gun bore. Then do the same for the other gun. Sometimes there may not be enough adjustment in the gun mounts. In that case, center the guns in their mounts and boresight each gun on the object. Then move the sight by its adjustment bolts until the dot is on the same object.

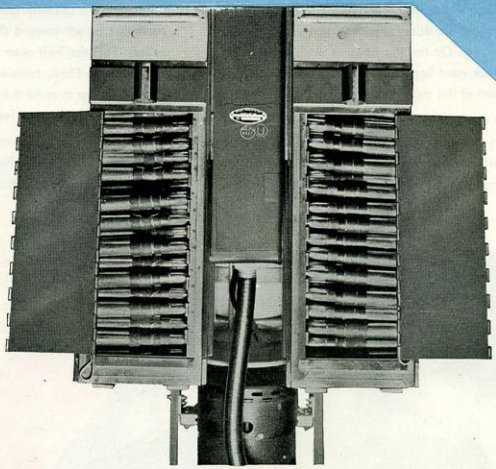
IMPORTANT: Check harmonization by swinging the turret on another small object off to one side, 1,000 yards away, and boresighting to make sure sight and guns all line up on the same object. Select another object and check again. If sight and guns are out of line on any object, call in turret maintenance.



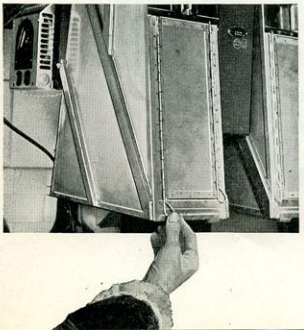
Another method of harmonizing the Bendix Upper is to boresight on a pattern stand, such as the one illustrated here. Set up the stand level with the guns at least 50 yards away. Center the guns in their mounts. Then boresight the guns on the pattern and line up the sight on the sight cross, using the standard technique described in the Sights and Sighting section.

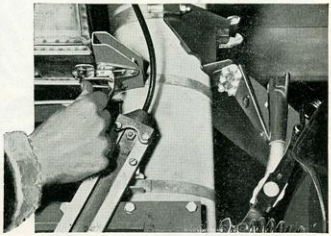
Both methods described here are parallel harmonization.

Loading Ammunition



Two big ammunition cans, one marked for the right gun and the other for the left, hold about 400 rounds apiece. They hook on the inside of the big ring casting circling your head and hang down on either side of the center column. Load them in the standard fold-in pattern, single-link end first, making sure the rounds will point toward the center of the turret when the



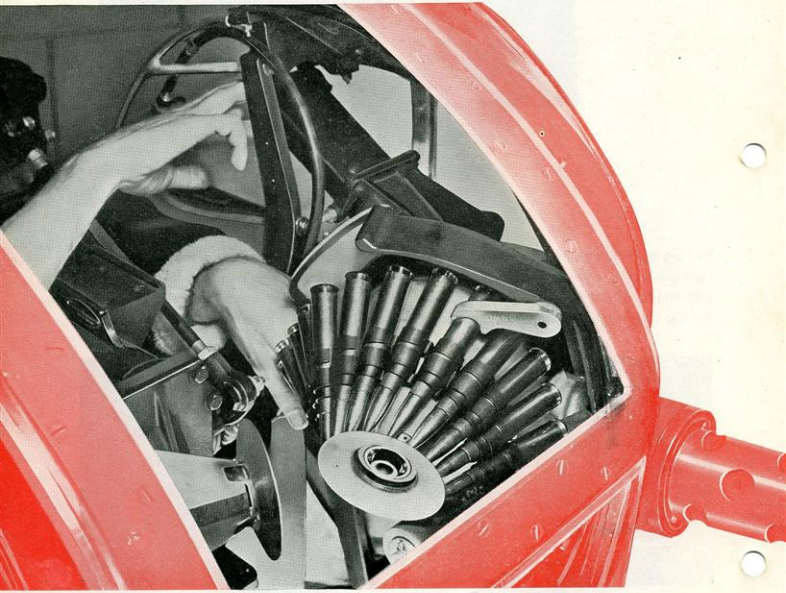


cans are hung up on the inner rim of the turret. Place the loaded cans on the turret floor, right below where they will hang. Then lift each can straight up, using one knee as a support under the can. On the top edge of each can is a bar which must hook into the support hook on the front of the main turret casting.

At the bottom rear of each can is a bar which fits into a bracket on the controller housing, held there by latch pin. Push the pin all the way in, then give it a quarter turn to lock it.

After the cans are securely in place, pull the double-link end of each ammunition belt over the top of the ammunition rollers, keeping the cartridge points toward the small ends of the rollers. Pull the belt over the top of the cone feed rollers. Then, twisting the belts slightly, bring them up around the guide rollers. Force the first rounds into the feedways.

Two spent round bags, to receive used brass ejected from the guns, hook to the mouth of the guns' case ejection chutes.



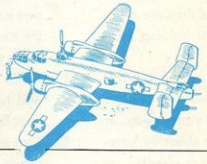
Pre-Flight Routine

. . . Follow Step by Step

1. Make sure the gun bolts are properly assembled, one for left-hand feed in the right gun, the other for right-hand feed in the left gun. Then install the bolt, barrel, oil buffer, and backplate groups in both guns.
2. Try to rock the guns in their cradles to make sure they are securely mounted. Check the front and rear studs and mounting bolts to make sure that they are properly safety wired and tight.
3. Inspect the charging units to make sure that they are securely mounted and safety wired.
4. Inspect the ammunition rollers and case ejection chutes to make sure they are properly mounted and the pins holding them have cotter pins and keys.
5. Check harmonization with a boresight tool by boresighting the sight and guns on some small object at least 1,000 yards away, or on a pattern stand. Double-check by boresighting on two or three other objects.
6. Inspect the electric cables. Make sure all cannon plug connections are tight. Report any frayed or damaged cables. Take particular note of the interphone cable on the right side of the controller housing to make sure it is not loose or frayed.
7. Inspect your ammunition belts to make sure the rounds are in good condition and properly belted.
8. Load the ammunition cans and lift them into place in the turret. Make sure the cans are hooked up securely in front, and the latch pins are locked at the bottom rear of the cans. Open the inspection doors in the front of the cans to see that the ammunition is correctly placed in the cans, with the cartridge points facing toward the center of the turret.
9. Pull the ammunition belts up over the lead rollers, then over the cone rollers, and twist them slightly over the guide rollers leading up to the guns' feedways. Don't insert the first rounds in the feedways as yet.
10. Adjust the footrests, if necessary, and raise the seat if you wish—making sure that the seat is securely latched up in place. Get into the turret.
11. Make sure the dome is clean.
12. Reach out to the left wall of the fuselage and turn on the main power switch and heat-light switch.
13. Turn on the sight rheostat and turn it from dim to bright to adjust the brightness of the light and make sure it is working properly. Flip the sight filament switch to both positions to make sure both filaments in the sight bulb are working. If either filament is burned out, replace the bulb. Make sure the optic head is clean.
14. Make sure there is no ammunition in the gun chambers. Charge the guns by lifting up and stepping down sharply on the footrest. Check the guns' headspace. Then test your triggers by pulling one at a time, charging the guns each time and checking the adjust-

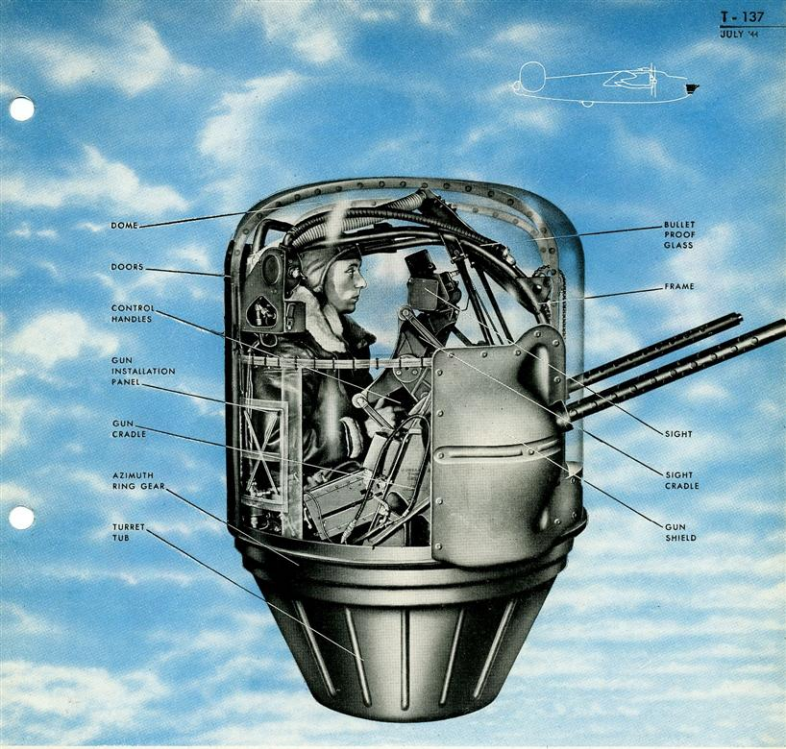
ment of the electric triggers. Listen for a "click" as the firing pins in the guns release. Both guns should fire from either trigger.

15. Run the turret under power in azimuth and elevation at normal speed and then with the high speed button held down, to check on ease of operation. Make sure the turret runs with either safety switch held down. Test the limit stops (called brakes on the Bendix) by attempting to bring the guns down on the fuselage forward and backward. Then stop the turret suddenly and check for creep.
16. Check the fire cutoff system by swinging the turret and guns on the tail and propeller areas of the plane, charging and attempting to fire the guns on each area. Make sure the guns stop firing with the proper amount of safety margin around all sides of the restricted areas—your crew chief will tell you how much.
17. Plug in your headphones and microphone to test whether your crew mates can hear you and you can hear them.
18. Plug in and test your heated suit and the rheostat. Make sure the rheostat controls the amount of heat by turning it to various positions on the dial.
19. Make sure your trouble light operates. Flip on the switch. Pull the light out on its cord all the way to make sure the retractable reel is working properly.
20. Make a final visual check of the turret, inside and out.
21. Just before takeoff, press the first rounds of the ammunition belts into the guns' feedways over the belt holding pawls. In flight, charge both guns on the order of the flight commander.



Post-Flight

1. Run the turret to its stowing position—guns level and pointing straight back on the tail.
2. Clear the guns by opening the gun covers and then charging them twice.
3. Shut off all switches.
4. Remove ammunition from the feedways and all ammunition from the turret.
5. Remove and empty the bags which receive spent rounds and links from the case ejection chutes.
6. Field strip the guns.
7. Clean and inspect the gun casing groups, following the procedure outlined under the post-flight check in the Guns section of this manual.
8. Detail strip the parts removed from the guns, cleaning them and making a thorough check on their condition, as outlined in the Guns section.
9. Report any malfunctions of turret or guns noted on the mission.



THE EMERSON BOW

EMERSON 250CE-1

The Emerson Bow Turret, located in the bow position of a number of PB4Y Liberator bombers, can swing a large cone of fire around the whole forward area of the airplane.

It is a relative of the Consolidated Tail, and has many points of similarity in design and action. If you are acquainted with the Consolidated, you will feel right at home in the Emerson, though its actual operation is quite different. There is one model—the Emerson 250CE-1.

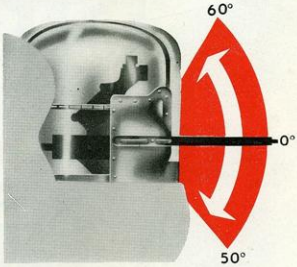
Facts and Figures

POWER

The Emerson is all-electric, operating on power supplied by the bomber's central electrical system.

SIGHT

Its sight is the N-8 or N-6A optical, described in the Sights and Sighting section of this manual.



AZIMUTH

The turret moves in azimuth about 75 degrees to either side of the ship's center line.

SPEED

The turret has two speeds—normal tracking speed and high speed.

ARMOR

A heavy plate of bulletproof glass, which moves up and down with the guns, helps protect the gunner. Below is a large panel of armor plate, ⅝ inch thick in some places and ⅜ inch in others.

ELEVATION

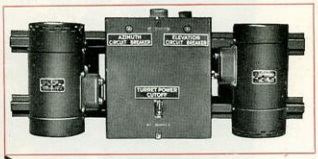
In elevation, the turret guns can be lowered and raised from 50 degrees below the horizontal level to 60 degrees above horizontal.

STOWING POSITION

The stowing position is 0 degrees azimuth and 0 degrees elevation—guns pointing directly forward.

Getting In

As you start getting acquainted with the Emerson Bow Turret, remember first of all that it is no place to be hanging around on takeoffs or landings. Quick changes of speed as the bomber leaves or approaches the ground make the turret a dangerous place at those times. On a mission, always get in after the plane is in full flight and get out before the landing.
You will have to be careful as you step in. The only way to get in is illustrated here.

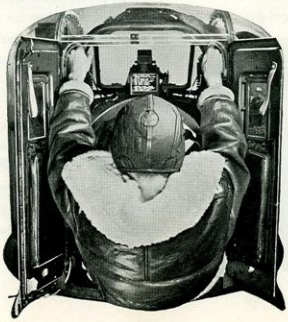


1
First check the power switch mounted outside the turret, on a box which you will find on the fuselage wall just left of the nose wheel. Make sure it is on. (In many planes, the switch is safety wired in the ON position.)

2
Then open the turret doors and look in to check the switch box on the left rear support. Make sure that all the switches are off—so that the turret cannot move and trap you while you are in the doorway.

3
After you are sure the switches are off, grasp the support above the doorway, chin yourself on it, and swing both feet straight into the turret pit. Slide into the seat.

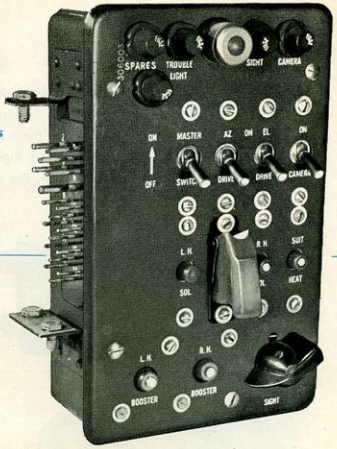
4
Finally, reach back and close the doors behind you. Make sure they are securely latched. Then you are ready to operate the turret.



Operating the Turret

. . . where to find the controls
. . . how to use them

The switch box — now over your left shoulder—holds all the switches to run the turret.



First turn on the **master switch,** then the **azimuth drive switch** right beside it. Wait a few seconds, then turn on the **elevation drive switch.** Just below these three switches is a red plastic cover: under it is the **gun switch,** which must be turned on next. Then turn on the **camera switch,** if you need it. Finally, grasp the control handles in front of you, using the bottom edges of your hands to press down the two safety switches (A). The turret won't operate and the sight won't light up unless at least one of these switches is held down. Hold one handle while reaching back to the switch box to turn the **sight rheostat** to adjust the brilliance of light in the sight. (In some later Emersons, the sight operates independently of the safety switches.)

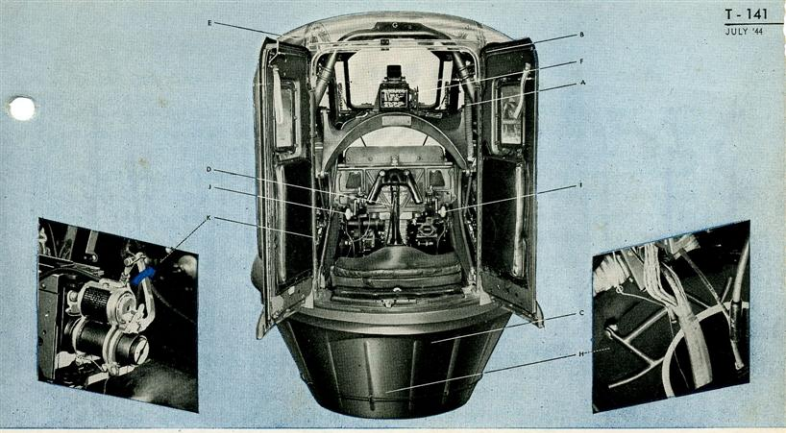
To operate the turret, simply turn the handles as you would steer a bicycle—to the right to go right, left to go left. Press down on the heels of the handles to raise the guns, and pull up on them to lower the guns. Don't jerk the controls. Move them smoothly.

The other controls you will need in combat are right at your fingertips. Right under your index fingers on both handles are the triggers (B). On top of the right handle next to your thumb is the **high speed button** (C) that throws the turret into high speed for changing from one target to another.

On top of the left handle next to your thumb is the **push-to-talk button** (D) that opens the interphone system for you to speak.

Near your knees are charging levers (E) for hand charging the guns. To use them, pull them up sharply, then release them and let them drop back by themselves.

The Emerson has fuses to protect some electrical circuits, reset buttons to protect others. Most of them are on the switch box, with spare fuses in the upper left corner. Reset buttons for the azimuth and elevation power circuits are on the junction box outside the turret.



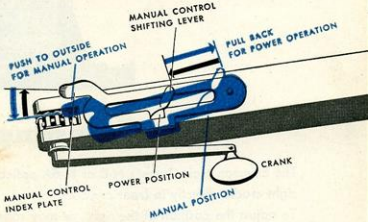
Using the Auxiliary Units

For your oxygen mask, you will find a hose connection leading from a demand type regulator (A) mounted on the support framework near your right shoulder. Alongside is a flow and pressure gage (B). Oxygen is supplied from the bomber's central tanks.

The heated suit plug-in (C) is mounted near your right foot on the wall of the turret tub. Jacks (D) for plugging in your earphones and microphone lead out of the column mounting the control handles. The jack box is outside the turret in the bombardier's compartment.

You will find the trouble light (E) and switch on the top left support tubing, and a gun camera bracket (F) to the right of the sight. At the top of the bulletproof glass is an electric heater (G) to keep the glass clear at low temperatures. The mechanism for operating the turret by hand in emergencies includes a foot-firing pedal (H), which permits you to fire the guns while your hands are occupied.

You will find the azimuth hand crank (I) in a bracket near your left knee, and the elevation hand crank (J) near your right knee.



To shift to manual operation:

1. Turn off all switches.
2. Press the manual control index plates on both hand crank brackets outward to their manual positions.
3. Press down the foot trigger firing keys (K) on each electric trigger.

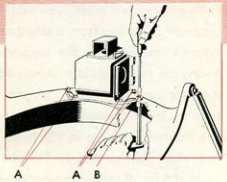
Getting Out

When you are ready to leave the turret, run it to stowing position—guns pointing straight ahead. Then turn off all switches. Open the doors behind you and step out of the turret. Then close the doors and make sure they are securely latched.

The Emerson has a special feature called the **emergency azimuth control,** which enables your crew mates to help you out of the turret in case of accident. By pulling on a cable leading out of the turret, they can disengage the azimuth power system. Then, using a hand crank which is kept in a bracket beneath the door, they can move the turret in azimuth by turning a shaft that sticks out of the bottom of the turret. Thus they can get the turret door into position to open it.

Preparing the Turret for Combat

At this point, you have read how to get into the turret, operate it, and get out. With this information, and practice, you could take over in combat. To be a specialist in the Emerson Nose, you will need additional instructions on how to get the sight and guns ready for a mission, and load the ammunition. You will find this information in the following pages.



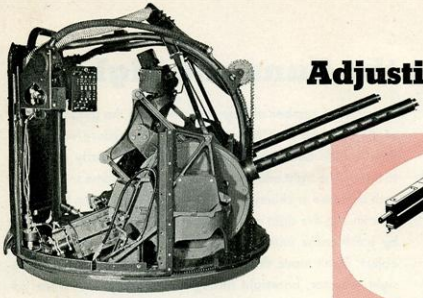
Adjusting the Sight

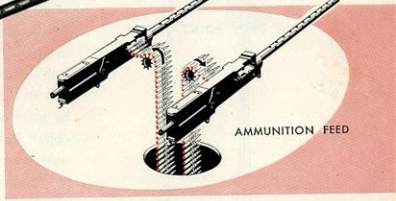
The Emerson Nose Turret's N-8 or N-6A optical sight is held by five mounting bolts on top of the sight cradle directly in front of you.

To adjust the position of the sight, as may sometimes be necessary in harmonizing it with the guns, the bolt at your extreme right serves as an adjusting bolt for moving the sight sideways to left or right. Loosen all the mounting bolts (A), but do not remove them. Then reach under the cradle, loosen the nut which holds the adjusting bolt (B), and move the bolt right or left with a screwdriver. When you have the sight in position, tighten the adjustment nut and all five bolts. No up or down adjustments can be made.

For full instructions on care of the sight and checking it before and after missions, see the Sights and Sighting section of this manual.

Adjusting the Guns





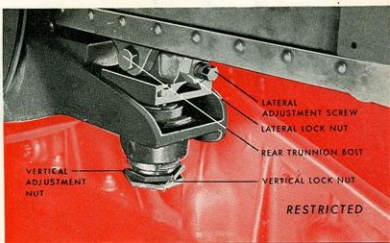
The guns are mounted in the Emerson to feed from the inside—the right gun from the left, the left gun from the right.

Each gun is held in its cradle by a rear mount block and slide, and a front gun mount. The rear mount block, bolted to the rear of the gun, dovetails into the slide in the cradle—simply check to make sure it fits. The front gun mount is a jaw-like affair that snaps over two bearing pins on the gun's adapter, and is locked in place by a gun release handle on the inside of the cradle. This handle, or lever, is safety wired to the gun shield in its up or locked position. Special charging units are mounted on the inside of the guns; their mounting bolts must be safety wired and the cable connections to the units must have cotter pins. Sticking up from each charging unit is a special gun safety latch for holding the bolt in its retracted position after charging—push it down before charging, pull it up when ready to fire. Foot-firing mechanisms, mounted on the buffer tubes of the guns, must have their mounting bolts safety wired. For adjusting the guns up, down, or sideways in their cradles, the rear mounts have bolt and screw adjustment assemblies.

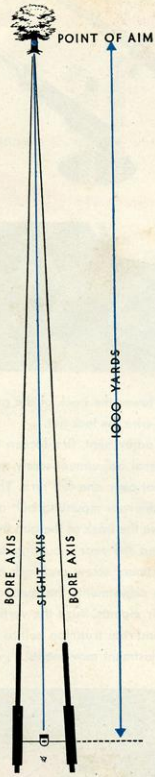
To make a vertical adjustment, first loosen the lock nut on the bottom adjustment bolt. Then turn the vertical adjustment collar just above

the nut to raise or lower the back of the gun. Tighten and safety wire the lock nut.

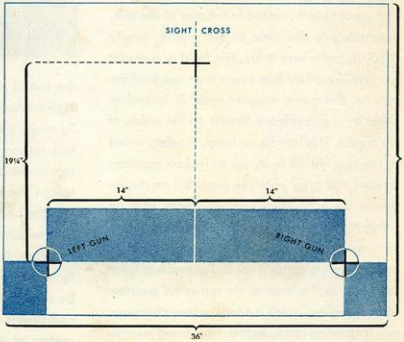
To make a lateral adjustment, first loosen the lock nut on the lateral adjustment screw, and loosen the screw not over one full turn. Then loosen the nut on the rear mounting bolt and turn the bolt to move the back of the gun from side to side. Tighten the rear mounting bolt nut, then the adjustment screw and lock nut. By means of these adjustments the guns can be centered in their mounts. Turn the vertical adjustment collar and rear trunnion bolt to the centers of their adjustment movements.



Harmonizing the Guns and Sight



There are a number of ways to harmonize the guns and sight of the Emerson Bow Turret. The exact procedure will be defined by the Squadron Gunnery Officer. A handy method is to line up the sight and boresight the guns on some small object such as a tree or chimney, at least 1,000 yards from the plane. First line up the sight on the object selected, moving the turret by hand crank until the dot of the sight is squarely on the object. Don't move the turret after this. Then, using a boresight reflector, boresight through each gun barrel while adjusting each gun by its rear mount adjustment collar and bolt assembly until the same spot the sight is sighted on is in the exact center of each gun bore. (A boresight reflector must be used because there isn't enough space in the nose to sight directly through the gun barrels.) Tighten and safety wire the rear mount lock nuts and bolts.



Another method of harmonizing the Emerson is to boresight on a special pattern stand, such as the one illustrated here. Set up the pattern stand level with the guns at least 50 yards from the plane. Center the guns in their mounts. Then line up the sight to center the dot on the sight cross and boresight the guns on the pattern, using the standard technique described in the Sight and Sighting section of this manual. Both methods described here are parallel harmonization.

Loading Ammunition

Two ammunition cans, one for each gun, ride outside the turret along the right and left fuselage wall. Chutes carry the ammunition belts from the cans up through the floor of the turret to the guns. Each can is loaded in the standard folded pattern, starting at the corner of the can farthest from the turret, single-link end of the belt first, rounds pointing toward the outside of the plane.

To get each belt to the gun, force it up through its chute, double-link end first, until the first round starts up the vertical section of the chute into the turret.

Inside the turret, you will find a joint in the vertical section of the chutes (A, B). Break the chutes apart at the joints, and with a piece of hooked wire reach down and haul the belt up. For the next step you will need two extra lengths of belt of about 25 rounds to use as feed strips. First, open the latch on the armor plate in front of you and lift the plate up out of the way. Then drop a piece of hooked wire down the upper chutes (D) and pull the feed strips up over the booster sprockets (C) to the guns, double-link end first. Make sure the rounds point forward. Close the armor panel. Finally, connect the bottom of the feed strips (E) to the main ammunition belts. Make sure that the connecting rounds are evenly shoved into the links. Then re-fasten the chutes at the joints. Just before the takeoff open the armor plate panel again and press the double-link end of each belt into each guns' feedway. Close the armor plate panel, and, after hand charging twice, the guns are ready to fire.

Pre-Flight Routine

. . . follow it step by step

1. Make sure the gun bolts are properly assembled, one for left-hand feed in the right gun, the other for right-hand feed in the left gun. Then remove the two plexiglas gun installation panels on each side of the turret door, and install the bolt, barrel, oil buffer, and backplate groups.
2. Try to rock the guns in their cradles to make sure they are securely mounted. Check to make sure the rear mounting bolts are safety wired and the front gun release handles are safety wired to the gun shields in their up position.
3. Check the charging units on the inside of the guns to make sure their mounting bolts are safety wired and cable connections have cotter pins.
4. Check the foot-firing mechanisms on the guns' buffer tubes to make sure they are securely mounted and safety wired.
5. Check harmonization by boresighting the sight and guns on some small object at least 1,000 yards from the plane, or on a pattern stand.
6. While harmonizing the guns, make sure the manual system is working properly.
7. Inspect the electric cables. Make sure all cannon plug connections are tight and the main switch box is firmly seated. Report any frayed or damaged cables.
8. Check the oxygen connections to make sure they are tight.
9. Inspect the ammunition belts to make sure the rounds are in good condition and properly belted.
10. Load the ammunition cans and force the belts up through the guide chutes until the first rounds start up the vertical chutes inside the turret.
11. Make sure the external power switch on the outside junction box is on.
12. Open the turret doors. Before entering, make sure all switches are off and the azimuth and elevction clutch levers are in their manual position. Then get into the turret, taking two ammunition feed strips with you.
13. Make sure the dome is clean.
14. Test the foot-firing mechanisms by charging the guns, pressing down the foot-firing keys on the back of each gun, and stepping on the foot-firing pedal. Listen for a click as the firing pins release.
15. Pull the azimuth and elevation clutch levers back into their power position. Then turn on the master switch.
16. Turn on the azimuth drive switch. Wait a few seconds, then turn on the elevation drive switch.
17. With one safety switch held down, turn the sight rheostat to check its operation and adjust the brightness of the sight. Flip the sight filament switch to both positions. If either filament of the sight bulb is burned out, replace the bulb. Make sure the optic head is clean.

18. Still holding the safety switch down, check the booster motors by tilting them toward the guns. The motors should cut on and off sharply, without lag.
19. Flip on the gun switch. Check headspace in the guns. Then pull one trigger at a time, charging the guns each time, to check electric triggers for proper adjustment. Listen for a click as the firing pins release. Either trigger should fire both guns.
20. Run the turret in azimuth and elevation at normal speed, then with the high speed button held down, to check on ease of operation. Make sure the turret runs with either safety switch held down. Check the limit stops to make sure the turret stops about 75 degrees on either side of the center line and about 60 degrees above and 50 degrees below horizontal. Watch for any binding in the up or down movement of the seat, sight, and bulletproof glass. Then stop the turret and check for creep.
21. Put on your oxygen mask, connect it, and test by turning on the direct flow valve. Check the gage to make sure there is proper pressure in the tanks, as determined by your crew chief. **Then close the valve.**
22. Plug in your headphones and microphone to test whether your crew mates can hear you and you can hear them.
23. Plug in and test your heated suit and rheostat.
24. Make sure the trouble light works. Pull the light out on its cord to make sure the retractable reel is working properly.
25. Break the two vertical ammunition chutes and pull two feed strips up through the chutes over the booster sprockets to the guns. Connect the feed strips to the ammunition belts in the lower chutes, and close the chutes at the breaks.
26. Turn off all switches, and move the clutches to their manual position. Get out of the turret, and make a last visual check of the turret, inside and out.
27. In flight, press the first rounds into the guns' feedways over the belt holding pawls. Charge the guns on order of the flight commander.

Before Landing

1. Run the turret into its stowing position—guns level and pointing straight forward.
2. Clear the guns by lifting the gun covers and hand charging them twice. Remove all ammunition from the feedways.
3. Shut off all switches and pull the clutches to their manual position.
4. Get out of the turret and close and latch the doors.

Post-Flight

1. Clear out all ammunition from the chutes and cans.
2. Field strip the guns.
3. Clean and inspect the gun casing groups, following the procedure outlined under post-flight checks in the Guns section of this manual.
4. Detail strip the parts removed from the guns, cleaning them and making a thorough check on the condition of their parts, as outlined in the Guns section.
5. Report any malfunctions of turret or guns noted on the mission.

NOTES